Record book of journeyman Kratz, 18th century (Deutches Apotheken-Museum, Heidelberg; museum guide, fig. 10). The balance as an instrument for comparing the mass between two products –its use without balance weights is considered an old tradition– never ceased to be used for relative measurement as well.

SCRIPT AND METROLOGY: PRACTICAL PROCESSES AND COGNITIVE INVENTIONS*

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> '*Mathematics and Writing have, it has become clear in recent years, a close, symbiotic relationship. Born at the same time, their destinies have always been closely linked, even if the latter has to a large extent –and long since– liberated itself from the constraints of the former.*'[1]

INTRODUCTION

Researchers have been much concerned with the relationship between counting and writing. It has been argued that writing was the 'by-product of abstract counting',[2] which is tantamount to accepting that writing did not exist in the preceding stage of concrete counting.[3] First of all it is important to clarify what we mean by the term writing, whether we are referring to an inscription (in the sense of word or text) or simply to a sign. In both cases, particularly when an unknown script is concerned, there is also the possibility of signs having an aesthetic function. Writing is not only a cognitive invention but also an art form.[4]

Alexander Marshack is probably right in maintaining that the first thing man measured was time,[5] the Palaeolithic incisions on bones –which count the moons– record the result of concrete counting. Schmandt-Besserat distinguished the concept of 'computing' (which also subsumes the above action) from the concept of 'accounting', and attributes in principle the first to egalitarian societies and the second to ranked societies. She considers the system of 'tokens' as the first evidence of 'accounting',[6] it seems that the system of tokens further led to the first tablets of which the earliest examples –from Uruk– are also the first numerical texts.

The above views inevitably lead us to the thought that man began to write in order to record the results of counting. Script is therefore considered as an invention to serve the needs of bureaucracy[7] and is linked with the centralizing regimes. However, just as we can distinguish various stages in counting (e.g. one-to-one correspondence, concrete counting, abstract counting),[8] so we can in writing, which is not necessarily associated only with the stage of the

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[1] Benoit *et al.* 1992, 3.

[2] Schmandt-Besserat 1992, 199.

[3] On the terms abstract and concrete counting, see indicatively Schmandt-Besserat 1996, 112.

[4] Cf. the phrase 'the art of writing', in Evans 1921, 636.

[5] From Schmandt-Besserat 1996, 101.

[6] Schmandt-Besserat 1996, 103.

[7] The study of sealings has led in the same direction, namely that 'record-keeping was a phenomenon that preceded writing' (Response by J. Aruz, in Palaima 1994, 331).

[8] Schmandt-Besserat 1996, 112.

texts in the tablets, which represent a highly organized textual 'system'.[9] In my view the individual signs of the script are linked –as cognitive function– with the so-called 'potters' marks' that appear as early as the Neolithic Age, and writing is a means of expressing diverse subjects (ownership for instance) rather than a solely bureaucratic tool. On the contrary, the development of writing into a recording system acceptable in a wider domain and the invention of the metrical system for the same purpose, are both objectives of a central authority.

In this chapter I shall discuss the advanced stage during which metrical systems developed. The reference to the above issues was made because we shall face the problem of the continuity or not of 'primitive' methods of counting and calculating. For example, it is not certain that the method of 'tokens' was abandoned –at least as intellectual practice– with the establishment of writing,[10] after all, both historians and ethnologists give us examples. The practice of counting with pebbles still exists today among certain peoples[11] and Herodotus (IV.92) mentions the characteristic case of calculating the size of Darius's army by estimating the volume of accumulated stones deposited by the soldiers as they passed by.[12]

So, the term 'practical processes' in the subtitle of this article means ways of practical calculation and related signification, methods which we believe continue to be used to a certain degree in parallel with systematic bureaucratic recording.[13] Whereas in the term 'cognitive inventions'[14] we include the devising of the metrical system and especially the system of measuring weight. Powell believes that in Mesopotamia this is the latest of the three metrical systems (of length, volume and weight), and it is interesting that he considers the other two as antedating the 'invention' of writing.[15] He also refers clearly to 'metrological organizers'. Kopcke also notes that: '...to proclaim standards by which things can be weighed and measured appears to be a time-honoured prerogative of central authority'.[16] It is, moreover, characteristic that the invention of measuring weight using a balance is attributed by the Egyptians to the god Thoth, the inventor of writing and of mathematics. In the *Instruction to Amenemore* we read:

'The Ape sits by the balance, his heart is in the plummet;
Where is a god as great as Thoth,
Who invented these things and made them?'[17]

The view has been expressed that the invention of the balance scale with two pans perhaps preceded the invention of weights.[18] The balance-scale permitted first of all the comparison of two quantities that had to balance the horizontal axis (beam) of the scale, thus confirming either

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[9] Particularly interesting in this respect is the discovery of the wooden tablet at Dispilio, see Χουρμου-ζιάδης 1996 and the chapter by Marangou in this volume.

[10] See also Oates 1993, 151 on the complex tokens.

[11] Such as the example of the shepherds in Iraq, cited by Oates (1993, 149).

[12] From Bennett 1992-93, 334, where another two cases of practical calculation in Herodotus and Homer are cited.

[13] I am grateful to I. Tzachili for first pointing out this phenomenon, in expressing similar views about the clay cylinders from Akrotiri, Thera, at the two-day colloquium on the 30th anniversary of the excavation, held in the Archaeological Society at Athens, 19-20 December 1997.

[14] Influenced by the term 'Cognitive Archaeology', introduced by C. Renfrew (1983), which also includes the ponderal system as a subject of study.

[15] Powell 1971, 208-209.

[16] Kopcke 1987, 257.

[17] English translation of the Egyptian text, from Lichtheim 1976, 156. The ape is one of the epiphanies of the god. The plummet is the pendent stone or lead weight that constituted a technological improvement of the accuracy of the balance-scale in the age of the New Kingdom.

[18] See by way of example Μιχαηλίδου 2000, with relevant bibliography.

equal parts of the same product,[19] or double a given quantity (that is the sum of the content of the two pans). At the level of relative measuring, a stone –of suitable weight– in one pan is verification of the quantity that was placed in the other pan. However, the absolute measurement of mass demands the standardization of the stone weights and their inclusion in a metrical scale, and this is linked with workshop and bureaucratic needs. The invention of balance weights was linked with the weighing of gold[20] and with the development of metalworking in general, since metals are a non-fluent material and therefore cannot be measured using measures of volume. Consequently, we can consider that measurement with the help of balance weights began with the stage of 'concrete counting', and so introduce the term 'concrete weighing' for the measuring of gold. Moreover, the Egyptian unit of gold (about 13.5 gr.) is considered as the oldest and most enduring ponderal unit.

That the balance weight is in essence the stone that measures emerges easily from the words themselves: In Akkadian it is called *abnu* (= stone), while the dominant ponderal unit in Mesopotamia (and subsequently in the Orient in general) is *manu* (Sumerian MA-NA) which means 'count or counter'[21] (from which the Greek word *mna* derives). Therefore the original method of calculation with the help of a stone remains as a concept. As man modified the stone's natural weight, to achieve the desired weight, he gave it different shapes, more varied in Egypt and with a greater tendency towards standardization in the Near East, ending up with shapes (such as the bullet or barrel-shaped weights, the duck-shaped or zoomorphic weights in general)[22] that helped the ancient user (and the modern researcher) to recognize their role and sometimes even the system to which they belonged. Of these, the disc shape (Fig. 2) is particularly characteristic of the so-called 'Minoan' ponderal system, from the late Middle Bronze Age onwards. The reasons for this preference should perhaps be investigated, as well as the eventual use of metal –lead– for making many of these weights.

The most obvious relationship between writing and weighing is apparent in the cases of inscriptions on weights, both Egyptian and Near Eastern ones. Such inscriptions may denote the weight, the name of the king, the name of the deity, the name of the owner and so on. However, the percentage of inscribed weights is small in relation to their total number,[23] and there are cases of simple signs, such as plain lines or geometric shapes.[24] Since there are even fewer instances of inscriptions on Aegean weights (and these undeciphered), it is pertinent to collect together the existing data from the Aegean world.

AEGEAN BALANCE (?) WEIGHTS WITH INCISED SCRIPT SIGNS

It is well known that some of the (disc-shaped) balance weights found in the Aegean and dating from the Middle and Late Bronze Age bear diverse incised signs, usually referred to as denominational marks.[25] This designation had been proposed by Evans[26] for certain balance

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[19] This does not mean that the balance-scale ceased to be used for comparison of quantities without the use of balance weights. There are several examples from ancient Greek vase-painting; perhaps the possibility that this is for monitoring standardized packing of commercial products should be investigated.

[20] Skinner 1954, 779.

[21] Powell 1995, 1955.

[22] See *in passim* Petruso 1992 and work in general on metrical systems of Egypt and the Orient.

[23] Cour-Marty 1985.

[24] Petrie 1926.

[25] Petruso 1992, 61, table 27.

[26] Evans 1935, 650-655.

weights in the Herakleion Museum (cf. Fig. 1), as well as by Petrie for some balance weights from Egypt.[27] These signs (Fig. 3) in comparison with potters' marks[28] or masons' marks display less variety and appear to contain a 'mathematical message' of inclusion in a given system. The commonest case on balance weights is small circles (to a lesser degree triangles or the cross) and the number of circles has been interpreted sometimes as a multiple and sometimes as a fraction of the 'Minoan' (according to Petruso) or 'Aegean' (according to Parise) basic ponderal unit of 60-65 gr.[29] These signs have little to do with script, even though this is not entirely absent: a few specific cases exist, for which reason we shall focus our interest on those balance weights bearing at least one sign recognizable as a script sign.

1. The large lead disc-shaped balance weight from Mochlos (Fig. 4)

I begin with the most certain case of an inscription incised on a real balance weight, namely the largest of the 11 lead weights recovered from the old excavations by Seager at Mochlos and now in the Herakleion Archaeological Museum.[30] This weight is 11 cm. in diameter and weighs 1,458 gr.[31] The inscription was revealed much later, in the course of cleaning the oxidized incrustation from the weight, and was published by Olivier. The inscription **MO Zf 1** includes the following Linear A signs:

A 333 - AB 31 - AB 23

or

AB 18 - AB 31 - AB 23

and is a *hapax* in the inscriptions known to date.[32] It ends with a 'punctuation mark', while on the same side of the weight there are five vertical lines.[33] The incision[34] is shallow, giving the impression that the inscription post-dates the making of the weight (contemporary or not with the lines?).[35] What might this mean?

On the other side the weight bears a deeply incised cross sign that was made while the lead was still soft and whose presence was therefore planned from the outset (this is reinforced by the fact that strips of lead added later to adjust the weight were applied over the cross). Theoretically the cross could be included among the signs denoting mass; Petruso suggests that it indicates the multiplier 24 of the Minoan unit of 60 gr.[36] Since the same sign (cross) appears on the smallest weight in this group too (weight 19 gr. = 1/3 of the Minoan unit, cf. the three dots on the other side of the same lead disc), Petruso sought an explanation in the possibility that the cross on the smallest weight denotes 1/24 of Evans's *mna* of 483 gr.[37] But even if we accept that the cross can denote both the denomination 1/24 and the multiplier 24, this must have applied on a limited

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[27] Petrie 1926, 5.

[28] See indicatively Bikaki 1984, 9.

[29] Petruso 1978, 1992; Parise 1971.

[30] Petruso 1992, 40-41, context unknown. Others have been found in more recent excavations, see indicatively Brogan 1998, 391.

[31] Petruso 1992, 41, no. 84 (Herakleion Museum inv. no. 83).

[32] Olivier 1989, 145.

[33] Olivier 1989, 140-141.

[34] To be precise, the signs are '*ciselés et non pas gravés*' (Olivier 1989, 141).

[35] Olivier (1989, 139) also believes that the inscription is not necessarily contemporary with the making of the weight and that we could perhaps accept '*une datation plûtot basse pour l'inscription...*'.

[36] Petruso 1992, 41.

[37] Petruso 1992, 42.

scale (perhaps local?) because on a disc-shaped balance weight –of stone– from Zakros[38] the same ratio (24 x 60) is marked in a different way: by two large circles (for number 20) and four small ones (for number 4).

Could the cross be related in some way to the script signs, AB 02 (Linear B phonetic value: *ro*) or A 702 (a fraction)? There is an additional line in the incision, parallel to one of the arms of the cross, and another trace (Fig. 4).[39] The weight of the balance weight, about 1.5 kg., is close to the value of half the special unit –in the Linear B records– for weighing wool (*LANA*), which was equivalent to 3 kg.[40] Could the cross, as inscribed in the circle of the weight's circumference, denote the participation of the object bearing it in the metrical system for wool, since in Mesopotamia a cross inscribed in a circle was the abstract sign for the sheep?[41] There is, however, a large time interval to account for. The script sign no. 77 of Linear A and Linear B (cross inscribed in a circle) is the acrophonic (phonetic value *ka*) of the word χλαρῇεις (*ka-ra-re-we*), which characterizes stirrup jars in the Linear B tablets, and this sign *ka* is drawn both in the ideogram of the stirrup jar and on the shoulder or the belly of actual stirrup jars[42] thus indicating that these vases were for oil;[43] it is reasonable to expect the same indication by the cross-inscribed in a circle on the shoulder of a Canaanite jar (Fig. 5) found at Akrotiri.[44] But if the sign denotes oil, I should point out that oil is not among the products that are weighed but is measured in units of volume,[45] so there was no need for such an indication on a balance weight. I think it is more likely that the cross sign on balance weights has a taxonomic value (that is it assigns the weight to some kind of category) than that it constitutes a numerical symbol.

2. Stone disc-shaped balance weight from Knossos (Fig. 6)

This particular balance weight, 4.3 cm. in diameter and of weight 96.4 gr.(-) comes from the area of Hogarth's House A on Gypsades hill (LM IA period)[46] and bears on one side two (?) Linear A signs (inscription **KN Zg 21**):[47]

AB 41 - AB 07

Godart and Olivier present the inscription as consisting of just one sign, that is the composite sign A 528, which derives from the complex of sign AB 41 and AB 07.[48] Another four cases of a

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[38] Petruso 1992, pl. 8, no. 86.

[39] See description by Olivier 1989, 140.

[40] This ponderal unit of 3 kg. most probably existed even in the time of the Linear A script, cf. Michailidou 1990, 416. Parise (1994, 14) is of the opinion that the cross on this balance weight indicates ¼ of the value of a double *LANA* unit.

[41] Nissen 1993, 60.

[42] The other viewpoint is that it represents '*ro?*', as Hallager & Vlasakis 1976, 216 argue for three stirrup jars from Knossos, on which the cross is incised within the disc of the false mouth. On the motif of the cross inscribed in a circle, painted on the body of stirrup jars see Raison 1963, 136-137. Of course, other stirrup jars were for wine, cf. the inscription *wi-na-jo* on stirrup jars from Midea, Knossos and Armenoi: Shelmerdine 1997, 565 and note 173, for the bibliography up until 1997.

[43] *Documents*, 551.

[44] *Prakt* 1994, pl. 84β. Doumas compares the sign on the Canaanite jar with the letter *kap* in the Protocanaanite alphabet (*Prakt* 1994, 161).

[45] I also add *karpatu*, Akkadian name for the transport vase of measured capacity (Powell 1989, 504) and the Babylonian measure of volume *qa* (Thureau-Dangin 1921, 128ff.) as working hypotheses for further research on this sign on stirrup jars and the Canaanite jar.

[46] Petruso 1992, 38, no. 69, with relevant bibliography on its publication.

[47] *GORILA* 4, 164.

[48] *GORILA* 5, xxiv, xxxv and 159.

complex of sign 41 perpendicular to other Linear A signs are mentioned, which give the composite signs A 529, A 530, A 531, A 532, while in other cases sign 41 is linked horizontally to give complexes such as A 533 or A 590.[49] Consequently it could be a monogram and not an inscription of two signs. Nonetheless, I am intrigued by the fact that in Kea there is a potter's mark exactly the same (that is a combination of a horizontal line with three vertical lines) as the sign above the AB 41 on the Knossos weight, and Bikaki's observation that certain potter's marks at Kea are similar to corresponding signs on lead weights from Kea is interesting in this respect. I add, however, that the signs she parallels occur on imported pottery.[50]

3. Rectangular fragment of schist from Hagios Stephanos, Lakonia (Fig. 7)

The stone, of dimensions 4.21 x 1.9 x 0.62 cm., has four smooth surfaces with rounded edges but is broken at both ends. It bears two incised Linear A signs and is dated most probably to early Mycenaean times (LH I-IIA). I mention this piece because the hypothesis has been proposed that it may have been a balance weight: its weight is 9.8 gr.[51] The publisher of the object states that: 'it is difficult to believe that anything has been lost at the ends, but surprising that these ends are not neatly finished like the other surfaces', and mentions the possibility that the likewise rectangular object –of clay– from Kythera may also be a balance weight (see below no. 4). The inscription on the schist object from Hagios Stephanos (**HS Zg 1**)[52] is:

AB 08 - AB 80

and with the phonetic values of Linear B can be read as *a-ma*.[53] According to Ventris and Chadwick the word occurs in Linear B tablets recording large quantities of grain, therefore it perhaps means harvest there, deriving from the verb ἀμάω, which means to reap, as well as to cut, to cut off (in middle voice ἀμάομαι, meaning to collect).[54] It seems that the first sense was to cut or to reap and the concept of gathering was secondary. Of interest is the phrase in Hesiod «ἤμησαν καλῶς» which means they tried their luck.[55]

4. Clay weight from Kythera (Fig. 8)

It is possible to identify a Linear A ideogram with a sign-fraction (?) next to it, on a *peson en argile* from Kythera, found in a MM IIIB horizon; unfortunately the object is not intact and so its original weight is unknown. Although well made, its material (clay) does not advocate its use as a balance weight and it bears two holes. It could be a loom-weight. It measures 5.8 (pres. length) x 5.6 x 4.8 cm. and the inscription (**KY Zg 1**) comprises:

AB 120 and the Linear A fraction E, giving the composite sign A 581.[56]

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[49] *GORILA* 5, xxiv-xxv.

[50] Bikaki 1984, 9, 4: 'Composite marks survived in Keos into the early part of the LBA, and always on imported pale ware... They are of special interest because they are similar to marks on lead weights found in Keos, ...and therefore might be interpreted as expressing values of measurement'.

[51] Janko 1982, 98, 99.

[52] *GORILA* 5, 16.

[53] See Janko 1982, 100. Ἅμα is an adverb that denotes synchronization of two actions (see Liddell & Scott, *s.v.*), but there is the possibility that it is the Doric type of the ancient Greek word ἀμή which means shovel or pick or hoe or even a little bucket for drawing water (see Liddell & Scott). The Akkadian word *ammatu* denotes a measurement of length (Thureau-Dangin 1921, 133). Was it perhaps a broken 'yardstick'?

[54] *Documents*, 530; cf. Killen 1994-95, 333: '*a-ma e-pi-ke-re*' = harvest at hand.

[55] Liddell & Scott, *s.v.* ἀμάω.

[56] *GORILA* 4, 166; 5, xxv and 274.

It could perhaps be regarded as an indicator of a fractional quantity of AB 120 (= barley).[57] However, the sign's possible affinity with the incised potter's mark on the second Canaanite jar (Fig. 9) from Akrotiri, Thera,[58] should be investigated; in this case it might function as a label perhaps denoting a product analogous to the content of the jar and not a weight.

5. Lead disc-shaped balance weight from Akrotiri (Fig. 10)

The weight is 3.7 cm. in diameter, weighs 86 gr.(-) and bears an incised sign that can be identified as AB 31, with the reservation that the three arms are of equal length. In Linear B the ideogram *31 denotes flax (its phonetic value SA is also the acrophonic of sa-sa-ma). Flax is measured by weight in the Knossos tablets but we do not know if *31 had the same meaning in Linear A.

6. Stone disc-shaped balance weight from Zakros

The object is of limestone and weighs 220 gr. Incised on one side is a sign that is perhaps an ideogram of cloth; on the other side are six small circles.[59] The sign on one side is associated with the Linear B ideogram *164, occurring on the tablet L 520 (Fig. 26, first sign on the right). On tablet L 698 the same ideogram is introduced with the term pe-ko-to therefore it denotes a special type of cloth.[60] Since the balance weight is of MM III date (it was found in a room of Hogarth's House H), we are more interested in the appearance of the same ideogram in Linear A, with four variants (*164 a-d).[61] This is found incised on 'roundels'[62] at Chania and there is only one stamp on the circumference of the roundel in the examples known so far.[63]

7. Stone disc-shaped object from Hagia Triada (Fig. 11)

A sign that perhaps represents a Linear A fraction is incised on a disc-shaped object of steatite, perforated with a hole at the centre, of diameter 3.15 cm., height 0.5 cm. and weight 8.40 gr. Its terminus ante quem is LM IB.[64] The publisher precludes its interpretation as a pendant, an amulet, a loom weight or a spindle whorl, and suggests that it was most probably a balance weight. He believes that the hole was perhaps used for keeping it on a string, together with others of the same system. He parallels its weight with the disc-shaped alabaster balance weight from the Palace of Knossos (8.54 gr.),[65] with a lead balance weight from the same site (8.45 gr.)[66] and, primarily, with a sphendonoid limestone weight in the Metaxas Collection, in the Herakleion Archaeological Museum (8.40 gr.).[67] The comparison of the weight of the disc-shaped object with stone balance weights is more reliable (in contrast to comparison with metal balance weights). Militello believes that instead of comparing it with the Babylonian shekel

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[57] On the interpretation of the ideogram see Palmer 1992.

[58] Prakt 1994, pl. 83β.

[59] Petruso 1992, 42; Hogarth 1900-01, 136; Evans 1935, 662.

[60] Documents, 321.

[61] GORILA 5, xliv-xlv.

[62] GORILA 5, 279.

[63] Hallager 1996.

[64] Militello 1988-89, 163-172.

[65] Evans 1906, 347 (no. 8); 1935, 655; Petruso 1992, 37 (no. 58).

[66] Evans 1906, 348 (no. 12); 1935, 655; Petruso 1992, 37 (no. 57); Grumach 1962, 163.

[67] Grumach 1962.

(8.40 gr.), we can include it in the 'Aegean' ponderal system, considering it as equal in weight to ⅛ of a basic unit of 67.2 gr., which is quite close to Parise's unit of 65.25 gr. (or 65.5 gr. of Evans and Caskey). He considers it possible to identify the sign on the 'balance weight' as the Linear A sign A 705, even though it is reversed –a not unusual occurrence for Linear A. Sign A 705 is one of those which Evans himself had recognized as fractions, whose value –like that of the rest– is, however, debatable. Militello notes that this particular fraction is of secondary order, because only 22 appearances are known to date (16 of them from Hagia Triada)[68] and opts for Bennett's value of ⅛, which fits his interpretation of its weight representing ⅛ of the basic unit of 67.2 gr. He points out that if we accept this coincidence of weight with the value of the fraction, then we undoubtedly have a case of the abstract function of this number, since the same sign was apparently used for fractional quantities both of volume and mass: he refers of course[69] to the known inscriptions **MA 10a, c, d** (cf. Fig. 12 in which this fraction seems to denote the volume of the first vase) and **HT 44.b.1, 125.b.**4 (where it seems to denote a special quantity of grain). He rightly stresses that if the stone disc from Hagia Triada is indeed a balance weight, then it is possible to correlate two classes of data in the field of the ponderal unit: on the one hand the archaeological documentation and on the other the textual evidence.

This is indeed the first possible instance of marking a balance weight with a Linear A numerical sign.[70] (The identification of the Mycenaean unit for wool in the Linear B tablets with two balance weights –at Akrotiri and at Thebes– of 3 kg. weight[71] is another example of textual documentation of actual weight-values). As for the disc-shaped object's weight, the unit of 67.2 gr. that emerges is close to the ponderal unit (68 gr.) proposed by Weingarten[72] for a serpentine disc-shaped balance weight marked with three circles, from the Royal Villa (?) at Knossos, which weighs about 204 gr. (she attributes it to a heavier unit of the Mycenaeans at Knossos, even though its dating to LM IIIA or B cannot be proven). On the pretext of the Hagia Triada balance weight, Militello makes the useful observation that the same geometric signs (more often circles) on weights, of which there is a corpus in Petruso,[73] sometimes denote a multiple and sometimes a subdivision of a unit, and are consequently of local character and do not belong to an official system of signifying weight-value. I add to this comment that in certain cases they are accompanied by a different sign on the other side of the balance weight. For example, the same weight can bear small circles on one side and a sign reminiscent of a potter's mark or script on the other. If the sign on the Hagia Triada balance weight is indeed a Linear A fraction, then it might belong to an official –palatial (?)– metric system.

8. The ovoid stone from Hagia Photia (Fig. 13, 15-16)

The largest Linear A inscription known to date on a weight (?) is incised on a 'melon'-shaped stone[74] also bearing an incised fish motif. In the publication of the inscription the bearing surface

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[68] Militello 1988-89, 170.

[69] Militello 1988-89, 171.

[70] There is also the possible identification of the sign of double cross on two lead weights from Kea with the script sign *PA* or the fraction A 701, but the two items are of different weight values: ½ and ? of the 'Minoan unit' (Petruso 1992, 33-34, nos. 14 and 23).

[71] Petruso 1986; Αραβαντινός 1995.

[72] Weingarten 1994, 85-86.

[73] Petruso 1992, 61.

[74] 'Near Hagia Photia, Siteia, a strange melon-shaped object was found, bearing an incised fish. A similar object, without decoration, was collected at Praisos. Bronze double-axes and a slightly curved knife come from this area' (Πλάτων 1957, 340). Unfortunately it is not clear whether the bronzes were found

is referred to as a *pierre ovoide*,[75] which prompted me to seek out the object in the Herakleion Archaeological Museum some years ago, suspecting that it might be a barrel-shaped balance weight. It is of limestone,[76] which has been carefully smoothed, of length 17 cm., max. width 11.5 cm. and weight 3,405 gr.

I believe that this object could have been used as a counterweight in weighing. Indications are the working of the stone to achieve a bullet shape, the absence of use marks that would classify it as a tool and its heaviness, since it is obvious that the makers of balance weights would have selected material that enabled them to weigh the largest possible quantity (of the heavier metals) with the smallest possible (in volume) balance weight (this is the main reason for the frequent use of lead for making Aegean balance weights). However here we have the additional element of the representation of a fish, the significance of which we must try to interpret.

First of all, what species of fish is represented? Mylona makes the following suggestions:[77] '1) The shape of the tail refers to fish that swim swiftly and over long distances, such as the migratory members of the Scombridae and Carangidae families (tunny, mackerel etc.). Most of these fish are large and seasonal fishing of them yields large quantities of meat, much of which is preserved for consumption later. 2) The fins are mainly of members of the Sparidae (gilthead, red snapper) or Serranidae (e.g. garfish) families, of coastal fish. 3) The representation is an assemblage of 'typical' features denoting a 'fish', without reference to a particular species. Perhaps the fact that the features of seasonal, migratory fish predominate denotes indirectly their importance. It is in any case characteristic that in the iconography of fish from the Bronze Age Aegean, only the dolphinfish held in a bunch by one fisherman in the wall-painting from the West House at Akrotiri, are rendered with accurate ichthyological features'.[78]

Of particular interest is Mylona's information that to catch migratory fish requires the organization of a communal effort. We could propose theoretically that the weight was not necessarily a regular balance weight but a standard weight for the specific quantity to be shared out after the end of the venture, to those who had participated in it. Indeed, since seasonal fishing of this species yields large amounts of meat, which can be kept (e.g. dried) for consumption later, we could even propose the periodic use of this oval stone also as a counterweight for weighing a specific portion of food for labourers other than fishermen. This thought is prompted by the archaeological evidence of the Egyptian balance weights with representation of fish, that were used for the distribution of portions of dried fish to labourers in the mines in the Sinai peninsula,[79] as well as by written testimonia and similar balance weights from the village at Deir el-Medina.[80] I note that the only weights with representation of a fish that I know of are from Egypt (cf. Fig. 14).

If we consider the ovoid stone as a counterweight in weighing, then the questions arise as to whether we should then include it as a balance weight in a specific ponderal system (which does

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at Praisos or at Hagia Photia. In the Herakleion Archaeological Museum inventory both stones (inv. nos. 2615 and 2616) are referred to as handed in. First publication of the item 2615 (the inscription had previously appeared in a *GORILA* volume) by Alberti (1998) who does not believe it to be a balance weight. See also Μιχαηλίδου 2000, fig. 18.

[75] *GORILA* 4, 168.

[76] Macroscopic examination identifies the stone as marly limestone, which exists in Crete (I am grateful to Marina Panagiotaki and the geologist Ch. Fasoulas for this information).

[77] I quote from a letter (in Greek) from Dimitra Mylona, whom I thank warmly for her help with the problem of identifying the incised fish with a specific species.

[78] See also Mylona 2000.

[79] Hodges 1970, 112, fig. 124.

[80] Brovarski *et al.* 1982, 62.

not seem to be Petruso's Minoan one); whether we should assign to it periodical and repeated use; whether we should consider it *'en fonction d'une pesée déterminée'*,[81] as is the case with a special class of inscribed weights from Deir el-Medina in Egypt (mainly of the Ramesside dynasty), without any Aegean parallel so far. Several of these Egyptian weights are ordinary pebbles from the desert, others are pieces of limestone (like the inscribed *ostraca* from the same village) bearing an hieratic inscription in red or, more commonly, black ink, from which it is deduced that they were normally used for one weighing;[82] in a few cases of repetition of weighing, there was a reduction of the original mass of the stone and a corresponding replacement of the first inscription. These weights are published by Valbelle who, on the basis of the commonest type of inscription –*'poids de tel objet pour un tel ± circonstances de la pesée'*– remarks that: *'Un poids de cette sorte offre un double intérêt: il garde la trace d'une opération (distribution de matériel ou de vivres, échange, partage, inspection...) reposant sur une pesée et il permet de vérifier celle-ci à tout moment. Il doit donc concerner une action en cours ou, du moins susceptible de se répéter'*. As an example she cites Černy's analysis of those *ostraca*-weights that denote the weight of bronze tools issued to the stone-masons working on the royal tombs and afterwards returned by them.[83] However the fish could not be returned, therefore the action was repeated only with regard to the quantity, which leads us to ask what the quantity of 3,405 gr., which is the weight of the stone from Hagia Photia, represents. (The heaviest of the regular balance weights for weighing fish, from Deir el-Medina, which Valbelle also cites, weighs 3,250 gr.).[84]

If we class the ovoid stone in this particular category of objects (for which we have no other evidence from the Aegean to date), then we should consider that it was used, like the Egyptian ones, *'pour une opération particulière'*,[85] but without necessarily considering that it was used only once. Weighing could have been repeated, if the weight quantity was predetermined for some reason. Moreover, in comparison with the Egyptian examples, it is more like the regular Egyptian balance weights –of diverse shapes– bearing a representation of a fish.[86] Whether we consider that it weighed –each time– a specific weight (of a dismembered large fish or several small ones), in the distribution of food or collection of 'tax', or we presume that it weighed –just once– the catch and then constituted the 'proof' of the weight of a large fish offered to a shrine or perhaps an heirloom or a grave good in a tomb,[87] the question is whether it falls within the function of the Minoan bureaucratic system, on account of the Linear A inscription it bears and which, fortunately, dates it –at least some stage of its use, if not its making– within the chronological *termini* known for Linear A, that is the period MM IIA - LM IIIA. P. Stephanaki, who made the drawing of the balance weight (Fig. 15), is of the opinion that the inscription and the fish motif (Fig. 16) were not incised by the same hand.[88] So, who was the scribe of the inscription and who the artist of the graffito?[89] Did the head of priestly or palatial control weigh

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[81] Valbelle 1977, 1 and 1.

[82] Valbelle 1977, 1 and 1, and note 6. The smallest is of weight 22 gr. and the largest 13.870 kg.

[83] Valbelle 1977, 5 and 5; cf. Michailidou in the present volume, the chapter on the recording of metals.

[84] Valbelle 1977, 2-3 and note 4.

[85] Valbelle 1977, 1 and 1.

[86] See also Hodges 1970, fig. 124; Brovarski *et al.* 1982, 62; Valbelle 1977, 2 and 3.

[87] Since the find spot of the ovoid stone is unknown; it was handed in to the museum.

[88] For the first facsimiles of the graffito of the fish and the Linear A inscription see *GORILA* 4, title page and p. 168 respectively.

[89] See a graffito of a fish caught by a hook, on the wall-painting of the fisherman from the West House at Akrotiri, Thera (*Thera VI*, pl. 89b).

with this? Did a scribe specially charged with the management of fishing weigh with it?[90] (From the MM IA period there existed at Hagia Photia a monumental walled complex in a strategic location for control of the plain between Palaikastro and Siteia).[91] Perhaps, on the contrary, the inscribed stone was an 'agreed upon' distribution tool for the catch of collective fishing; it is explicitly stated in an Egyptian papyrus that the tomb-robbers in the Valley of the Kings kept safe in one house the stone balance weight with which they shared out the loot, but when they were forced to hand over their portions they presented another, smaller, balance weight.[92]

We return now to the Linear A inscription, which Godart published as **SI Zg 1** (Fig. 17) and consists of four signs:[93]

AB 08 - [.] - AB 01 - AB 118

the second of which is not legible and the last depicts the balance scale. The prevailing view is that sign *118* is a metrogram only in Linear B where it denotes the highest ponderal unit (the talent). Its meaning in Linear A is not certain.

The advantage of the above mentioned Egyptian balance weights is that we are able to read the inscription on them. For example, the inscription 'weight for fresh, cleaned fish' is engraved on a stone weight (not much smaller than the one from Hagia Photia), which is considered to have been used for weighing food distributed to workers (cf. also Fig. 18).[94] There are various standardized inscriptions on the *ostraca*-weights from Deir el-Medina, on which the last hieroglyph is usually Gardiner's A 9, which shows a man holding a basket on his head[95] (Fig. 18) a sign denoting load, weight. If the ovoid stone from Hagia Photia is a balance weight for weighing fish, then theoretically the sign *118* in the same position, that is at the end of the inscription, could play a similar role to A 9 representing a word corresponding to the Egyptian *f'*, which according to Valbelle is the noun deriving from the verb to weigh.

However, could *118* be independent of the word preceding it (despite the absence of a separator) and denote the weight or the process of weighing of a product (fish?) with the name 08 - [.] - 01? Or, instead of the kind of product weighed, could it be the name of the person charged with weighing? The absence of a separator between the possible name and the sign for weighing would not be a problem if there was a consensus on the meaning of *118*.[96] What could the name *a-[.]-da* mean (if we transfer to it the phonetic values of Linear B)? If it is *a-[pu]-da* it could be related to the Linear B word *a-pu-da-se-we* (= ἀπυδασσεύς, that is distributor, derivative of the verb ἀπυδατέομαι-ἀποδατέομαι)[97] or with the ancient Greek words ἀπόδασμα (the part), ἀποδασμός (part-portion of a whole). Leaving the area of hypotheses aside, I shall summarize only that this combination of signs in the inscription is a *hapax* in the Linear A corpus, and that the textual data on the various positions of sign *118* are as follows:

On four tablets (**HT 12, HT 24b, HT 38** and **KN 2**) it is possible that it functions as an ideogram,[98] followed by numbers:

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[90] At Deir el-Medina, 'the relatively frequent references to deliveries of fish and wood "by the hand of scribe so-and-so" are to be taken as references to commodities due from the fishermen and woodcutters under his control' (Eyre 1980, 115).

[91] Dierckx & Tsipopoulou 1999, 286. It is near the sea too.

[92] Peet 1930, 160, 163.

[93] *GORILA* 5, 273. Alberti (1998) adds a shallow Z-shaped incision as a possible fifth sign (?).

[94] Brovarski *et al.* 1982, 62; cf. Μιχαηλίδου 2000, fig. 19.

[95] Gardiner 1957, 443.

[96] Cf. Evans's comments (on tablets) that '...the "balance" may be taken as a determinative indicating that the individual referred to was some kind of accountant' (1935, 658).

[97] *Documents*, 533; Προμπονάς 1978, 179-180.

[98] See *GORILA* 5, 273 and *GORILA* 1 for the above tablets.

On **HT 12.**4 and 5, it is preceded by the monogram for wool, from which is separated by the dot, and followed by the number 5. It could –theoretically– define quantities-weights of wool, since it is known from the Linear B tablets that wool was measured by weight. Palaima transcribes it as *L* 5, perhaps 150 kg.,[99] though it is not generally accepted that it functioned as the subsequent talent in Linear B.

On **HT 24b.**1.2.2 it is depicted three times singly, followed by the unit 1, and in two of the cases also by the composite fraction A 732 (so perhaps the number 1 and ¾).[100] Palaima considers it possible that it is mentioned as a unit of weight (talent?) for the commodity on the first side of the tablet, that is wool.[101]

On **HT 38.**3 it is quite clearly one of the seven ideograms counted and is followed by the number 3; two textiles of the type *TELA+KU* and one textile of the type *TELA+ZO* are also recorded.

On **KN 2.**2 it is followed by the number 3.

In the remaining instances of its appearance in Linear A, it seems to function as a syllabogram. It occurs at least three times inside a word. However, in most cases it is encountered at the end of a word (as on the stone weight): at least 7 times it occurs at the end of 2-5 syllable words.

Regarding the barrel shape[102] of the object from Hagia Photia, which was the reason for its characterization as a weight, this shape is more widespread in Cyprus and the Near East. Minoan (or Aegean) balance weights are as a rule disc-shaped (of stone or lead), although stone barrel or bullet-shaped balance weights –firstly called sphendonoid by Evans– are not unknown in Crete. I cite the published ones, such as one of haematite, from Knossos (Fig. 19), of weight 12.6 gr. (around the Egyptian gold unit),[103] and five balance weights from Tomb H at Katsambas (of gypsum, diorite, serpentine and jasper), weight 10-48 gr.[104] (dated in the LM IIIA:2 at Katsambas).

A third published example (Fig. 20), of limestone and unknown provenance (in the Metaxas Collection), weighs 8.4 gr. and bears the incised representation of an amphora and three stacked arcs.[105] Grumach explored the possibilities that it denotes a quantity that is treble a unit of 2.8 gr., that it denotes ¾ of the Cypriot shekel and, of course, that it represents 1 Babylonian shekel. Last, Grumach also compares its weight with the two Knossian disc-shaped balance weights already mentioned, the lead one of weight 8.45 gr. and the alabaster one of weight 8.54 gr.[106] Whether the incised signs are secondary remains a matter for speculation, although the smallness of the surface (length 2.7 cm.) suggests that they are primary. There is no counterpart for this amphora motif in the ideograms of Linear A and Grumach rightly approaches it in ideogram *209* of Linear B, but he also identifies it with the amphora imprint that is exactly the same on a clay rectangular object (a comparable case to the Kythera weight?), of weight 113.55 gr., among Hogarth's finds from Zakros.[107] In my view the sphendonoid shape was more widespread in Crete than we believe and perhaps balance weights that may not correspond exactly to the classical, small, carefully made haematite balance weights (Fig. 19), which were used for

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[99] Palaima 1994, 318.

[100] 'On **HT 24** the same "weight ideogram" AB 118 is found on the verso after a ligature of AB 13, which itself occurs next to A 559 in three entries on the recto. This lends some support to an identification of the Linear A and Linear B signs' (Palaima 1988, 326, note 82).

[101] Palaima 1994, 317.

[102] For this term see Evans 1906, 348.

[103] Evans 1935, 655f.; Petruso 1992, 37, no. 59.

[104] Αλεξίου 1967, 54, pl. 28α; Petruso 1981; 1992, 52-54; Μιχαηλίδου 2000, fig. 30.

[105] Petruso 1992, 50, no. 178.

[106] See above p. 59.

[107] Grumach 1962, 163, Taf. a, b; cf. Hogarth 1900-01, 128, fig. 40: Herakleion Museum inv. no. 2263.

precision weighing (usually of weight less than 100 gr.),[108] await identification: there must have been larger ones of other stones. In an excavation report for the Palace of Zakros, 'seven stone weights of ovoid shape',[109] are mentioned; I suspect that these are sphendonoid balance weights, which are unpublished.[110]

It is perhaps pertinent here to add, as a comparandum for the 'non canonical' shape and the large size[111] combined with the practice of incising an inscription, a diorite sphendonoid balance weight from Mesopotamia, dating from the era of the third dynasty at Ur (Fig. 21). This is 19.8 cm. long and of max. width 9.3 cm. Its inscription dates to the years 2037-2029 BC, to the reign of the king mentioned: '*Cinq mines, certifiées. (le dieu) Shu-Sin, roi fort, roi d'Ur, roi de quatre regions*'.[112]

We summarise that with regard to the fish graffito the Hagia Photia weight is reminiscent of balance weights from Egypt, and with regard to its shape is reminiscent of balance weights from the Near East. Nevertheless, examples from Praisos, Zakros, Katsambas, Knossos, the Metaxas Collection, indicate that the shape was known in Crete, as well as in the rest of the Aegean; I cite the carefully made sphendonoid balance weight from Akrotiri, Thera, which could have been made *in situ*, since waste from the same stone was found at site (Fig. 22, left and centre).[113] Its weight is 478.1 gr., perhaps referring to the Mina of North Syria.[114] We shall not extend the discussion to the barrel-shaped artefacts of the Early Bronze Age from the Northeast Aegean, what interests us is the continuity in the habit of using the stone for measuring.

It was the stone that was first used as a counterweight in weighing and it was the stone that first became –after choice of kind and appropriate working– the codified balance weight. This emerges both from the number and antiquity of stone examples, and from the corresponding names for the balance weight. As mentioned at the beginning of this chapter the Akkadian name was *abnu* (= stone),[115] frequently qualified by adjectives meaning 'standard', 'true', 'heavy'.[116] The Egyptian name is *f', n inr* (= weight of stone), which is also abbreviated as *inr* = stone.[117] The term stone exists already in the Old Kingdom and is encountered in tomb paintings, in scenes of craftsmen weighing.[118] I cite indicatively the formula '*Pierre d'un deben et demi*', on a regular stone balance weight (of weight 1½ *deben*); or the inscription '*12 deben, poids en deux pierres, du fil de X*' on a stone ostracon-weight from Deir el-Medina,[119] which states clearly that this ostracon, of weight 12 x 91 gr., is a witness of the weight of the yarn measured on scales with the help of two stone balance weights.

9. The catalogue of inscribed weights from the Aegean ends here with the hypothesis that perhaps the earliest inscribed relevant artefact might be (Fig. 23) 'a stone with incised Linear B

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[108] Petruso 1992, 1, with comments on the advantages of haematite for precision weighing.

[109] *Prakt* 1962, 162.

[110] There is no mention of the shape –perhaps because they are disc-shaped?– of other 'four stone weights' mentioned in the same report, recovered from Building A at Zakros (*Prakt* 1962, 144). I do not know whether these have been published.

[111] The two main arguments against its function as balance weight (Alberti 1998, 17).

[112] The quotation is in the language into which the Sumerian text was translated (*Naissance de l'écriture*, 79).

[113] Michailidou 1990, fig. 19.

[114] 'The mina of Karchemish may represent an old and commonly used norm (470+ or -5 gr.) in the North Syrian area' (Powell 1989, 516).

[115] *CAD* A/1, 59f.

[116] Powell 1971, 242.

[117] On papyri and on ostraca, Valbelle 1977, 5.

[118] Cour-Marty 1990, 18, note 3.

[119] Valbelle 1977, 3 and 4.

syllabograms from a late MH context at Kafkania, 7 km. north of Olympia. No numbers or logograms appear on this isolated find, however, and it shows at best an early stage of Mycenaean writing, not the kind of written administration seen later'.[120] If it could function as a balance weight, then this would explain why it does not bear a usual bureaucratic text. If one accepts Godart's translation, the owner of this 'circular pebble of dimensions 4.9 x 4.08 cm. and weight 48 gr.',[121] will have been Charops, whose trade, if he was indeed a metalworker,[122] would have entailed the use of balance scales and balance weights. In the presentation of the object, no identification is proposed for a 'graffito', which seems to be outside the text of the inscription[123] and brings to mind a fraction in Minoan hieroglyphic script or the fraction A 713. Furthermore, on the back of the object is the graffito of a double axe; it may be mere coincidence that the shekel in the Sumerian language is called GIN, which originally means axe, and that the weight of this stone is *ca.* 6 shekels (6 x 8 gr. = 48 gr.) equivalent to the number of the incised lines around the representation of the axe.

REMARKS

It is time to summarize whether the above catalogue of selected items with incised signs relating to contemporary script leads to some thoughts or observations. Since we are unable to read the Linear A signs, and therefore understand what we have,[124] we shall analyse what we do not appear to have in the Aegean examples in comparison with the Egyptian or Near Eastern ones. It is obvious at first glance that the examples of inscribed balance weights are few, particularly if we exclude those whose identification as balance weights is uncertain. However, the difference from the Egyptian ones, for example, is not so much quantitative (although thousands of Egyptian balance weights have survived the percentage of incised ones remains considerably low) as qualitative: so far we have a normal inscription on only two examples –the balance weight from Mochlos (no. 1) and that from Hagia Photia (no. 8)– and in both it is not absolutely certain that we have a primary inscription. Neither of the weights is sufficiently carefully made to be regarded as an official standard. On the other hand, the monogram on the disc-shaped balance weight from Knossos (no. 2) and the ideogram on the stone disc-shaped balance weight from Zakros (no. 6) seem to be primary signs that belonged to the balance weights, and the latter case is particularly interesting because there the script sign on one side is possibly combined with a signification of practical measuring on the other side (6 small circles).

The conclusion so far is that certainly no institutionalized or even customary practice of incising inscriptions on Aegean balance weights emerges. If as the first aim of an inscription on a balance weight we posit the validation of its weight value, theoretically we would seek this in the palatial weight-standard. However, comparison between the uninscribed-pyramidal porphyry 'talent' with relief octopus motif, from the Palace of Knossos (height approx. 40 cm.) with the diorite weight (Fig. 24) of the same shape (unusual in both cultures), from third-dynasty at Ur (height 6.2 cm.), shows the difference in custom: An entire text is written on the smaller weight confirming its weight of half a mina (about 250 gr.):[125]

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[120] Shelmerdine 1997, 559, and note 137.

[121] Αραπογιάννη *et al.* 1995, 251-254. For the common use of pebbles as balance weights: Petruso 1992, 1, 3.

[122] As Αραπογιάννη *et al.* 1995, 253.

[123] Arapogianni *et al.* 1999, 40.

[124] This does not mean, however, that endeavours will not continue. E.g., the inscription on the weight from Hagia Photia has been read recently as *a-re-tar-wi* and translated as *araire* (La Marle 1998, 308).

[125] Weight equivalent to the –later– Mycenaean unit *N* in the Linear B tablets.

'*Pour (le dieu) son maitre, Shulgi, l'homme fort, le roi d'Ur, le roi de Sumer et d'Akkad, a certifié (ce poids d'une) demi-mine*'.[126]

Another indicative case is the stone duck of the Old Babylonian period, on which there is a cuneiform inscription: '*2 minas, certified, belonging to Šamaš*'.[127]

The same corresponding weight (of 2 minas) is certified on an inscribed Egyptian porphyry balance weight, of weight 954 gr. (slightly less than its original weight) and bearing the inscription: '*Senusret, given life eternally, 70 gold debens*', that is 70 units of gold (of 13.6 gr.) in the Middle Kingdom.[128]

It emerges from the above examples that, if we did not have the special signs for units of weight in the Linear B script, we would not be able to certify them from the surviving balance weights of the period. For example, the relationship 1 L (talent) = 30 M (double mina) emerges from tablet **Jn 415**.1-7 from Pylos; the relationship 1 M = 4 N from tablet **Jn 845**.1-8 from Pylos and so on.[129] However, even though we know the numerical signs of the –decimal– system, not only of Linear B but also of Linear A,[130] in the aforementioned inscriptions on Aegean balance weights no numbers are included. If it were the case that instead of the symbols of the numbers we had the corresponding words, then I should mention: a) the possibility of the existence of various words for the same number (as is the case with Sumerian numbering, where they are an indication of the previous stage of 'concrete counting'),[131] b) the fact of the testimony of just six words for absolute numeration in Linear B: these are the words for the numbers 1, 2, 3, 4, 6, 9.[132] One could perhaps suggest identification of the last sign (of the balance scale) in the inscription from Hagia Photia not with sign *118* but with sign no. 90 of Linear B (*dwo*), but the design of the balance scale is I think closer to *118*. The only possible case of denoting number –the 5 vertical lines on the same side as the inscription on the balance weight from Mochlos– does not seem to be a numerical symbol when compared to the 12 lines on a smaller weight in the same group. Also in other cases of Aegean balance weights, the dots or circles do not denote tens or hundreds (as in the numerical system of Linear A and B). There remains the case of the fraction-sign on the balance weight from Hagia Triada. It is obvious that the devising of a metrical system presupposes the concept of the fractional quantity. I cite the view of Bennett[133] that any Linear A ideogram followed by a fraction refers to a commodity that is measured (and not counted). It is very possible that the special signs/metrograms in Linear B are no more than a systematization of the various units for measuring area, volume and weight, which are denoted by fractions in Linear A. This also explains the absence of fractional numbers in the Mycenaean tablets.

We summarize that the cases of officially institutionalized script signs on Aegean balance weights are almost absent and that inscriptions giving diverse information, like those encountered in balance weights from Egypt or the Near East (such as the examples cited indicatively), are lacking. If few persons knew writing in the era of Linear A, then we could

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[126] *Naissance de l'écriture*, 213, no. 152.

[127] Al-Rawi 1994, 38, fig. 5-6. Weight equivalent to the –later– Mycenaean unit M in the Linear B tablets.

[128] Catland 1917, 89, fig. 5. Weight also equivalent to the –later– Mycenaean unit M in the Linear B tablets.

[129] Parise 1964, 6-7.

[130] The first studies by Evans, 1906, 1935, and Bennett 1950.

[131] Powell 1971; Schmandt-Besserat 1996, 113: 'Several Sumerian numerations based on a three-count system suggest that abstract counting in the Near East may have been preceded by an archaic concrete counting system which used different numerations to count different items. These numerations are ...'.

[132] Hooker 1994, 114: *e-me, dwo, ti-ri-si, qe-to-ro, we, e-ne-wo*. In Sumerian arithmetic 'only one through ten ... and the numerals twenty, thirty, forty, fifty and sixty are attested in the lexical lists with phonetic glosses' (Powell 1971, 47).

[133] Bennett 1950, 205.

consider that both inscriptions, from Mochlos and from Hagia Photia, point to individuals with a special social status if they are inscriptions of ownership. The Hagia Photia inscription might not be secondary and might be the name of the scribe charged with weighing. But why only in this case? If again it were the name of the fisherman, he could have been the person in charge of fishing;[134] or the one who succeeded in obtaining a large catch[135] (and the inscription is commemorative or dedicatory). There remain the hypotheses that have been mentioned already, that it is an explanatory inscription of the product or of the redistributionary role of the specific stone. In the end, this is the only possible case of an 'official' inscription from the catalogue 1-8 (I exclude the exceptional object no. 9).

Since there are no widespread cases of an 'official' script on balance weights, are we justified in considering the circles or triangles on balance weights as a practical signification for everyday use, or as denoting validity by a central authority? In this direction I shall compare two balance weights from Knossos. One, which has already been mentioned, was published by Weingarten (see above p. 60) and has three circles made by drilling. It possibly comes from the Royal Villa Pillar Room and is perhaps dated in the LM IIIA or LM IIIB period.[136] The other is unpublished, is registered as purchased in 1903, and 'was found in the rubble of the road'[137] and has five incised circumferences of circles. I mention these weights together because they are both of serpentine, come from Knossos and have a particular detail in their workmanship: both the circular surfaces are surrounded by a shallow groove. The weight of the first (204 gr.) is considered to be 3 x 68 gr., and of the second (329.52 gr. -) can be interpreted as 5 x 68 gr. So they might belong to the same system. The circles made on one by removing the material certainly affected the weight, so were they planned from the outset or were they made after control of the weight?

The incised circle on the Egyptian balance weights denotes the *deben*, that is the ponderal unit, followed however by a number (sometimes also by the hieroglyph for gold),[138] or incorporated in a text. Does the simple circle on the Aegean balance weights denote their participation in a specific ponderal system, further to the mathematical information given by the number of examples (i.e. circles)? And how do we interpret the triangles? We can say that whatever the role of the simple signs was, these were not essential, since they exist on a small proportion of the total of balance weights.[139] What is more important is that they appear the same (e.g. two triangles) on balance weights of different weight.[140] Certainly, as far as the subject of this chapter is concerned, we can conclude that although Aegean balance weights constitute part of a cognitive invention (of a full metrical system), they function more with the manner of the tradition that exists behind them, since even in the cases of incised signs, the system of simple signification prevails over that of the regular inscription.

For the issue of the continuity of tradition in the sector of measuring, I shall return to the case that I called 'concrete weighing', on the pretext of the special units for weighing specific products. The Mesopotamian system itself was based on two defined values: on the weight of the load of an ass, as the largest value, and on the weight of a grain of barley as the smallest. However, the system had to be organized also on the basis of the numerical system –of the

[134] E.g., in the 'Turin Strike Papyrus' from Deir el-Medina, the fisherman named Sethi is characterized as 'Chief Fisherman' and it seems that members of the same family participated in fishing: Eyre 1980, 155.

[135] See the wall-paintings of the fishermen at Akrotiri, Thera. Papageorgiou 2000.

[136] Weingarten 1994, 85. Diam. 6.8 cm.

[137] This is the information in the inventory. Diam. 7.5 cm.

[138] Cf. balance weights of the Middle Kingdom, e.g. in Petruso 1981, fig. 2.

[139] See Petruso 1992; Michailidou 1990.

[140] Cf. Kea, Akrotiri.

Sumerians– which is based on multiples of 60, which is why Powell believes that it is the result of high-level planning and perhaps commissioned by a ruler.[141]

Whereas 'concrete counting' as a preliminary stage of counting ended up in the abstract numbers, 'concrete weighing' seems to continue or to recur as a special scale for certain goods. This is the case of the Egyptian balance weights belonging to the system for weighing gold, with basic unit of 13.6 gr.; beginning from the Predynastic period, balance weights which bear the hieroglyph for gold (followed by numerical symbols) are securely recognized both in the Middle[142] (Fig. 25) and the New Kingdom,[143] although there functions in parallel in the New Kingdom, a ponderal unit which is the *deben* of 91-93 gr., used in general for any commodity plus metals. Vercoutter argues for the Middle Kingdom the existence of another special unit for weighing copper, double the value of the gold unit, that is 27.2 gr.[144] An even clearer indication of 'concrete weighing' is the existence in certain areas and certain periods of a special –heavier– unit for weighing wool. The earliest indication is the kidney-shaped stone balance weight, of weight 680 gr., from Lagash in Mesopotamia, which bears the inscription: '*1 mina in wool [guaranteed by] the priest Dudu*'[145] and it is a fortunate coincidence that the same name appears on another – regular– mina of weight 497 gr.[146] At Ebla (which basically follows the Babylonian system), three standard measures exclusively for weighing wool are attested in the surviving texts.[147]

A special unit for wool, the *nariu*, reappears at Nuzi. This is a much larger quantity –3 kilos– that finds exact correspondence in the *LANA* unit of the Mycenaean tablets.[148] What is interesting is that the *LANA*, although a special unit for measuring wool, is part also of the regular metrical system of the Mycenaeans, since it is equivalent to 1/10 of the talent and subdivided to three *M* units (the subdivision 1/30 of a talent).[149] Only in the Thebes tablets does a special subdivision of the *LANA*, the *PA* unit, appear.

Some of the special units have a long history, such as that for gold in Egypt and for wool in Mesopotamia. An interesting subject for research is when and for what reason these special ponderal units were incorporated in the current general ponderal system or abandoned.[150] At Nuzi there is reference to stone balance weights with incorporated unit of cloth.[151] It is possible that one of the balance weights in our catalogue, no. 6 from Zakros, is a special balance weight for weighing cloth of the type of the ideogram it bears on one side, AB 164. On the Linear B tablet **L 520** (Fig. 26) it seems that the cloth is woollen, each counted piece manufactured from 6 units of wool (*LANA* = 3 kg.). There are six circles on the other side of the balance weight, but the balance weight is of weight 220 gr. (and not 18 kg.!). There is another possible designation of cloth on the stone disc-shaped balance weight from Knossos, with the denoting of 24 (by two large and four small circles) on one side and a rectangular motif (cloth?) on the other.[152] Its weight of

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[141] Powell 1971, 209.

[142] Vercoutter 1959, pl. XXXIIb.

[143] Dilke 1987, fig. 44.

[144] Vercoutter 1977, 438.

[145] The English translation of the inscription is from Petruso 1986, 32.

[146] Powell 1971, 198.

[147] Sollberger 1986, 5.

[148] Cf. Petruso 1986; Melena 1987.

[149] The possibility of the participation of the wool unit in the ponderal system of the Linear A period as well, also emerges from the study of the total of the balance weights from the West House at Akrotiri, Thera. See Michailidou 1990; see also Petruso 1986, 34.

[150] Other examples of weighing products with heavier units are mentioned by Powell (1971, 201).

[151] Powell 1989, 515 and VB.3b. For Aegean units for cloth cf. Parise's view (1987).

[152] Evans 1935, 653-465; Petruso 1992, 38, no. 72; see also Parise 1987, 4-6.

about 1.5 kg. associates it with the balance weight from Mochlos already discussed. I propose the hypothesis that the weight of 18 kg. for each item in the tablet refers to a standardized large quantity of cloth, so that the tablet **L 520** is a collective inventory of 3, 2 and 4 'bolts' or 'bales' of this particular cloth,[153] whose weight is checked before record; in such a case the Zakros balance weight would weigh only one piece of cloth, but taking into account the ratio of the standard quantity of the specific kind of cloth to the weight of wool (6 *LANA*). The possibility of recording cloth in a large unit may be the reason why the general ideogram for cloth (AB 54) on the Linear A tablets is followed by *different* fractions.[154] Of course, a possibly standard quantity in Linear A (in the period to which the Zakros balance weight dates) did not necessarily include the same length or weight of cloth as the corresponding one in Linear B. The subject of standardization of the weight or area of a principal transactional commodity, such as cloth, is a special chapter in research.[155] (For example, Veenhof deduces that the Old Assyrian merchants were probably trading large standard pieces of cloth –and not garments– of area 18 sq.m. and weight 5 minas, and comments that the weight of 130-140 gr. per square metre that emerges is acceptable for hand-woven woollen textiles).[156] Certainly the Zakros balance weight (no. 6) combines the signs of practical signification on one side with a script sign on the other, and in contrast to the Mochlos balance weight (no. 1) the signs on both sides of the stone disc all belong to the stage of its making, therefore they are indicative of a planned function for this balance weight. Consequently, the Zakros balance weight well represents the two aspects in Metrology: the practical process and the cognitive invention.

The volume and the composition of the product are mentioned as reasons for the function of special units for measuring certain products.[157] However, I think that the reason lies more in the manner of production (since the relationship between the *LANA* and four fleeces has been certified),[158] perhaps also the exchange value and the means of distribution. In the end, I believe that the special ponderal units survive or reappear for the needs of recording. It is logical that the smaller (or more valuable) the quantity distributed the smaller the basic unit on the metrical scale, and *vice versa*. For example, the crocus in the Mycenaean tablets seems to have its own metrical scale, on account of the lightness of the stamens of saffron, the rarity of its dyeing property, perhaps also of its religious significance: the units symbolized by acrophonic ideograms *RO* and *QI* are used on for this.[159] I present tables from the relevant database in our Institute, in which it is obvious that the regular units *N*, *P* and *Q* were used along with the special units *RO* and *QI* included in the general metrical system (as is the case with the *LANA* unit). It is well known from the general inventories of products that in the Mycenaean system the *P* unit is

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[153] Some Egyptian tomb paintings are eloquent in this regard.

[154] See tablets **HT 16.2.3**, **HT 20.4** (*GORILA* 1). 'The ligatured cloth signs are found on tablet **HT 38.3** in quantities of 2 and 1 respectively. We do not know what units are being used. The pure cloth ideogram occurs on two other tablets, **HT 16.2** and **HT 20.4**, by the same scribe (10 HT), in both cases followed by a fractional sign. This may indicate that the units in question are fairly large and are subdivided by fractional amounts. Finally, cloth appears on roundel **HT Wc 3019**, again in connection with a fractional sign written over a seal impression on the edge of the roundel'. Palaima 1994, 317.

[155] It is included in A. Michailidou, *Weight and Value in the Prehistoric Aegean and the Near East* (in preparation).

[156] Veenhof 1972, 93 and note 151.

[157] As Ruipérez & Melena 1996, 88, maintain for wool.

[158] Killen 1964, 9.

[159] From Ruipérez & Melena 1996, 88-89.

larger than the Q unit. From the tables (1-5)[160] and the tablets (Fig. 27-29) relating to saffron (crocus) it emerges that:

tablet **Np(1) 270**: *CROC P* 2 *QI* 4

tablet **Np(1) 7508 + 8594**: possibly *CROC,*   ] *RO* 1 *Q* 1

tablet **Np(1) 271**: *CROC RO* 1 *QI* 1

Consequently the *RO* unit for crocus is certainly larger than the *QI* unit for crocus or the current unit Q. It emerges that the largest quantity of saffron recorded is approx. 500 gr. (*N* 2), that is as much as the Babylonian mina, though commoner is the record of 250 gr. (*N* 1). The basic unit of inventorying crocus seems to be *P* of the general metrical system (the most records). Perhaps the measuring of the stamens of the saffron in the stage of collecting together, was made with the special units *RO* and *QI*, whereas the recording during the storing also used the current units. And so we are led to the other end of the relationship between metrology and script: to the question of when the result of a weighing is recorded directly and when indirectly, with the sum of many measurements. But here we end, because we have now entered the world of pure texts.

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[160] The tables are in the Greek language because they come from the Institute's databank.

Table 1. Saffron, *N*-unit.

ΠΙΝΑΚΙΔΑ	ΣΤΙΧΟΣ	ΑΓΑΘΟ	N	L	M	P	Q	QI	RO
KN Np(1) 286	01	κρόκος		0	0	0	0	0	0
KN Np(2) 1000 + 5004	01	κρόκος		0	0	0	0	0	0
KN Np 2138	01	κρόκος		0	0	0	0	0	0
KN Np(2) 8249	01	κρόκος		0	0	0	0	0	0
KN Np(2) 5725 + 5886 + 8515	01	κρόκος	1	0	0	0	0	0	0
KN Np(2) 856 + 7915 + 7917	01	κρόκος	1	0	0	0	0	0	0
KN Np(2) 861	01	κρόκος	1	0	0	0	0	0	0
KN Np(1) 274	01	κρόκος	1	0	0	1	0	0	0
KN Np(2) 5721 + 5945 + frr.	01	κρόκος	1	0	0	0	0	0	0
KN Np(2) 5982 + fr.	01	κρόκος	1	0	0	0	0	0	0
KN Np(2) 7418	01	κρόκος	1	0	0	0	0	0	0
KN Np(2) 7439	01	κρόκος	1	0	0	0	0	0	0
KN Np(2) 8003	01	κρόκος (;)	1	0	0	0	0	0	0
KN Np(2) 5002	01	κρόκος	1	0	0	0	0	0	0
KN Np(1) 7423 + 7641 [+] 7445	01	κρόκος	2	0	0	0	0	0	0
KN Np(1) 8059	01	κρόκος (;)	2	0	0	0	0	0	0

Table 2. Saffron, *RO*-unit.

ΠΙΝΑΚΙΔΑ	ΣΤΙΧΟΣ	ΑΓΑΘΟ	RO	L	M	N	P	Q	QI
KN Np(1) 267	01	κρόκος		0	0	0	0	0	0
KN Np(1) 268	01	κρόκος	1	0	0	0	0	0	0
KN Np(1) 271	01	κρόκος	1	0	0	0	0	0	1
KN Np(1) 7508 + 8594	01	κρόκος (;)	1	0	0	0	0	1	0

Table 3. Saffron, *Q*-unit.

ΠΙΝΑΚΙΔΑ	ΣΤΙΧΟΣ	ΑΓΑΘΟ	Q	L	M	N	P	QI	RO
KN Np(1) 272 + 7419 + fr.	01	κρόκος	1	0	0	0	0	0	0
KN Np(1) 7508 + 8594	01	κρόκος (;)	1	0	0	0	0	0	1

Table 4. Saffron, *QI*-unit.

ΠΙΝΑΚΙΔΑ	ΣΤΙΧΟΣ	ΑΓΑΘΟ	QI	L	M	N	P	Q	RO
KN Np(1) 271	01	κρόκος	1	0	0	0	0	0	1
KN Np(1) 270	01	κρόκος	4	0	0	0	2	0	0
KN Np(1) 277	01	κρόκος	4	0	0	0	0	0	0
KN Np(1) 85 + 5047 + 7938 + 8057	01	κρόκος	6	0	0	0	0	0	0

Table 5. Saffron, *P*-unit.

ΠΙΝΑΚΙΔΑ	ΣΤΙΧΟΣ	ΑΓΑΘΟ	P	L	M	N	Q	QI	RO
KN Np(2) 7420	01	κρόκος		0	0	0	0	0	0
KN Np(1) 8462	01	κρόκος (;)		0	0	0	0	0	0
KN Np(1) 8459	01	κρόκος		0	0	0	0	0	0
KN Np(2) 7442 + fr.	01	κρόκος		0	0	0	0	0	0
KN Np(1) 274	01	κρόκος	1	0	0	1	0	0	0
KN Np(1) 5013	01	κρόκος	1	0	0	0	0	0	0
KN Np(1) 7441 + fr.	01	κρόκος (;)	1	0	0	0	0	0	0
KN Np(2) 7447	01	κρόκος (;)	1	0	0	0	0	0	0
KN Np(1) 8123 + 8460 + fr.	01	κρόκος (;)	1	0	0	0	0	0	0
KN Np(2) 9306	01	κρόκος (;)	1	0	0	0	0	0	0
KN Np(1) 8062 + fr.	01	κρόκος (;)	2	0	0	0	0	0	0
KN Np(2) 8649 + 9677 + fr.	01	κρόκος (;)	2	0	0	0	0	0	0
KN Np(1) 270	01	κρόκος	2	0	0	0	0	4	0
KN Np(2) 860	01	κρόκος	2	0	0	0	0	0	0
KN Np(1) 278 + 7436 + fr.	01	κρόκος	2	0	0	0	0	0	0
KN Np(2) 855 + 7434	01	κρόκος	3	0	0	0	0	0	RO
KN Np(2) 860	01	κρόκος	4	0	0	0	0	0	0
KN Np(1) 273	01	κρόκος	5	0	0	0	0	0	0
KN Np(2) 855 + 7434	01	κρόκος	6	0	0	0	0	0	0
KN Np(2) 5980	01	κρόκος (;)	7	0	0	0	0	0	0
KN Np(2) 859	01	κρόκος	9	0	0	0	0	0	0
KN Np(2) 5008	01	κρόκος (;)	10	0	0	0	0	0	0
KN Np(2) 8457	01	κρόκος (;)	10	0	0	0	0	0	0
KN Np(2) 9678	01	κρόκος (;)	10	0	0	0	0	0	0

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AE/NB 1902, p. 65.

[p.] 65

Notes on weights found in different areas

Weights   Another (o) 19.4

Gyps.[um]
1 Alabaster, (o on one side). In Myc. Meg. below E. Terrace (with big Pithoi)

W⁴[weight] as found, 58,5 grammes

2 Limestone (or Gyps) At S.E. Corner
(o   o   on one side)
   o o
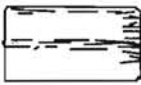
W⁴[weight] as found, 232,0 grammes

(Kapheneion)   E. slope.
3. Black Steatite. o o o on both sides   W ι as found
                     o o
                     W   272. 75

To At N.E. of Palace on Myc. floor level with Steatite lamp of Typical class

4   Black Steatite.   o O o   Moulding
                       o O o
                       1507.5

grammes
Plaster.   o   broken   20.5   - unbroken, 21.
  —   o o   broken   89.5   - unbroken 105.5
          o o
  —   o o o broken 120.1.   unbroken, 144
          o o
        o O o broken   669.   unbroken 696.6
        o O o

Leadweights. { 8.45 grammes   130.5 grs.   ½ Shekel
              { 22.05   —   340   —   (3 Phan ½ shekels)
              { 42.7   —   680 659   ⅕ = 131.8

                                     (or 3 'Phan' Shekels 9
                                              c 14 grammes)

Fig. 1. A page from the Note Book of A. Evans (transcribed by Vasso Fotou).

Fig. 2. Stone disc-shaped balance weights from Knossos (courtesy of Herakleion Museum).
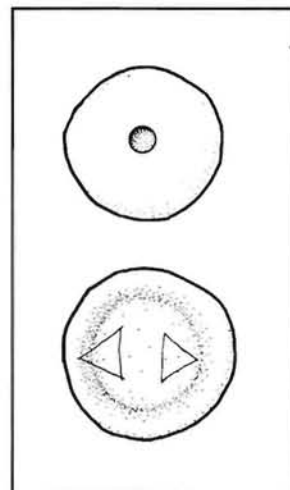
Fig. 3. Inscribed signs on lead weights from Kea (after Petruso 1992, pl. 5).

Fig. 5. Canaanite jar from Akrotiri on Thera (after *Prakt* 1994, pl. 84β).

Fig. 4. The two sides of the lead weight from Mochlos (courtesy of the Herakleion Museum).
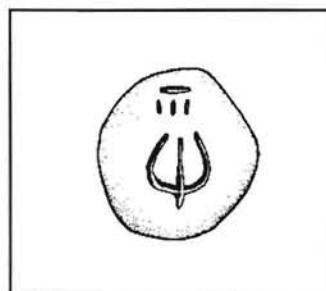
Fig. 6. Stone discoid balance weight from Knossos (after Petruso 1992, pl. 6).
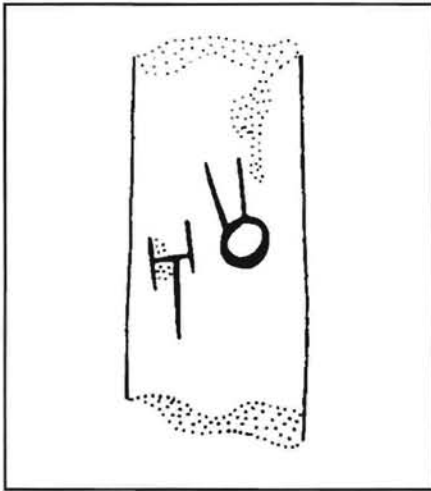
Fig. 7. Fragment of schist from Hagios Stephanos, Lakonia (after *GORILA* 5, 16).
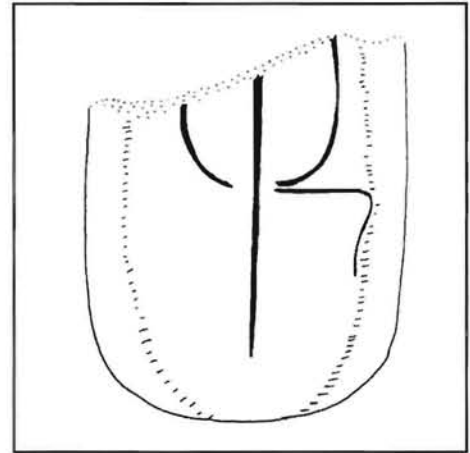
Fig. 8. Clay weight from Kythera (after *GORILA* 4, 166).

Fig. 9. Canaanite jar from Akroriri on Thera (after *Prakt* 1994, pl. 83β).
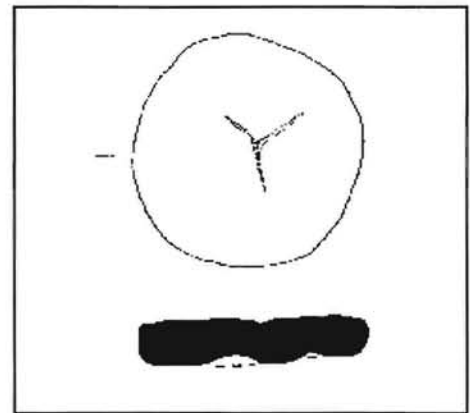
Fig. 10. Lead balance weight from Akroriri on Thera (by O. Apergi).

Fig. 11. Stone disc-shaped object from Hagia Triada (after Militello 1988-89, fig. 2).

Fig. 12. The inscription **MA 10a** (after *GORILA* 5, 51).

Fig. 13. The ovoid stone from Hagia Photia (courtesy of the Herakleion Museum).
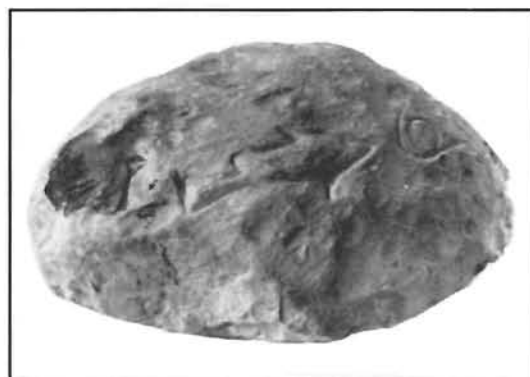
Fig. 14. Stone weight from Deir el-Medina (after *Naissance de l'écriture*, no. 221).
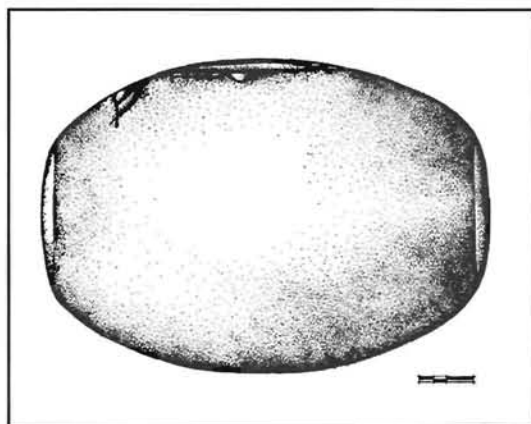
Fig. 15. The sphendonoid shape of the stone from Hagia Photia (by P. Stephanaki).
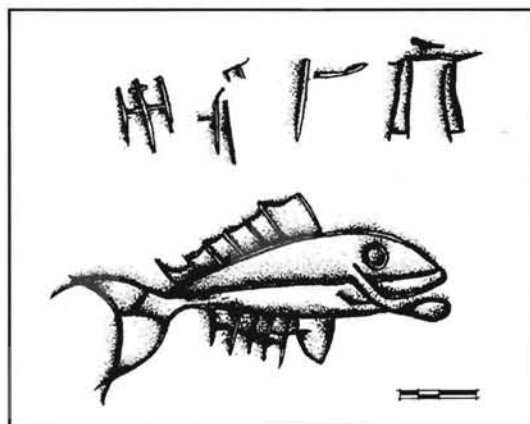
Fig. 16. The inscription on the stone from Hagia Photia (by P. Stephanaki).
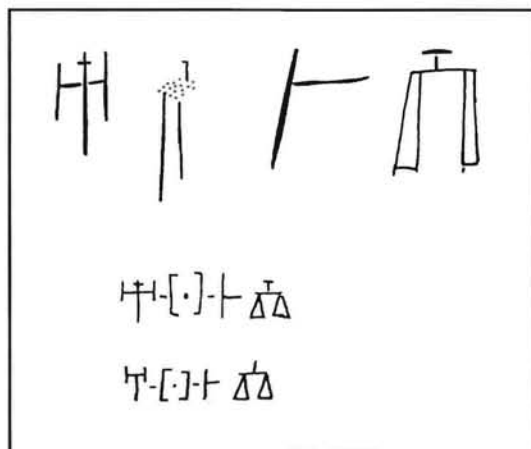
Fig. 17. The inscription on the stone from Hagia Photia as transcribed by L. Godart.

Fig. 18. Egyptian stone weight from Deir el-Medina (after Brovarski *et al.* 1982, 62).
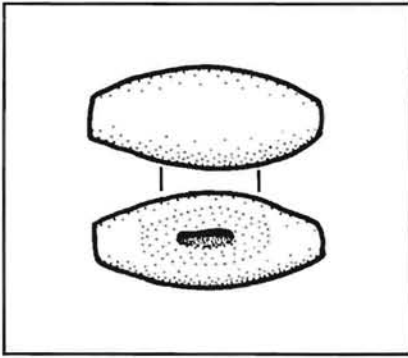
Fig. 19. Stone sphendonoid weight from Knossos (after Petruso 1992, pl. 6).
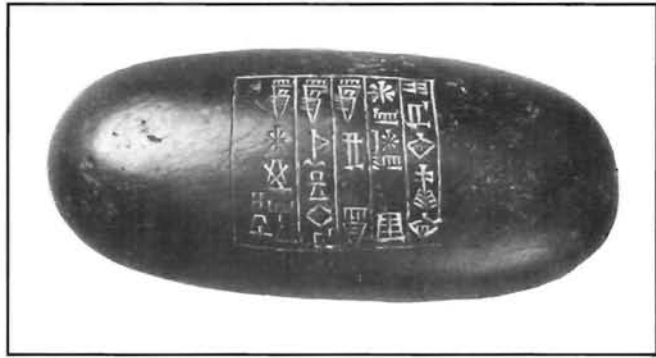
Fig. 21. Stone sphendonoid weight of Ur-III period (after *Naissance de l'écriture*, no. 34).
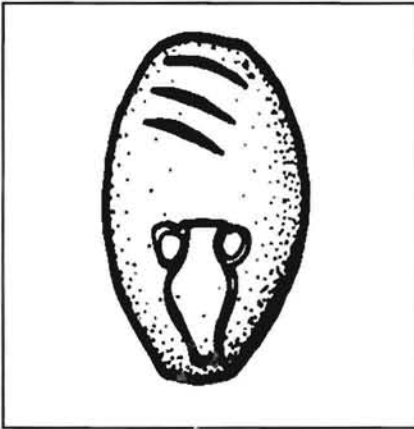
Fig. 20. Stone sphendonoid weight from the Metaxas Collection (after Petruso 1992, pl. 9).

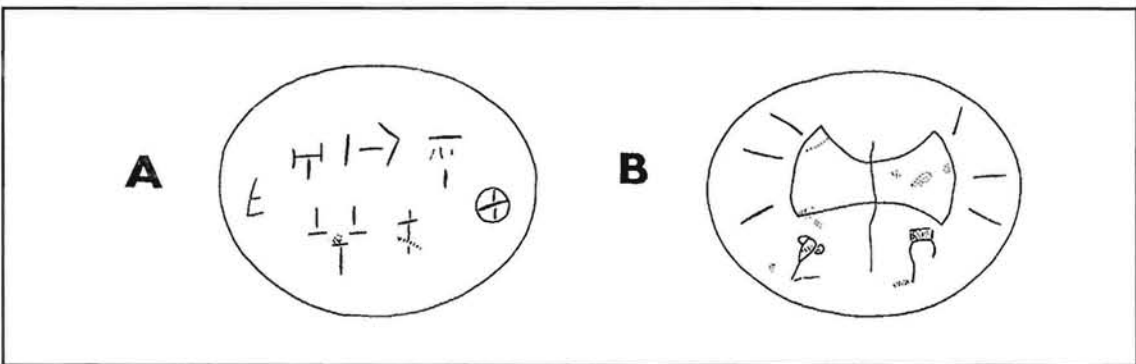**Fig. 22.** Stone sphendonoid weights from Akrotiri on Thera.

Fig. 23. The pebble from Kafkania (after Arapogianni *et al.* 1999, 40).

Fig. 24. Stone weight of Ur-III period (after *Naissance de l'écriture*, no. 152).
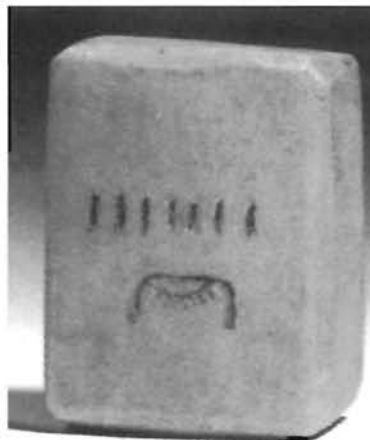

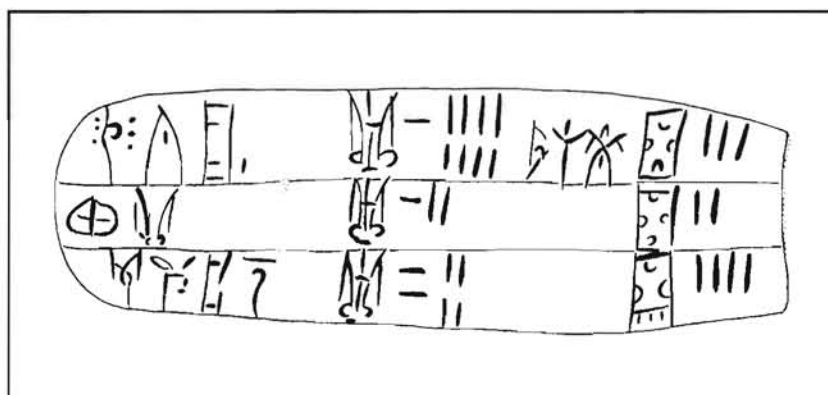**Fig. 25.** Egyptian stone weight from Nubia, 12th Dynasty (after Schoske & Kold 1996, 11).

Fig. 26. Tablet **L 520** from Knossos with records of wool in *LANA* units followed by the corresponding quantities of cloth (after *CoMIK* I).

Fig. 27-28. Tablets **Np(1) 270** and **Np(1) 7508 + 8594** from Knossos with records of saffron (after *CoMIK* I and III).
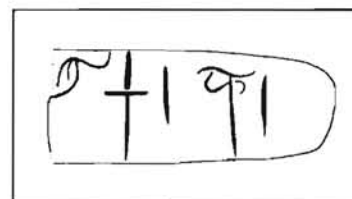
Fig. 29. Tablet **Np(1) 271** from Knossos recording a quantity of saffron (after *CoMIK* I).