

The pastoral calendar and the importance of the growth rate of lambs in the management of breeding: the case of the Knossos archive*

by

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Abstract

The first part of this paper is aimed at establishing the production capacity and, consequently, the exact age of the so called *ki* lambs. From some inconsistencies on the wool productive rate of *ki* lambs, emerging from the **DI** series, one gets the impression that the palace administration was not able to predict exactly their production rate. This is probably due to their very young age.

In the second part, is expounded the hypothesis that these lambs were six-eight months old, and exactly just after the weaning phase and before the gathering of the mixed female flocks. This hypothesis can offer a solution to the problem of the missing lambs and wool, because we might consider such missing not as real deficit in the herd, but simply as a consequence of the separation of the lambs from the ewes during the process of weaning.

1. Introduction

It is well known that Mycenaean scribes used to record the exact composition of palace herds placing different determinatives, such as *ki*, *ne*, *ki ne*, *pa*, *za*, etc., before the ideogram for sheep (*OVIS*).¹ Chadwick and Ventris first studied these abbreviations systematically,² and proposed some hypotheses on the meaning of some determinatives. They concluded that *pa* was the abbreviation of *palaios*, “old,” *ne* of *neos*, “young,” and that *o* was the acronymic abbreviation of *o-pe-ro-me-no*, “owed.”

Also Killen studied the tablets dealing with sheep breeding and wool production.³ On the one hand, he suggested that the lambs marked with *za*⁴ were *za-we-te* lambs, “this year lambs,” and those marked with *pe* were *pe-ru-si-nu-wo*, “last year lambs.” Further, he suggested that the abbreviation *WE* were the acronym of “*wet-alon*,” “this year lamb.”⁵ On the other hand, studying the **Dk** and **DI** series, Killen focused his attention to the sheep marked with the determinative *ki*. He pointed out that, in the **DI** series, the numerical ratio between the ewes (*OVIS*) and the *ki* sheep (*ki OVIS*^m) was constantly of one to one.⁶ Furthermore, he calculated that in these mixed flocks there was an average productive rate of ten animals per each produced wool unit. Since in the **Dk** series the standard ratio of the wool production is of one wool unit per four mature sheep, Killen deduced that these scarcely productive flocks might have been formed

of ewes and of their lambs,⁷ and tentatively suggested that the determinative *ki* might have been the abbreviation of a Mycenaean form of the classical Greek term *neophilòs*, “young lamb.”

In these important studies reasonable answers were given to many problems regarding the Mycenaean sheep rearing, and the complexity of palatial animal husbandry was aptly underscored. However, a problematical disproportion seems to have been underestimated. Since the determinatives *WE*, *ki*, *ne*, *ki za*, *ki ne* and *ne ki* were all interpreted as referring to young lambs—precisely to lambs less than one year old—, only one determinative (*pe*, which coupled with *OVIS*^m should mean “last year lamb”) seems to stand as an indication for all other lambs between the first and the second year of life.

It is well known that in sheep-farming the different ages of young lambs are tightly linked with their productive capacity in wool and in milk, and that the age of the lambs implies precise selections at the moment of the herd composition.⁸ On the other hand, since it is clear that Mycenaean scribes were highly specialized bureaucrats, it is reasonable to suppose that they used the determinatives in a very precise manner and not randomly. Thus, if they distinguished, for example, between *ki* and *ki ne* lambs, the distinction must have been absolutely necessary and clear for both the bureaucrats and the shepherds. In my opinion, it is hardly possible, if not impossible, that the scribes used different determinatives in order to designate animals which they considered pertaining to similar classes; on the contrary, I think that the scribes labeled different and specific categories of lambs with different determinatives, even though their distinctions may appear very subtle.

This paper is aimed first at establishing the production capacity of some kinds of lambs and, secondly, at determining, albeit tentatively, their exact age and their role in the process of wool production in the Mycenaean palaces.

Table 1

Tablet series		line	sheep	wool units	rate
DI (1) 463	present	1	sheep 45 + ki lambs 5	5 M1	10:1*
	missing	2	sheep 35 + ki lambs 45	10 M2	7,5:1
	present + missing	3	130	15 M2	<u>8:1*</u>
DI (1) 932+ fr	present	1	sheep 40	3	13,3:1
	missing	2	ki lambs 40	5	8:1
	present + missing	3	80	8	<u>10:1</u>
DI (1) 935+942	present	1	sheep 27	2	13,5:1
	missing	2	sheep 43 + ki lambs 70	11	10:1
	present + missing	3	140	13+1	<u>10:1</u>
DI (1) 938	present	1	sheep 50 + ki lambs 40	7	13:1
	missing	2	ki lambs 10	3	3.3:1
	present + missing	3	100	10	<u>10:1</u>
DI (1) 943	present	1	sheep 90	11	8:1
	missing	2	ki lambs 90	7	13:1
	present + missing	3	180	18	<u>10:1</u>
DI (1) 944	present	1	sheep 60	5M2	10:1
	missing	2	sheep 40 + ki lambs 100	x	?
	present + missing	3	200	?	?
DI (1) 946+fr	present	1	sheep 70	7	10: 1
	missing	2	ki lambs 70	7	10:1
	present + missing	3	140	14	<u>10:1</u>
DI (1) 947+7626	present	1	sheep 80 +10 ki lambs	11	8:1
	missing	2	ki lambs 70	5	14:1
	present + missing	3	160	16	<u>10:1</u>
DI (1) 948+977	present	1	sheep 20	2	10:1
	missing	2	sheep 30 + ki lambs 50	8	10:1
	present + missing	3	100	10	<u>10:1</u>
DI (1) 950+fr	present	1	sheep 50	5	10:1
	missing	2	ki lambs 50	5	10:1
	present + missing	3	100	10	<u>10:1</u>
DI (1) 952+7959	present	1	sheep 40	5	8:1
	missing	2	ki lambs 40	3	13,3:1
	present + missing	3	80	8	<u>10:1</u>
DI 1060	present	1	sheep 50+ 10 ki lambs	6	10:1
	missing	2	ki lambs 15	1	15:1
	present + missing	3	75	7	<u>10,7:1</u>
DI (1) 7132+fr	present	1	sheep 50 +50 ki lambs	6	16:1
	missing	2		4	
	present + missing	3	100	10	<u>10:1</u>
DI (1) 7132 + fr	present	1	sheep 50	6	8:1
	missing	2*	ki lambs 50	4	12,5:1
	present + missing	3*	100	10	<u>10:1</u>

2. The production rate of lambs (*Table 1*)

This diagram concerns ewes, lambs and wool belonging to the less fragmentary tablets of **DI** series.

As it is well known, these tablets record herds composed of sheep and *ki* lambs and their wool production. The indications of the present animals and wool are followed by the indication of the missing ones. Following the acknowledged scribal usage, the missing animals and the missing wool were marked by the determinative *o*, standing for *o-pe-ro*, “missing.”

In this diagram, in the first line of each tablet reference is made to animals and quantities of wool which in the documents are labeled as “present.” The quantities of wool are calculated in Mycenaean wool units (LANA), which correspond ca. to three kilograms; the sub units (M) corresponded ca. to one third of the whole unit.⁹ In the second line I have marked the sheep and the wool labeled as “missing.” In the third line I have listed the sum of missing and present animals, and the sum of missing and present wool, establishing the hypothetical economical value of the whole flock as if it were complete, *i.e.*, such as it was required by the palace administration.

As Killen had pointed out,¹⁰ from the third line one can deduce that the production rate of an individual flock was expected to be constant, following a rate of ten animals per one wool unit, regardless of the number of present or absent animals and of their age.¹¹ Also from the first line one can argue that the average rate is of ten animals per one wool unit. However, some data may alter that picture.

In **DI (1) 935+942**, ewes produce wool according to a low rate (13,5:1); however, the expected final balance is reached thanks to a mixed group of 43 female and 70 lambs which produce ca. 12 wool units,¹² according to a lightly overcharged rate of 9,4 to 1. In **DI 932**, ewes produce less wool than the expected target, *i.e.*, according to a rate of 13,3:1. However, again the correct balance appears to be obtained thanks to the overproduction expected from the absent lambs, according to an 8:1 rate. Also in **DI 938** the animals at hand produce wool according to a rate of 13:1; in this occasion, the final result is in balance because the missing lambs are clearly overcharged according to a rate of 3 animals per 1 wool unit. It must be noted that this rate appears to be unique in the whole archive, and that it is larger than the average rate of 4 animals per one wool unit, which is standard for rams or for mature ewes. On the other hand, in **DI 943, 947** and **952** ewes are overcharged according to a 8:1 rate, while the lambs are expected to produce wool according to a 13:1 rate, which is lower than the average rate.

From these inconsistencies one gets the impression that the palace administration fixed a precise general productive target, but also that, on specific occasions, the productive rate was rather variable and subject to changes. Thus, the problem consists in establishing whether this variability depended on the productive capacity of the lambs, or, on the contrary, on calculations made by the palace administrators.

First of all, this variability of rates can be tentatively explained studying the productive rate of the *ki* lambs and of the ewes. Following Killen, Halstead argued that in these tablets the true rate is not simply of ten animals per one wool unit, but of five ewes plus five lambs per one wool unit.¹³ Testing this assumption, however, we must consider that, since in these documents for each ewe there must be always one lamb, the productive rate might be based either only on the ewes, or on both the ewes and the lambs. In the first case, since 50 lambs plus 50 ewes usually produce 10 units of wool, we must conclude that if the production rests only on the ewes, they have to produce wool according to a 5 per 1 rate. In the second case, if the whole production rests both on the ewes and the lambs, the common rate must remain of ten to one — and the target suggested by Halstead appears not to be different from that suggested by Killen.

On these premises, a suggestion might be advanced. If a five to one rate is attributed to the ewes —which implies that the ewes alone can produce the whole quantity of the required wool—, it must be also admitted that lambs were not expected to produce any quantity of wool. However, the present status of the texts does not support this suggestion.

In **DI 932, 935, 943, 946, 948, 950, 952** all the lambs are missing from the herds: for this reason, a clear distinction between the production of the present ewes and that of the missing lambs can be envisaged. In this way we can see that, even if the rates are very changeable, no group of sheep produce wool according to a five to one rate. On the other hand, if lambs were not expected to provide wool, no explanation would be given for the fact that the balance provided in the tablets appears to be regularly conditioned by the presence or the absence of the lambs themselves, as it is clear from **DI 932, 943, 946** and **947**. In these tablets we can easily see that the final balance is reached only thanks to the production, or even to the over-production, which was expected by the lambs, and this regardless of the fact that also the ewes were overcharged (**DI (1) 943 DI (1) 947+7626**). Finally, if lambs were not expected to produce any wool, such an accurate attention to their wool production would appear frankly unjustified.

In my opinion, it must be taken as granted that lambs were expected to produce a certain quantity of wool; however, in the relevant documents a regular production rate could not be individuated. This may well be attributed to our inability to correctly understand the texts; but it can be reasonably suggested that it was the Mycenaean administration which met some problems in establishing a regular production rate.

Possibly, the problem can be given a solution taking into account tablets **Dk 1066** and **1067**, since they are clearly similar to the **DI** series tablets.

Dk(2) 1066 a] ‘ki’ ne X OVIS^m 200 LANA 19
b]te-u / ku-ta-to[
b [[*o* LANA]]?

Dk(2) 1067 a ‘ki’ ne X OVIS^m 100 LANA 6 M2
b a-ko-mo-ni-jo/ ku-ta-to
b [[*o* LANA]]?

These documents, although fragmentary, clearly mention flocks made up only of *ki ne* lambs which produce wool according to a reliable ten to one rate, no other kind of sheep being listed together.¹⁴ If we suppose that the determinatives *ki* and *ki ne* refer to similar kinds of animals, we can also assume that the *ki* lambs were expected to produce wool according to a ten per one rate. This same rate of ten per one can be found in tablets **DI 946** and **DI (1) 950+fr**, where the wool production is expected from the missing lambs. However, these are the only documents which attest such rate; data stemming from the other tablets are again contradictory. As we can see in the second line of the diagram, in the other tablets the production rate expected from the lambs is very variable, and fluctuates between three per one and fifteen per one.¹⁵

In my opinion, these conflicting data may be reconciled only if we admit that the palace administration was not able to establish a constant production rate for the *ki* lambs. The cause of this inability can be attributed to the problems arising from the very young age of the lambs. Actually, even few days of difference in age can involve great differences in maturity and physical development or in intrinsic strength. In a herd composed of under one year old lambs born in a period of one month, or even of two, the production capacity in wool can be extremely variable and thus is practically unpredictable.

However, it must be stressed that, notwithstanding the difficulty of predicting the wool production of young lambs, the palace did not renounce to take into account a minimal, albeit variable, quantity of wool produced by them. Since every bureaucratic administration always needs a budget, consisting of factual entries or of plausible estimates, it can be safely assumed that the Mycenaean scribes, in composing the budgets of wool production, had to recur to some peculiar estimate calculations.

In my opinion, they adopted the following procedure. On the one hand, they calculated a global, very low, ten per one rate for the mixed flocks. This was justified not only by the fact that young lambs could not guarantee a standard production of wool, but also by the fact that the ewes, affected by recent lambing stress, could not be considered fully productive. It must be stressed that ten per one is a very low rate for mixed lambs – female flocks, if we consider that the *ki ne* lambs were considered able to produce wool according to the same rate, or that four sheep can normally produce one wool unit. On the other hand, just thanks to such a low productive target, the necessary quantity of wool could be assured regardless of the kind of animals involved and of their productive capacity; as regards a single herd, the scribes did not make their calculations according to its real productive capacity, but took into account only the amount of the present wool plus the quantity of wool which was necessary in order to obtain the expected / desired balance.¹⁶

At this point, I would suggest a first set of conclusions: 1) A five per one rate does not exist. For the

mixed flocks the scribes constantly adopted a fixed rate of ten to one.

2) The *ki* lambs were considered able to produce a quantity of wool according to a ten to one rate only when they were included in the calculations together with the ewes.

3) The palace administration was not able to exactly predict the production rate of the *ki* lambs, since it is normally impossible to do so in any farming economy.

3. The age of the lambs

Since the productive capacity depends on the age of the sheep, the impossibility to calculate the *ki* lambs productive ratio can be something absolutely relevant for determining their exact age. Zootechnical and ethnoarchaeological research has demonstrated that lambs younger than twelve months should not be shorn in order not to compromise their future wool productivity.¹⁷ Moreover, it is well known that the wool produced in the first seven months is of poor quality: fleece is economically useful only after the seventh month, and generally after the first shearing.¹⁸ Considering these elements, we can develop two hypotheses.

3.1. First hypothesis: *ki* lambs are one-year old lambs

It might be supposed that these lambs were one-year old. Following this supposition, Killen in 1963 proposed that *ki* lambs were hogs.¹⁹ Moreover, referring to Middle Age England usages, He stated that the lambs were left to spend their first year in mixed flocks, and then were separated from their mothers and grouped in flocks exclusively made up of young lambs, where they remained until their maturity.²⁰

This kind of lambs is certainly recorded in the tablet **Dn 1319**, which bears the registration of a gathering in Amnisos of 11.900 lambs designated as *ne OVIS^m*. We know from the tablets that in Crete there were a high number of sheep-farms scattered in the whole territory; no farm with such a high number of lambs is ever attested in the texts. Thus, we have to admit that in Amnisos were gathered lambs coming from many, and distant, farms. This evidently required that the lambs had some specific capabilities. They had to be strong enough to afford long journeys; they had to be independent as regards their feeding; and they had to be enough mature in order to survive in the final, very large herd. Probably, one-year old animals can also be found in tablets **Dk 1066** and **1067**. In fact, as seen, in both tablets are recorded flocks made up of *ki ne* lambs which were required to produce wool according to an own rate of a ten to one. But it must be pointed out that in this case the animals are marked *ne* and *ki ne*, and not only *ki*.

In my opinion, a series of arguments clearly contradicts the possibility that Mycenaean scribes designated the one-year old lambs as *ki* lambs: in fact if we admit that *ki* lambs are one year old, as the *ki ne* lambs, we

couldn't understand: 1) why the scribes used different determinatives to designate animals of the same quality; 2) why *ki* lambs were not separated from ewes, unlike *ne ki* lambs. 3) why the palace administration established an exact productive rate for the *ki ne* lambs, while it maintained a vague rate for *ki* lambs; 4) why the ewes production, calculated according to their own rate, was not added to the production of the *ki/ki ne* lambs according to their own rate.

Finally, a consideration about the lambing stress is in place. Following Killen, these one year old lambs were the brood of those same ewes recorded on the tablets; obviously, they should have been generated at the beginning of year that *preceded* the drawing up of the tablets. However, This leads to a contradiction, since ewes pregnancy should have affected the productivity of the *previous* year, and not of the *current* one. In conclusion, I feel convinced that the *ki* lambs are not one-year old lambs.

3.2. Second hypothesis: *ki* lambs are four month old

However, a second hypothesis can be brought forth. If it is assumed that these lambs were less than one-year old, and that they were born roughly in January, it follows that at the time of the drawing up of these tablets, which is supposed to be roughly in May,²¹ the lambs might have been three or four months old. As we have seen, shearing lambs when extremely young is risky, and, most of all, economically unprofitable. However, the documents are clear in this regard: the *ki* lambs are expected to produce wool anyway.

As a solution to this contradiction, it has been suggested that when the palace scribes expected to gather wool from the lambs, they meant not a true shearing, but a mere plucking.²² As it is known, plucking is a kind of shearing, often used in ancient times, which does not require sharp instruments: it simply implies the plucking of the wool which falls naturally from the animal because of the seasonal moult of fleece. As a matter of fact, plucking submits lambs to a stress lower than that of shearing.

However, from an economical point of view, plucking involves two important problems. On the one hand, plucked sheep produce a lower quantity of wool than sheared sheep; on the other hand, plucking must follow the seasonal rhythm of moult, and for this reason it takes place, generally, two months after the usual spring shearing. According to the hypothesis that *ki* lambs were plucked, Halstead argued that the operations of gathering lambs and sheep took place in different periods,²³ thus finding a justification for the wool and lambs deficits.

In my opinion, plucking is a very probable option for the obtaining of wool from the lambs as attested in the texts. However, if, according to Halstead, we suppose that the procedures were performed in different periods, we might assume, for example, that ewes were sheared

at the right time, and the plucking of the lambs was effected two months later. Since the documents were recorded in May, it should be expected that the tablets would have listed a major quantity of ewes' wool, gathered recently, as well as a small quantity of wool provided by the lambs. However, this is not what we would need here: the tablets bear calculations of wool produced by both kind of animals, and the missing wool is expected both from the lambs and from the sheep.

On the Contrary, we can suppose that the scribes allowed the ewes to wait for the lambs' plucking, and recorded the whole amount of wool only after the plucking. In this case, we could not justify so high deficits either in wool or in animals; furthermore, plucking the sheep two month later than the right spring time would have caused an unreasonable loss of wool, because, as we have seen, shearing is economically more profitable from the point of view both of quantity and quality.

Finally, we can suppose that, at the time of the drawing up of the tablets, the work of plucking and shearing was *in fieri*; however, we must admit that the texts hint to a phase in which the wool was gathered from both sheep and lambs.

In my opinion, we may suppose that the Mycenaean administrators preferred to shear the sheep, and, at least, to make an early plucking of the lambs, perhaps waiting for the right time for plucking. In this case, the administration could secure the important wool production of sheep, however accepting the loss of a minimal part of the lambs' wool production, which anyway was low in quality and quantity. Consequently, I suggest that the whole operation of shearing the sheep and the lambs was performed contemporarily, not at the time of the lambs' moult, but exactly during the May - June shearing time, and that it was not yet completed when the texts were put into writing.

A further consideration is in place now. If the lambs were born in January, the time of shearing/plucking should correspond to the weaning phase, which takes place within their fourth month of life.²⁴ Thus, it might be suggested that, in April - May, when the tablets were drawn up, weaning either was being carried out, or had already been performed. In the first instance, *i.e.*, if weaning had not yet been carried out, we could hardly accept the absence of lambs from the herds, because it is well known that the lambs must remain with their mothers before weaning. In the second instance, *i.e.*, if weaning had already been concluded, we must argue that the Mycenaean shepherds forced lambs to afford a double stress, weaning and then shearing. Another kind of shock should be added, that is to say castration, which is imposed to the lambs within their first year of life. In my opinion, it is not conceivable that animals were subjected to so many stresses at such young age. For this reason, I cannot accept the hypothesis that these lambs were only three or four months old.

3.3 A third hypothesis: *ki OVIS* are six-eight month old lambs

In conclusion, I would suggest a different solution. As is well known, shepherds usually prefer that ewes are covered in July - August, in order that the lambs be born in January, and may enjoy the fresh spring pasture. Moreover, a spring covering can also occur: in this case, the birth of the lambs takes place at the beginning of autumn.

If we suppose that the *ki* lambs were born in autumn, and exactly in the autumn which preceded the destruction of the palace of Minos, at the drawing up of these tablets, which was during the successive spring, they should have been six-eight months old. At that age, generally lambs have already been subjected to weaning, probably to gelding, but are surely not yet independent: they do not need the physical presence of their mothers, but they still need to live in mixed female flocks. Thus, they are close to be ready to the final separation from the mixed female flocks, and are almost ready to be grouped in only-lamb flocks, as attested in **Dk (2) 1066, 1067** and **Dn 1319**. From the point of view of wool production, they are certainly more mature than four-months old lambs, and for this reason they should be enough strong for resisting to plucking or even, perhaps, to the shearing stress. They are not yet ready to provide a regular standard of production as the *ki ne* lambs, but the palace administration can require from them a small quantity of wool, since, as we have seen, animals begin to have a valuable fleece just around their seventh month. On the other hand, as concerns the ewes which are mentioned in the texts, nothing prevents that they may be the mothers of these lambs: they provided a low wool production because of the lambing stress they had suffered in the previous autumn.

4. Conclusions: “weaning”, “missing lambs” and “missing wool”

If we accept the hypothesis that the *ki* lambs were born in autumn, at least two problems remain to be explained. First, the great number of lambs, and the great quantity of wool which were missing at the moment of the census; and, second, the fact that the palace administration was able to require from the missing animals a specific quantity of wool which could not be granted by the present animals, although their production rate was very low.

If the *ki* lambs can be considered about six-eight months old, they had certainly been weaned previously, since weaning implies that the lambs be separated from their mothers during their fourth month of life. We must conclude that the Mycenaean shepherds had to separate lambs from female during the weaning period, as it was and is customary in every pre-industrial sheep breeding. However, as we have already stressed, lambs must also be placed in mixed female flocks until they are one year old. According to this hypothesis, we can assume that

the Mycenaean sheep breeders had to separate the lambs from the ewes for the weaning phase, and later to gather again the animals, and to make up mixed, lambs - female flocks.

In such a double process, the palatial administrators had two management options. The first is represented by a series of operations: first the disbanding of all the flocks, and the creation of new economical and fiscal units, and finally the composition of all the herds anew after the weaning, i.e. ca. one month later. The second option is simpler and avoids such operations which sound clearly useless. The scribes might have considered all these flocks as a whole, from a fiscal and economical point of view, and for all intents and purposes, even though the flocks had been temporarily disbanded.

This hypothesis may offer a solution to the problem of the missing lambs. We might consider the rather high number of missing *ki* lambs not as a real deficit in the herd, but simply as a consequence of the separation of the lambs from the ewes during the process of weaning. It is probable that all the lambs were grouped together in a different sheepfold.

At the time of the drawing of these tablets, which can be ascribed to the period which followed immediately the weaning of the lambs and preceded the gathering of the flocks, the lambs which had previously been in the mixed flocks were not with the mothers just because of the weaning operations. For this reason the scribes had to record the fiscal missing of lambs, regardless of the fact that they were only temporarily absent, and not factually missing: within a month the flocks would have been gathered, but at the moment of the drawing of the texts, they were not yet. This assumption implies a consequent hypothesis: if the lambs were not factually missing, their wool too was not missing. Exactly for this reason the scribes were able to require “missing” wool from the “missing” lambs: the lambs were not factually missing, and consequently the wool was only temporarily missing.

If the age of the *ki* lambs was between the sixth and the eighth months, a more precise definition of the related kind of lambs, such as *ne* and *ki ne*, is in place here. We have already seen that in **Dk (2) 1066, Dk 1067, Dp 699, and Dn 1319+5307+5568** these lambs must be considered slightly older than the *ki* lambs, since, unlike the latter, they are capable to produce wool according to an exact rate (a ten per one rate in the absence of the ewes), and they can also be inserted into flocks made up exclusively of lambs. On the other hand, it is clear that they cannot be considered fully mature lambs, as it is demonstrated by their low production capacity. In conclusion, I think that the determinative *ne* added to the determinative *ki* refers to the lambs which are slightly more than one year old.

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¹ The meaning of this ideogram was identified in the first edition of Chadwick-Ventris' *Documents in Mycenaean Greek*. For references see Chadwick-Ventris 1973, 195-196.

² Chadwick-Ventris 1973, 195-213.

³ Killen 1962, Killen 1963, Killen 1964, Killen, 1966, Killen, 1979.

⁴ Killen 1963, 81-83, Killen 1972, 434-440, Melena, 1974, 309.

⁵ The abbreviation *WE* appears in **D 411+511**, **DI(1) 790**, **DI(1) 791**, **DI(1) 792+7619**, **DI(1) 916**, **DI(1) 934+7082**, **DI(1) 7072**, **DI(1) 7076**, **DI(1) 7086**, **DI(1) 7092** **DI(1) 8103**. For details see Chadwick-Ventris 1973, 590, Greco 2001b, 252-278, Halstead 1998, 187-199, Killen, 1987, 327-328.

⁶ Killen 1964, 12.

⁷ Killen 1964, 12-13.

⁸ Greco 2003.

⁹ For a recent study on wool weights with ample bibliography see De Fidio, 1999, 195-204.

¹⁰ Killen 1964, 11-12.

¹¹ In **DI (1) 463** the productive rate is 8:1. However, we have to stress that the reading OVIS⁴ 46 in the line 'a' of the tablet is not sure.

¹² The tablet is fragmentary, and the number of the wool units (11) is certainly not complete; however, an emendation of the number to 11[+1] is highly probable.

¹³ Halstead 1994, 346-347 and Halstead 1998, 189.

¹⁴ Both these documents are fragmentary; however in both tablets there is space for an integration. In **Dk(2) 1066** [o LANA I] can be supplied in the 'b' line; in the more problematic **Dk(2) 1067** it is necessary to supply [o LANA 3 M I].

¹⁵ **DI(1) 938**: 3:1; **DI (2) 946**, **DI (1) 950** 10:1; **DI(1) 943**, **DI(1) 952+7959**: 13:1; **DI(1) 947+7626**: 14:1; **DI 1060**:15:1.

¹⁶ This is what happens even in PY **Ma** and KN **Mc** series, where, using the words of Halstead 1999a, 38: "assessments... were based on a fixed ratio between commodities and made no allowance for the local ecology of each contributing sub center or community, implying that taxes were collected in readily attainable quantities."

¹⁷ Ryder 1993, 17.

¹⁸ Mascheroni 1926, 38.

¹⁹ Killen 1963, 73 note 12 and 80, note 28. In zootechnical language, the hogg is an unshorn lamb between its first and second shearing. However in the successive papers, Killen abandoned such specific definition and considered the *ki* lambs simply as one-year old lambs: Killen 1993, 210.

²⁰ Killen 1963, 79-80.

²¹ Godart 1992, 201.

²² For plucking, see Melena 1987, and Ryder 1993. For the connection with this context, see Halstead 1999, 156.

²³ Halstead 1999, 157-158.

²⁴ For the seasonal weaning see Tortorelli, 1984, 94-96.

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