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On the Minoan economy: a tribute to 'Minoan weights and mediums of currency' by Arthur Evans

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As early as 1906 Arthur Evans published some weights found in the area of Knossos, which he called Minoan balance weights. Evans was one of the first archaeologists — Tsountas (1890) and Karo (1933) the others — to identify these discoid stone and lead artefacts as balance weights. He invented a way to restore the original weight of the damaged specimens from Knossos (1906, 343–4); in a page of his diary of the 1902 excavation season (FIG. 26.1)[1] we can see his calculations on their weight value. In this paper I intend to pay a tribute to Evans's publication of the weights, as being valuable even 100 years after, because it is aimed at crucial domains of ancient economy: measuring, recording and exchanging.

EVANS'S PUBLICATION OF THE WEIGHTS; AND SOME COMMENTS

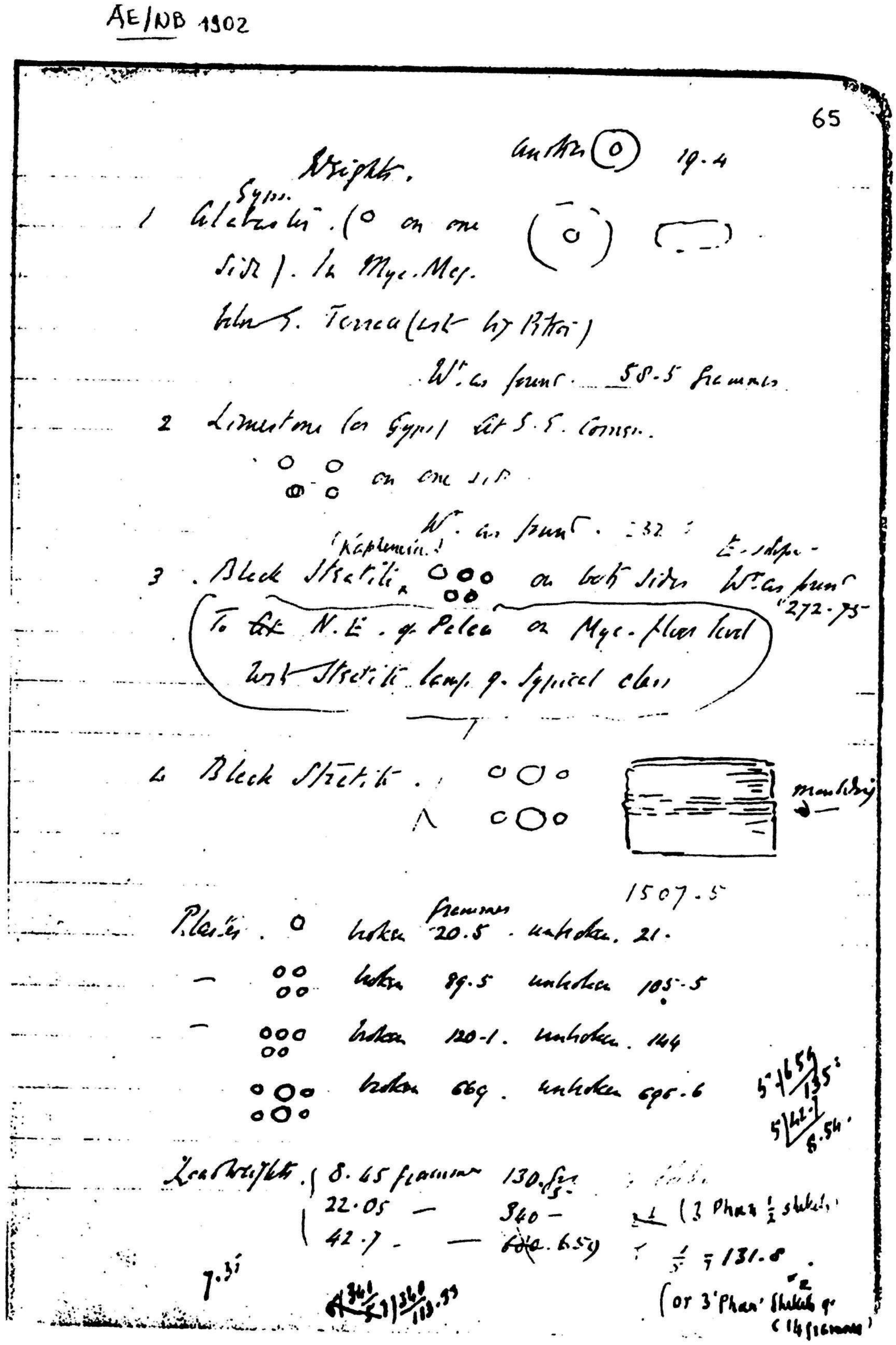
That Evans approached the material not merely from the metrological aspect is obvious even from the title of his contribution — 'Minoan weights and mediums of currency' — and its publication in the volume *Corolla Numismatica*. Subsequently, there has been the suggestion of Nicola Parise (1971) to use the adjective Aegean for the unit. It is true that many more specimens have now been recorded, not only from Cretan sites, but also from the Cyclades and the Mainland, and even as far as Samothrace (Matsas 1995) and Miletus (Niemeier 1999, 553). We have to decide if the system incorporated in these weights (FIG. 26.2) was invented and imposed by Minoan Crete in a trade network; if so, the title Minoan would be justified. On the other hand, the term Aegean is used to mark a contrast between a system or systems expressed by these discoid shaped weights coming from Aegean sites in general and already distinguished by Evans as of indigenous character (1906, 354) but curiously modern in appearance (Evans 1906, 343), as against other shapes of balance weights — such as sphendonoid (a name given by Evans to the almond, olive or barrel shaped weights: 1906, 348) or animal shaped weights that are immediately indicative of different, foreign standards.

At this stage we may add a comment: was the availability of lead from Lavrion the main reason for the extensive use of this material for making the discoid weights that were so useful for weighing bulk non-precious commodities (Petruso 1992, 2)? Or is there any connection at all with the — earlier — appearance, noticed by Buchholz (1987, 174), of some lead discoid weights among the majority of stone sphendonoid ones, at Kültepe in the Kanesh Ib levels, and at Boğazköy (Özgüç 1986, 77–8). It is difficult to infer that there was an earlier Anatolian tradition, working solely from the coincidence that one of them has the weight of almost 60 grams (Petruso's later "Minoan" unit), others have the weight of two "Minoan" units, and another has a value of 1012 grams, like the later double *mina* of the Mycenaean Linear B texts, etc. If such a tradition once existed, we have to seek for some continuity in Anatolia through till the floruit of the Aegean system in the Neopalatial period.

To return to Evans's publication: in the first domain — of metrology — he established the so-called Minoan unit of 65.5 grams, a value later adopted by Caskey (1969) and Parise (1971), while Petruso (1992) reduces it to 61–2 grams. Evans further correlated the Minoan unit with 5 Egyptian gold units of circa 13 grams (this unit, called a "*deben* of gold", having a long history in Egypt) or to 10 half units of 6.5 grams (Evans 1906, 345). Evans's correlations with the value of 6.5 grams are also considered by Zaccagnini (1986, 422), who defines the Aegean standard as the tenth multiple of a smaller unit of 6.5 grams (though this value is taken as a lighter Near Eastern *shekel*).

In the second domain — the recording of measures — Evans identified the octopus stone weight found in the West Magazines area of the Knossos Palace as the official standard of the talent (1906, 342–3). He also commented on Linear B tablet Oa 730 (Evans 1906, 361) — at that time *undeciphered* — where he recognised the sign for ingot, the decimal system of the numerals, and the metrogram for talent (the balance sign). After Emmett Bennett's seminal article on 'Fractional

1 I am grateful to Vasso Fotou for giving me the information and to Sue Sherratt for arranging the permission to illustrate it here.



AE/NB 1902

65

Weights. 19.4

1 Alabaster (○ on one side).

Wt. as found 58.5 grammes

2 Limestone (or Gypsum)

on one side

3 Black Steatite ○○○ on both sides Wt. as found 272.75

4 Black Steatite

1507.5

Plaster ○ broken 20.5 unbroken 21.

broken 89.5 unbroken 105.5

broken 120.1 unbroken 144

broken 669 unbroken 695.6

Lead Weights 8.65 grammes 130.5

22.05 — 340 —

41.7 — 659

(3 Phan ½ shekels

= 131.8

(or 3 'Phan' Shekels of 14 grammes)

Fig. 26.1. Page 65 of A. J. Evans's notebook with calculations and experiments of weight restoring; weights 1–4 = HM 248, 247, 246, 245. Courtesy Ashmolean Museum.

Fig. 26.2. Stone balance weights from Knossos: HM 245, 425, 247, 248. Courtesy Herakleion Museum.

quantities in Minoan bookkeeping' (Bennett 1950) and the decipherment of Linear B in 1952, we are in a position to know the exact total weight of the 60 ingots recorded. What is more, this tablet is proof that, although the manufacture of metal ingots followed rules of standardisation in weight, the actual pieces were in fact weighed before being recorded in the archives, as was the practice in the Near East (Zaccagnini 1986, 414).

In the third domain — of economic transactions — Evans dealt with the antecedent stage to coined money, thus hinting at the problem of estimating value in barter exchanges. He published a silver "dump" from Knossos of 3.6 grams in weight and a gold "skilling" from Mycenae of 22.6 grams, among other metallic units such as bars or rings of metal, all of which he regarded as halfway to coinage (1906, 354–5, 363–4). What is most significant is that he thus correlated the material reality of weight with the economic concept of value. He would have been pleased to see in the future Miriam Balmuth's article on the earliest coins with comments on eighth century gold dumps from Teke north of Knossos (Balmuth 1971, 4; Hood and Smyth 1981. 46), though he might be more in accord with Parise's scepticism (2000, 107), and also interested in the special session at the 99th Meeting (December 1997) of the Archaeological Institute of America, devoted to the subject of the so-called *Hacksilber*, which, whether private treasure or intended for circulation, was precious metal regulated by weight (Balmuth 2001). Recalling the Aristotelian requirements for coinage that it should be metal, weighed and guaranteed (*Pol.* 1257a), we notice that, in the Orient, the first guarantee was stamped as a rule *on the stone weight*, on which a mark of royal authority accompanied the mark of denomination (FIGS. 26.3, 26.5). So Barry Kemp (1991, 248) is right in claiming that the nearest step on the road to money is to be found in these stone weights. Stone weights were meant for accurate weighing of precious metals or aromatic substances, in industry or in economic exchanges (cf. depictions of weighing in Egyptian iconography, to date not frequent in the Aegean art: Michailidou 2000*b*). The lead weights were less accurate but more efficient for weighing heavier commodities, like larger quantities of copper or wool. A comparison in volume between the half- talent lead weight from Akrotiri (Marinatos 1976, pl. 56 *a*) with any Mesopotamian stone duck weight of the same weight would argue in favour of the use of lead to make smaller yet heavier weights.

MEASURING: "NUMISMATIC" EQUIVALENCES IN WEIGHT METROLOGY

In tribute to Evans's work, but in the short space available, I shall try to raise only a few points, concerning mainly the domain of exchange in the pre-coinage economies of the Late Bronze Age. If we turn first to metrology, it would be informative to proceed to comparisons between foreign actual weights and Minoan/ Aegean weight values, looking for the possibility of equivalences among different systems of weight, and so trying to understand one of the parameters defining trade mechanisms between the Aegean and the Orient. Towards this end, some foreign balance weights are cited below, adaptable to a unit in the vicinity of the Aegean one (see Petruso's catalogue [1992, 79–80], for instances of a Minoan unit around 59 to 67 grams).

Egyptian systems

I shall base my discussion on stone weights from Egypt, because some of them are inscribed with the name of the Pharaoh, or of other guaranteeing authorities, together with the indication of mass. It is interesting that we can find among them some examples with the value of 61 to 68 grams — that is in the vicinity of Petruso's or Evans's units.

From the Old Kingdom, a stone oblong weight in the Metropolitan Museum (FIG. 26.3) bearing the name of Userkaf (Dynasty V) and the denomination of 5 *deben* (the circle means *deben*) weighs 68.22 grams, giving the value of 13.64 grams to the gold unit of the period *(L'art égyptien* 1999, 268. 106). In the same museum (Catland 1917, 89, figs. 5–6), a weight of basalt inscribed with a name of Old Kingdom date and the denomination of 8 *deben*, weighs 126 grams (that is twice a "Minoan" unit

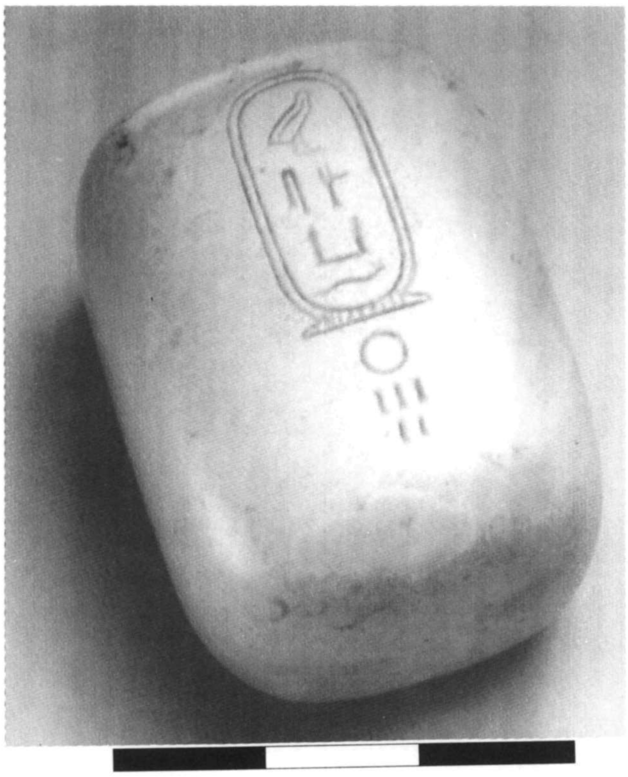


Fig. 26.3 (left). Stone weight with the name of Userkaf, Old Kingdom, Dynasty V: MMA (after L'art égyptien au temps des pyramides 1999, 268. 106).

Fig. 26.4 (below left). Stone weights from Uronarti, Nubia, Middle Kingdom (after Schoske and Kold 1996, 11).

Fig. 26.5 (below right). Stone weight with the name of Amenophis I, New Kingdom, Dynasty XVIII (after Dilke 1987, fig. 44).

of 63 grams), while another of polished porphyry, bearing the inscription "Senusret, given life eternally, 70 gold *deben*", weighs 954 grams, which is very close to 16 Minoan units (or the theoretical weight of a double *mina*).

From the Middle Kingdom, a weight made of dark serpentine from Uronarti, a station on the gold route from Nubia, has the hieroglyphic sign for gold and the indication of 5 units (FIG. 26.4, left). Its weight of 61 grams is equivalent to Petruso's Minoan unit and points to a gold unit of 12.2. It further belongs to a set of six pieces in total, three in Khartoum (FIG. 26.4) and three in Boston, all excavated in a single archaeological deposit: they thus constituted a working set. If we examine their weight values in TABLE 26.1 (after Petruso 1981, 46), we shall see in the last column the variations of the gold standard incorporated in the same set, variations indicating the percentage of tolerance in this system. According to Vercoutter (1977, 437–8): "*l' approximation obtenue par les artisans est déjà remarquable, et on ne saurait être plus exigeant*". We should note that the first two specimens with a value around the Minoan/Aegean unit (of 61 to 66 grams) are both marked as 5 times the gold unit.

From the New Kingdom (Dynasty XVIII), a weight in the British Museum (FIG. 26.5) with the name of Amenophis (Amenhotep) I, the sign for gold and the indication 5, weighs 67.2 grams (that is 5 times a gold standard of 13.44 grams and quite close to a heavier Aegean unit). So, it is obvious that the Egyptian gold standard (of 12 to 14 grams), with a long history in Egypt, where it was dominant till the end of the Middle Kingdom, and with a diffusion in the Levant as well, was still in use, even at the time when, from Dynasty XVIII onwards, a new unit, the *qedet* (or *kite*) of 9.1 grams becomes the rule — along with its tenth multi-

TABLE 26.1: **Gram values of six inscribed weights from Uronarti (after Petruso 1981, 46).**

Object	*Material*	*Inscription*	*Mass (grams)*	*Theoretical derived unit (grams)**
(in Khartoum)	Serpentine	"Gold 5"	61.0	12.20
MFA 24.751	Granite	"Gold 5"	66.3	13.26
MFA 24.750	Serpentine	"Gold 6"	74.5	12.42
(in Khartoum)	Alabaster	"Gold 6"	86.5	14.42
(in Khartoum)	Alabaster	"Gold 7"	92.0	13.14
MFA 24.752	Alabaster	"Gold 9"	116.0	12.89

*Mean theoretical derived unit (grams): 13.06.

ple of 91 grams, again called *deben*, but used for any commodity and not only gold.

If we take into account the current view that the invention of weight metrology is related to the measurement of metals, and in particular gold, it is a valid working hypotheses that the importation of gold (if from Egypt: Warren 1995, 1–2, 6) might bring its weight unit along with it.

We are not yet so well informed about Cretan or Cycladic weights before MM II (see a recent publication of Old Palace material from Malia: Alberti 2000) as to be able to decide about any contemporary equivalents for the weights of the Old Kingdom mentioned above. For the calculations that follow we prefer to leave aside the less reliable lead weights, using only the more accurate stone weights. For the New Palace period in Crete, I shall turn to three stone weights of 60 to 62 grams: two from Knossos (Petruso 1992, 38. **67–8**; cf. in FIG. 26.2 the smaller weight HM **248**) and one from Akrotiri, Thera (FIG. 26.6, right). They are equivalent to 5 times an Egyptian gold unit of 12–12.4 grams and bear an inscribed circle in the centre, perhaps deriving its meaning (as a mere unit indicator) from the sign for the Egyptian *deben*. It could be that the value of 12.4 grams was also the gold unit, at least from the MM II/III period onwards, in Crete and Thera as well. A sphendonoid weight of haematite (of LM III context? [Petruso 1992, 37. **59**]) from Knossos (FIG. 26.7), has exactly the weight of the gold standard of 12.6 grams (Evans 1906, 349–50). In this case I reach the conclusion that any Aegean weight around the value of the Egyptian gold unit should be considered as ⅕ of the Minoan unit — not ¼ as suggested by Petruso (1992, 78. **1**, **59**, **88**, **2**, **3**) — and any variations in the actual weight of the specimens could be correlated to the variations of the Egyptian gold standard from 12 to — even — 14 grams.

If we turn to the other Egyptian unit, used from the New Kingdom onwards for all metals, that is the *deben* of 91 grams (with a variation from 85 to 100 grams), it may be taken into account that half the value of Petruso's unit (that is 30.5 grams) is equivalent to one third of this new Egyptian *deben*. So, an Egyptian haematite weight in the form of an hippopotamus head, in the Cleveland Museum of Art, with a weight of 62.1 grams, represents two-thirds of the Egyptian New Kingdom *deben* and, as Castle pointed out, it is also equivalent to one "Minoan" unit (see Berman 1999, 311. **248**).

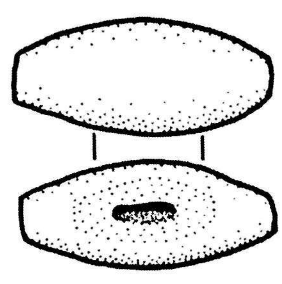


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Fig. 26.6 (left). Stone weights from Akrotiri, Thera. Weight values: 20.2 grams and 62 grams (from left to right).

Fig. 26.7 (above). Sphendonoid weight from Knossos: HM 262 (after Petruso 1992, pl. 6. 59). Scale 1:1.

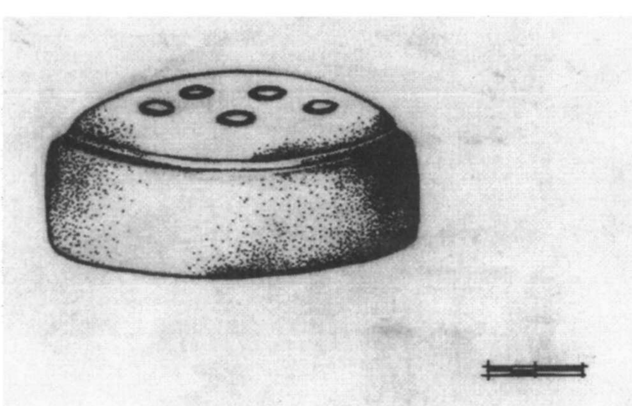
Other Near Eastern systems

The Amenophis weight of 67.2 grams mentioned finds parallels in some heavier Aegean unit weights of Petruso's catalogue (also De Fidio 1999*b*, 43), but at the same time is equivalent to 8 times the Babylonian *shekel* of 8.4 grams. This value of the Babylonian *shekel* can be attributed to some Aegean specimens of stone, like an alabaster disc from Knossos and a limestone sphendonoid weight in the Metaxas Collection (Petruso 1992. 58, 178). The same weight of 8.4 grams also belongs to a stone disc from Ayia Triada, published by Militello (1989). If it is indeed a balance weight, it is significant that it is inscribed with the Linear A fraction of 1/8 (Militello's view), in which case the *official* Minoan standard at Ayia Triada might have been 67.2 grams (at least for the LM IB phase), that is exactly the value of the above weight of Amenophis I (1551–1524 BC). Quite close is the standard of 68 grams, indicated by one or possibly two stone weights from Knossos: one is published by Weingarten (1994) as possibly coming from the Royal Villa, with three holes and a weight of three times 68 grams (204 grams). The other, HM 425 (FIGS. 26.8, 26.2) — of the same material (serpentine) and construction features (a grooved line about the circumference on both sides) — is slightly underweight (present weight 329.52 [-] grams), that is around 5 times the unit (Michailidou 2001*c*, 68). So the muliplers 3 (duodecimal system) and 5 (decimal system) both seem to be valid in the same system; Weingarten is of the opinion that the heavier unit of 68 grams was in use during the Mycenaean period (this would give the silver skilling from Mycenae mentioned by Evans, of 22.66 grams, the value of one third of this Mycenaean unit). Unfortunately, not many of the weights from Knossos have a clear stratigraphical context (Evans 1906; Petruso 1992, 37–8).

Carlo Zaccagnini has done similar research for weights around the value of 65 — or its 1/10 fraction — at Ebla, Nuzi and Boğazköy, and concludes by assigning an identity of its own to a "*shekel*" — or whatever its label — of 6.5 to 6.8 grams, of which the "Aegean" unit represents the tenth multiple (Zaccagnini 1986, 422; De Fidio 1999*b*, 52, 60–1). There is also the evidence of some weights from Ugarit that are recorded as being of "Aegean" standard (Courtois 1990, 120–1). Indeed, it is instructive to consider the dependence of the Ugaritic weight system on foreign trade, as Parise has proposed (1984): in this important trading port, the same *mina* — of 470 grams — was divided (Parise 1984, 128–9; Courtois 1990, 123) into 40 *shekels* for trade with the Hittite Empire (Hittite *shekel* of 11.75 grams), 50 *shekels* for domestic Ugaritic purposes and also for commercial relations with Egypt (the Ugaritic *shekel* of 9.4 grams being near to the Egyptian *qedet* of 9.1 grams), and into 60 *shekels* of 7.83 grams for relations with Carchemish. But this last value was also close to the value of 1/12 of the Egyptian *deben* (of 91 grams), and — what is more — according to Černy this special fraction of the *deben* was the weight (7.6 grams) of a special piece of silver, called *shaty* (or *sniw*) by the Egyptians and used by them as an index of value, or in some cases as a means of payment (Castle 1992, 269). So in Ugarit the *mina* of 470 grams (the western or Syrian *mina* as opposed to the Babylonian *mina* of 504 grams) formed the meeting point for four metric systems, and the differences started at the level of its division into *shekels*. A *mina* of 478 grams was found at Akrotiri (FIG. 26.9) in the foreign, sphendonoid shape. A glance at Petruso's tables shows us his correlations of Aegean weights with multiples of a *mina* (1992, 81–2).

We are still at the beginning with regard to the subject of "numismatic" equivalences between the "Aegean" and the foreign systems of weight (despite

Fig. 26.8. Stone weight: HM 425 (drawing by P. Stefanaki).



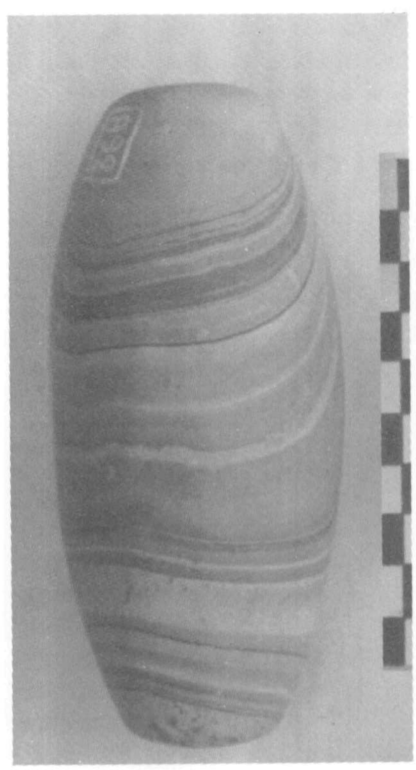


Fig. 26.9. Sphendonoid weight from Akrotiri. Weight value: 478 grams (a Syrian mina).

the fact that in previous articles, mainly by Parise and De Fidio, there are clear references to certain equivalences, e.g. Parise 1997, 5; De Fidio 1999*b*, 59). To proceed further, we have to be very cautious on chronological issues and on variations of the values of the *mina* in Mesopotamia and Syria. There is much to be done in the investigation of *intentional* equivalences. In my view, the best conclusion to date is that there were some particular weight values that functioned as *the keys* for interconnections among the various systems of weight, and actual balance weights were intentionally manufactured of these values. To give an example: the marble disc from Miletus with a weight of 378 grams, marked with six circles, belongs to the Aegean weight system of a unit of 63 grams (Niemeier 1999, 553, n. 120). But it is also equivalent to 45 Babylonian *shekels* (or ¾ of the Babylonian *mina*); this piece could also be used for checking the weight of 32 +⅙ Hittite *shekels* or 40 + ¼ Syrian *shekels* (or Egyptian *qedet*) or 48 + ½ *shekels* of Carchemish (or Ebla). Similar recordings (with fractions) are found in Near Eastern texts. Of course, the above possibilities should be tested against the artefact's cultural and geographical environment, before deciding about its real function; it is obvious, though, that a balance weight of 6 times 63 grams was more flexible than a weight of the unit value.

So, I suggest, that, when we are dealing with a *set* of weights, we should not confine our research only to the detectable mathematical scale because, apart from the abstract mathematical ratios, there may be other parameters defining their individual values, related to their particular function. One factor might be the — possibly intentional — equivalence to a foreign standard (as shown above). Another factor is the occasional particular connection of a specific balance weight with the commodity to be weighed, like wool for example; then its weight value is determined by the special wool-unit it incorporates. For instance, the balance weight from Miletus could also function as the ⅛ of a wool-unit of 3.024 grams (or indicate one half of one sheep's wool produce, at the normal rate of four sheep's produce to one wool unit).

RECORDING MEASURES OF WEIGHT AND ESTIMATING VALUES

I have suggested elsewhere (Michailidou 2001*c*, 55, 68) the use of the term "concrete weighing" corresponding to the term "concrete counting" currently used for the older primitive measuring techniques. What is remarkable is that *concrete weighing*, whether a survivor from earlier times for wool or maybe invented *ad hoc* for saffron (for other candidate commodities see, by way of example, Alberti 1999), was incorporated into the general — abstract — metric system of the Linear B script. For wool one may consult the table of the lead weights found in the West House at Akrotiri (Michailidou 1999, 103), most likely intended for weighing wool in a weaving workshop (Michailidou 1990). This is also the case of the special units *QI* and *RO*, used for weighing saffron, though again, like LANA (the wool unit), they easily form part of the general Linear B accounting system for weight (see by way of example the tables of quantities of saffron in Linear B tablets, in Michailidou 2001*c*, 72–3).

Two questions emerge. The first is why did the Minoan/Aegean system use as its base unit not the value of one (Egyptian) gold standard but its fifth multiple? One answer might be that this heavier unit was also meant for other (than gold) metals (cf. the Egyptian Middle Kingdom unit for copper, of a value two times the *deben* of gold: Vercoutter 1977); a heavier unit was more practical in accounting greater quantities of non-precious metals. Another, tentative, answer might be that the Minoan unit of 62 grams could check the value both of gold (5 gold *deben*) and silver (8 *shaty* — if this unit existed also before the Ramesside period), while the heavier unit of 67 was equivalent to 8 Babylonian *shekels*. So this unit could function as one of the keys for interconnections mentioned above (see also De Fidio 1999*b*, 44).

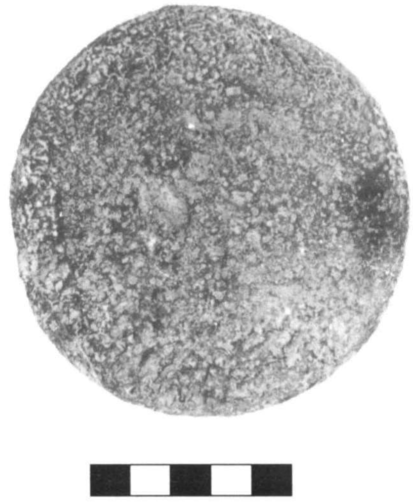
A second question, already posed by Petruso (1992, 63): why is there no special sign for this Minoan unit in the — later — Linear B script? And I would like to add to this second question the comment that there is also no sign for the value of the *mina*, the Near Eastern unit of 470 to 504 grams, though its presence is underlined by the metrogram of the double *mina*, called conventionally *M*, which seems to be the dominant unit in the Linear B system of weight recording (Petruso 1992, 19, table 1). If we turn to the sets of weights found in Akrotiri, no piece has so far been found with the value of one *mina*, except the sphendonoid weight mentioned above (FIG. 26.9), to which we can assign the value of a North Syrian standard of around 470 grams (Vargyas 1998, 310), while, on the contrary, there are weights at Akroriri (such as FIG. 26.11) with the value of the — later — double *mina* (*M*) of Linear B. But the weight value of one *mina* could be achieved by two weights of the value of the Linear B metrogram conventionally called *N* (*c.* 250 grams), and in fact there are two lead discs of this weight in the set from the West House (Michailidou 1990, 416). So what is the answer to the second question? I think it is that weight measuring and weight recording are two correlated processes but with different requirements, so that they do not always have to coincide. In practical terms it was the way of recording that differed between the two scripts Linear A and Linear B; there was no radical change in the system itself, which continued to calculate with the old Minoan unit (for discussion on this subject see Parise 1996, 1270; Aravantinos 1995; De Fidio 1999*a*, 204; also Chadwick 1976, 105). This is obvious in the table of the heavier Akrotiri weights of the Linear A period (Michailidou 1999, 103) that were adaptable to a theoretical Linear B recording frame. So, if we now turn to the subject of accounting, we shall proceed from Evans's contribution (1906) to Emmett Bennett's recent article and follow his question (1999, 168): "Why did the two different scripts of the Bronze Age in the Aegean, Linear A and Linear B, have two different accounting systems, when each one was sufficient in itself?" In other words, why this change from fractions of a larger unit (in Linear A: Bennett 1950, 1983) to multiples of integer fractional quantities (the Linear B metrograms for measuring weight and capacity)?

First, we must emphasise that the old Minoan unit of 62 grams is concealed behind the written quantity of 3 times the metrogram *P* (as calculated by Chadwick, 1976, 104). The quantities *P* 3 (one Minoan unit) and *M* 1 (one double *mina*) are respectively the lowest and highest amounts of gold contribution mentioned in Pylos tablet Jo 438 (Chadwick 1999, 33). It is instructive to see what gold items could have been offered of the above weight value: in the National Museum at Athens, for instance, the weight of cup NM **6441** from the tholos tomb at Marathon (FIG. 26.10) is 66.7 grams, and of goblet NM **351** from Shaft Grave IV of Grave Circle A at Mycenae 1004 grams. We could also mention the weight of cup NM **629** from Shaft Grave V of 254 grams, equivalent to the value of the metrogram *N* in Linear B (Michailidou 2001*b*, table 2 and figs 18, 7, 11; cf. also Palaima 1999 for the gold cups of Knossos tablet Tn 316).

So the answer to the second question (and to Bennett's too) might be that, in the Mycenaean system of weight in so far as it was a continuation of the Minoan one, the ratios were not changed when the recording method was transformed into a more flexible system (using integer numbers instead of fractions) as needed by the more centralised economy of Linear B times: for accounting greater quantities, the scribes moved the basic *recording* unit from the 62 grams (FIG. 26.6, right) to the *c.* 1000 grams of the double *mina* (*M*), a weight value also found in sets of weights of the Linear A period (FIG. 26.11) and, *en plus*, a unit of weight frequently used in official records from Mesopotamia to Anatolia. So *M* became the basic accounting unit. And the opposite: in other cases the scribes of the Linear B tablets preferred to record with the smaller (than the Minoan unit) value of *P*, a ratio also previously existing as indicated by its material evidence at LM IA Akrotiri (FIG. 26.6 *left*) and MM II Malia (Alberti 2000, 60. MA 03); it could have functioned as a special unit for more accurate weighing, since both the above pre-Mycenaean specimens have an inscribed mark, possibly emphasising their function also as a special unit: the first bears a triangle (an indication of its ⅓ relation to the Minoan unit: Petruso 1992, 61), and the second a circle recalling the *deben* sign which, according to Cour-Marty (1983, 29), at first simply meant *the unit in general*. This lower unit of ⅓ of the Minoan standard was useful in measuring small quantities of precious metals. As an example we can take the weight of a Mycenaean necklace of 22.8 grams or of the earrings of 20.06 grams (FIGS. 26.6 *left*, 26.12). So it is not unreasonable that measurements in units of *P* would occasionally be summed up in Mycenaean tablets as a total in quantities of *P*, thus resulting in records even above *P* 12 (currently estimated as the ratio to *N*).

All the same, was its usefulness for weighing gold or silver (or saffron) the only reason for the preference for this smaller unit? I take the answer from Evans: he explains the value of 19.4 grams of his weight 7, again bearing a mark of a single dot (Evans 1906, 346; cf. Petruso 1992. 62), as representing a double *qedet* of the full weight of 9.7 grams. As mentioned before, the *qedet* had a value close to the Syrian *shekel* of 9.4 grams. Unfortunately, we do not have a clear chronological date for the Knossos weights. But if we can be sure that the unit *P* of the Linear B system really had a value around 20 grams, then it could be useful for roughly estimating value (e.g. of the above earrings) in at least three metric systems, as being close to 2 Egyptian *qedet* or 2 Syrian *shekels*. Since, in Egypt, gold began from Dynasty XVIII to be accounted in the *qedet* system, the

Fig. 26.10. Gold cup from Marathon: NM 6441 (after Demakopoulou 1988, 125. 59).



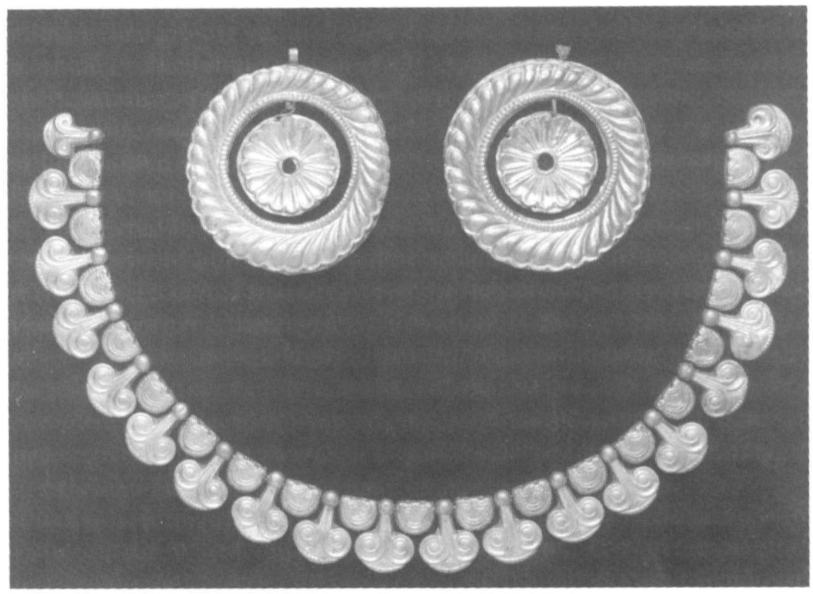


Fig. 26.11 (above left). Lead weight from Akrotiri. Weight value: 987 (-) grams (underweight).

Fig. 26.12 (above right). Gold necklace and earrings from Dendra: NM 8748, 8745 (after Demakopoulou 1988, 219. 196–7). Scale c. 1:2.

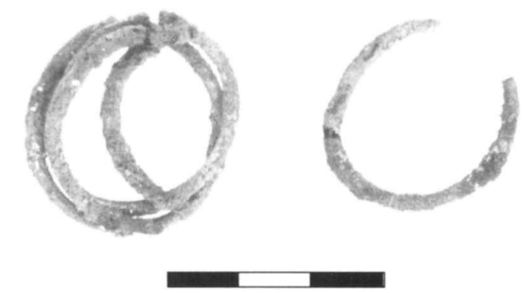


Fig. 26.13 (right). Silver rings from Akrotiri.

correlation to this new Egyptian system, as well as to the Syrian *shekel*, might be the reason for the preference for *P* units in Linear B accounting, and for the recording of the value of the old Minoan unit — still functioning — as 3 times the metrogram *P*. De Fidio may be right in explaining the change of the equivalence: 6.525(y) × 10 = x (65.25) to 6.525 (y) × 3 = P (19.575), as pointing to a change from the decimal to a duodecimal system that characterises the eastern *koine* of this later period (De Fidio 1999*a*, 204).

In order to proceed, we must turn to manufactured objects, to investigate for instance the weight values of the gold and silver miniature axes from the Arkalokhori Cave[2] which may represent a medium of currency, a suggestion I intend to elaborate elsewhere in the future.[3] Needless to say, the same may apply to some instances of copper circulation (the non-functional copper axes from the peak sanctuary at Juktas will also be of help to this subject[4]), because while *silver* was the prominent metal used as an index of value and reserve, we do not know how widely silver circulated in the Aegean (cf. FIG. 26.13: silver rings from Akrotiri, possibly in the role of currency). Surely copper was easier to procure and we know — from Eastern sources — that copper vessels were used as means of payment, along with smaller quantities of metal or scrap material (Sherratt and Sherratt 1991, 360; Kemp 1991, 250; information in Michailidou 2000*a*, 198–200, 2001*b*, 98–9). Hence the close relation between Weight and Value, a work in progress.[5]

One thing is certain after all these mathematics: that merchants in the Aegean, Egypt and the Levant could negotiate in foreign trade while using their *own* balance weights (Kemp 1991, 253; Pulak 1998; Michailidou 2000*b*, 145) and were in a good position to reach a mutual understanding in the estimation of the value of the foreign objects exchanged (see also Zaccagnini 1986, 422). So let us end with the owners of the balance

2 I am gateful to Loeta Tyree for providing me with her measurements of weight in the Herakleion Museum.

3 I thank Malcolm Wiener for drawing my attention to this material. A paper on metal non-utilitarian axes is to be published in the proceedings of the *Metron* conference (April 2002) in *Aegaeum*.

4 I thank Alexandra Karetsou for permission to weigh them.

5 The full title is *Weight and Value: Material and Textual Evidence from the Aegean, Egypt and the Near East*, and is in preparation by the writer.

weights. It is obvious that everyone involved in any kind of transactions would need them more or less. But if we decide to speak only about the merchants, carrying with them the "merchant's leather bag for weights" (Nemet-Nejat 1998, 282), should we not also decide about their cognitive equipment (Michailidou 2000*a*, 205–6)? They should have had training in mathematics, when involved with long distance trade. In the Rhind mathematical papyrus, there is only one problem concerning weighing activity (Robins and Shute 1987, 50): this problem asks for the values, expressed in *shaty* of silver, of three kinds of metals — of the same quantity — contained inside a bag. But apart from the scribes (depicted in Egyptian paintings as surveyors of weighing), could the merchants themselves *write* accounts? In letters kept by the Old Assyrian traders at Kültepe, there is clear reference to one — at least — member of the family firm being trained in script (Michel 1998, 250). So, apart from the problem of the status of Aegean traders — whether agents or merchants (Warren 1991; Kopcke 1987, 2000; Wiener 1991; Michailidou 2000*a*) — what was their relation to literacy? I deal with this subject in relation to some evidence from Akrotiri, the trade city of the "*nouveaux riches*" (C. Doumas's expression); the evidence consists of some makeshift inscriptions, one of them on a local amphora in a merchant's (?) cellar, and the conclusion is that people involved in trade could, if not write, probably understand the accounting records — at least at the level we ourselves understand today the undeciphered Linear A tablets: the numbers, and presumably some ideograms, those in which they were interested in, on a given occasion of exchange (Michailidou 2001*d*).

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