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NUMERICAL FRACTIONS IN THE MINOAN LINEAR SCRIPT A

II. THE MEASUREMENT OF DRY COMMODITIES AND THEIR USE IN THE PAYMENT OF MINOAN LABOUR

I. Introduction

In the preceding report[1] the symbols for fractions in the Minoan Linear Script of Class A have been given their appropriate values. The purpose of the present report is to analyze some of the questions concerning the Hagia Triada texts which, as far as the listed numerical values are concerned, can now be read. More particularly this report deals with the question whether, apart from the main unit for measuring dry capacity, any sub-units were in actual use and, if so, what were their absolute values. Besides this, the question of payment of labour will be investigated. Other questions — the measurement of liquid commodity and the use of a system for weight — are reserved for subsequent reports.

Basic to any consideration of the distribution of cereals and figs, which constituted the elements forming the basic pay-package, is the question of the amount thereof used as payment for one day's labour. On this issue Palmer[2] will be followed who, for the conditions recorded in the accounts written in the Linear Script B, set this amount at the equivalent of 1 khoinix, and in conformity therewith the full unit at sixty such khoinikes or about 54 litres. The question arises what symbol represented such per diem capacity.

In the following account the Ventris values as codified by the Wingspread Conference[3] will — as far as feasible — be given to the

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[1] D. A. Was, Numerical fractions in the Minoan Linear Script A—I. The evaluation of the fraction signs, Kadmos 10, 1970, 35—51

[2] cf. L. R. Palmer, The interpretation of Mycenaean Greek texts, Oxford 1963, 14, 96ff.

[3] Proceedings of the Third International Colloquium for Mycenaean Studies, Wingspread 1961, Madison 1964, 253ff.

Minoan syllabic symbols to facilitate the printing and recognition of Minoan words. This does not imply at all that it is permissible to do the same in the transliteration of these texts.

For ready reference the values for the symbols for fractions are given in Figure 1.

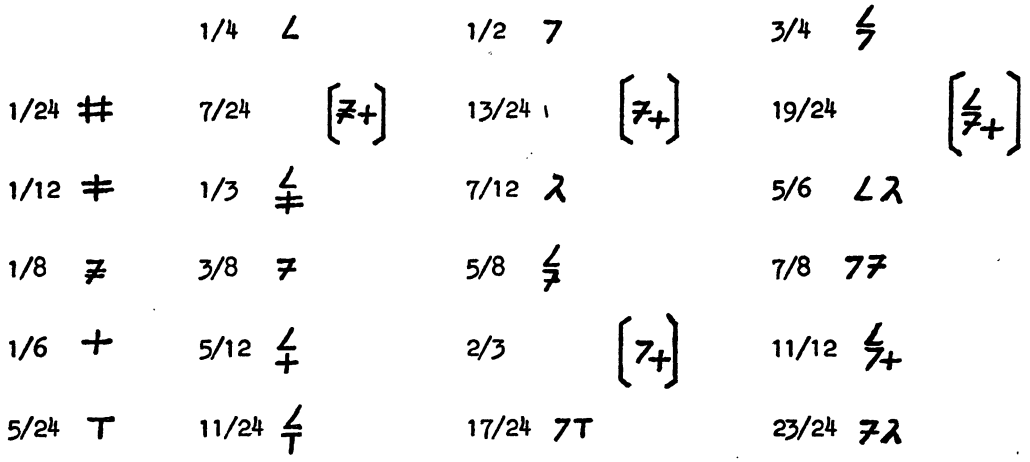

Figure 1 — Minoan fractions

II. The identity of the Minoan equivalent to the Mycenaean khoinix

As in the Mycenaean system, the symbol representing such a unit should be found at the lower end of the subdivision, but should not necessarily be the very smallest. In the previous report, such lower units have been established to comprise $^1/_{30}$, $^1/_{120}$ and $^1/_{144}$ of the main unit. These are also (and in the last-mentioned case exclusively) used as ligatures to the wheat symbol (cf. Figure 2) which discloses their possible use in a system of dry measure. No doubt exists that the units $^1/_{30}$ and $^1/_{120}$ were actually used as a separate measure. On a clay tablet from Knossos[4], IV 3b, we find the following:

1st entry	$^1/_{30}$
2nd entry	2
3rd entry	$3^1/_{30}$

This might be a simple record of different amounts, but it makes more sense when the amounts are expressed in $^1/_{30}$ units; in which case the scribe noted in sequence one, two and three of such units.

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[4] cf. W. C. Brice, Inscriptions in the Minoan Linear Script of Class A, O. U. P. 1961

Notation	Symbol	Fractions of dry capacity
L 42		1
Lc 6		7/12
Lc'7		1/2
Lc 7		3/8
Lc 74		1/6
Lc 8		1/8
Lc 4		1/30
Lc 2		1/120
Lc 11		1/144

Figure 2 — The wheat symbol ligatured with fractional signs

Similarily IV 14 lists:

1st entry	$^1/_{120}$
2nd entry	60
3rd entry	60
4th entry	60

Here again this might be a simple record of amounts expressed in main units, but in that case the ratio of 7200 between the largest and the smallest strikes one as odd. A more sensible interpretation would be that the first entry is considered as the heading, stating

that a certain commodity is listed below in $^1/_{120}$ full units; there follow three times 60 of such small units. This interpretation will be confirmed in Section III below.

	Linear B		Linear A			
Capacity in 0.9 litres	According to Palmer	V. & Ch.	Possibility 1	2	3	
120		Unit	Unit			
60	Unit			Unit		
30					Unit	
12		𐄷				
6	𐄷					
4			𐄀			
2		𐄁		𐄀		
1	𐄁	vacat	𐄂	vacat	𐄀	"khoinix"
5/6			𐄷 𐄀			
1/2		𐄃		𐄂		
5/12				𐄷 𐄀		
1/4	𐄃				𐄂	"kotyla"
5/24					𐄷 𐄀	

Figure 3 — Comparison of unit capacities

As to the identity of the symbol expressing the Minoan khoinix, we have no choice, as is demonstrated in Figure 3 in which the absolute capacities have been expressed in 0.9 litres to avoid the complication that the khoinix does not fit into the metrical system. Three possibilities of equating the Linear A system with that of Linear B appear to exist. The second possibility is ruled out by the fact that it does not include a symbol for one khoinix. The third possibility is also excluded, as will follow from Section V below, in which the allocation per man per diem will be demonstrated. Applying

that possibility would involve payments for inter alia 7½ and 12½ days of labour, which cannot be accepted as realistic. It follows that the only remaining possibility, the first, must be accepted.

The conclusion becomes inevitable that the Minoan medimnos was subdivided into 30 parts comparable in capacity to the classical hemina and subsequently into the khoinix ($^1/_{120}$) and five-sixths thereof. The reasons for the existence of this lowest unit will become apparent from the following sections of this report.

III. The measurement of wheat

With a single exception, wheat is the only commodity the symbol for which is ligatured with fraction signs (cf. Figure 2). The exception is the ideogram L 71, to be discussed in the next section of this report.

Ideogram Lc 9, the wheat symbol with two horizontal cross-bars, could be read "wheat + *pa*" or "wheat $^1/_{12}$" (cf. Figure 1). However, the latter alternative is excluded by the fact — demonstrated on HT 102 — that amounts of wheats so expressed can be added to unligatured wheat. Consequently, this symbol has no place in the list on Figure 2.

The roundel from Mallia, III 12, has four units of Lc′ 7 ("wheat ½"). This could have been written "wheat 2", and the fact that this was not done indicates that one half measure was in use as a separate sub-unit. It corresponds to the Mycenaean medimnos and 60 khoinikes. I propose to term this unit the hamina.

Similarly, on HT 86 the ideogram Lc 74 ("wheat $^1/_6$") is followed by the numerals 20 and 10 respectively, which amounts could have been expressed as "wheat $3^1/_3$" and "$1^2/_3$", both fractions being present in the list of fractions of Figure 1. This example therefore also presents us with a separate sub-unit, equalling 20 khoinikes, which may be termed the sekteus. This conclusion is substantiated by the entry "wheat $^1/_6$" followed by numerals 60 on HT 120, which otherwise would have been noted as "wheat 10". In view of the reference to a similar notation on HT 108, discussed below, it must be added that the interpretation relevant to that text is not applicable here, as HT 120 is a simple enumeration of deliveries (actual or due).

The ideogram Lc 8 ("wheat $^1/_8$") appears in the heading of HT 115, and although this may be taken as indicative of the

existence of the okteus, the amounts expressed on the tablet are such ($^{23}/_{24}$, $^{1}/_{12}$, $^{1}/_{4}$, $^{4}/_{5}$, $^{1}/_{5}$) that they could not all have been expressed in terms of a single fraction. It seems likely, therefore, that in the heading of the text the notation $^{1}/_{8}$ was solely intended for the purposes of calculation. At present, as long as we do not understand the words on the tablet[5], we cannot be sure of the existence of the okteus as a measuring unit[6].

Next, we can rule out such a function for the symbol Lc 6 ("wheat $^{7}/_{12}$"). On HT 108 this symbol is followed by numerals 70 under a heading including the ideogram L 126, depicting a woman with a bundle on her back and holding in front a pickaxe or hoe. If it is accepted that such female labourers were paid one khoinix of wheat per diem, the relevant entry should logically read "wheat $^{7}/_{12}$ for female labourers seventy". In Section V it will be shown that these people were actually receiving such pay.

The situation with respect to the ideogram Lc 7 ("wheat $^{3}/_{8}$") resembles that discussed above regarding Lc 8. It appears on HT 44 and 125. On the former tablet the numerals have been lost, on the latter we read 7¼. The amount $2^{23}/_{32}$ could not have been expressed otherwise; consequently, here also the ligature has been used solely as a tool for calculation.

Turning to the smaller fractions Lm' 1 ($^{1}/_{30}$) and Lm' 2 ($^{1}/_{120}$); as has been demonstrated in Section II, these are comparable to the classical hemina and khoinix; their actual use as sub-units of measurement is demonstrated by the following documents. The wheat symbol ligatured with the first, Lc 4, is followed on HT 22 by the numerals 230 which could have been written: "wheat $7^{2}/_{3}$ (full unit)".

Similarly, Lc 2 ("wheat $^{1}/_{120}$") is followed by the numerals 570 on HT 15, which could have been written 4¾, indicating the use of the khoinix as the unit of measurement. This text is even more instructive and needs fuller discussion. It can be rendered as follows:

HT 15	heading	
	Lc 1*	684

[5] Singularly enough, the entries comprise such words as *sekutu* and L 61-*mina*, readable as hamina (L 61 being the only symbol comparable to Linear B *25*, a_2), but any reading of the Minoan words at present involves extrapolation into the unknown.

[6] In an analysis of the Mallia tablet H 20 in the hieroglyphic script, such a unit appeared as a distinct measure (cf. the author, B. I. C. S. 18, 1972).

(wheat $^1/_{120}$)	570
L 87, *kiro*	400

N.B.* wheat + a three-syllable word

The second entry corresponds to 684 of a $^1/_{144}$ unit, or precisely $^1/_{144}$ of the first entry if the ligature of the wheat symbol Lc 1 signifies a quality, not a particular amount. In order to show more clearly the ratio between the two amounts of wheat, and assuming that Lc 11 ("wheat $^1/_{144}$") was a measuring sub-unit, the scribe would have noted: Lc 11.684. Consequently, Lc 11 has to be rejected as such a distinct unit of measurement.

The ideogram Lc 11 occurs on HT 86 with numeral 20 and on HT 120 with numeral 74; these amounts cannot be expressed otherwise and the notation was only used for calculating purposes.

Summarizing the above, it appears that the system of units of measurement was as expressed in Table I.

Table I

Minoan system of measures for dry commodities

Notation	Fraction of main unit	Fraction of preceding	Suggested denominator	Corresponding Mycenaean units
none	1	—	medimnos	
Lm 1	$^1/_2$	$^1/_2$	hamina	medimnos
Lm 19	$^1/_6$	$^1/_3$	sekteus	
Lm′ 1	$^1/_{30}$	$^1/_5$	triakosteus	
Lm′ 2	$^1/_{120}$	$^1/_4$	khoinix	khoinix

IV. The measurement of other cereals

The other cereals are barley, L 87, and another species, L 71, to which reference has already been made in the preceding section. The first has never been indicated with a fractional sign[7]; the latter (cf. Figure 4) only[8] with the symbols for $^1/_2$ and $^1/_5$.

This raises two questions: a) why is the barley ideogram never so ligatured? and b) why is L 71 calculated or measured in a unit — 24 khoinikes — not found with wheat?

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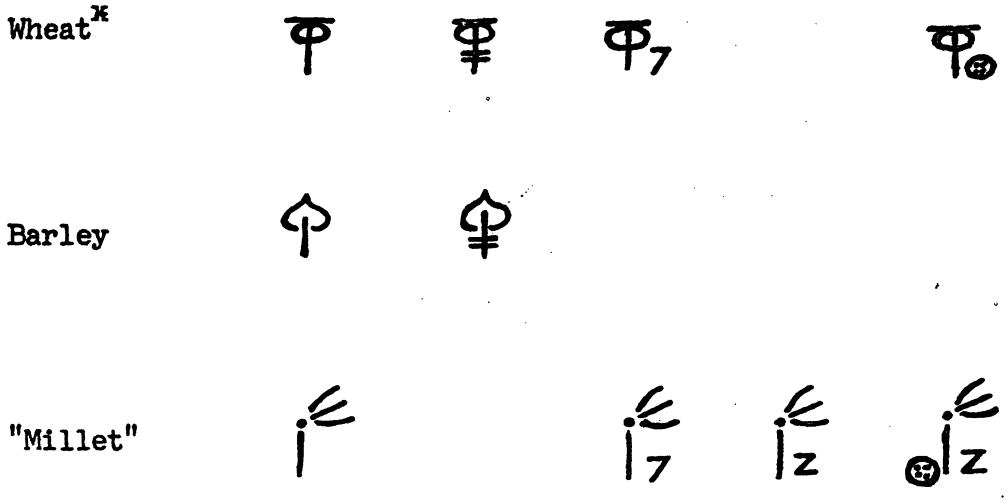
[7] Its only ligature involves the syllable *pa*

[8] Subject to being ligatured with the syllable k^we

Commodity



* for complete list cf. fig. 2

Figure 4 — Ligatured cereal ideograms

Judging from the Mycenaean texts[9], barley had a market value only half that of wheat, which complicates the calculation of pay-rations when they include this commodity. As the frequency of occurrence of the barley ideogram is only one-half that of wheat, and the amount much lower, usually about one-eighth, it appears that it only served a significant additional rôle in the Minoan economy. In that case it is understandable why it was not deemed necessary to measure it in sub-units. Why then did this not apply also to the cereal L 71? That species apparently ranked equal to wheat, and on many accounts it takes the place of the latter cereal in the sequence of listed commodities. The same is true in the Mallia account[10] H 20, where the symbol has the same design as L 71 on Cr V 3.

[9] cf. Palmer, op. cit. 14, 96ff.

[10] cf. F. Chapouthier, Mallia, Les écritures minoennes au palais de Mallia, 1930

It is tempting to identify this ideogram with millet (Panicum italicum L.) because of its multiple 'ears'. Moreover, its use would seem to place it on a par with wheat. For the sake of convenience this identification will be adhered to below.

As to the use of the fractions $^1/_2$ and $^1/_5$ for millet, the same arguments apply as with wheat; the evidence is given in Table II.

Table II

Amounts of millet listed in fractions

Document	$^1/_2$ Amounts	$^1/_5$ Amounts	Possible significance
HT 12	3		$1^1/_2$
HT 110	21		$10^1/_2$
Cr IV 4		2	$^2/_5$
Cr IV 6		1	$^1/_5$
Cr IV 9		3	$^3/_5$
Cr V 3		3	$^3/_5$

A complication arises from the observation that in the Cr series the millet ideogram is associated with Lc' 5, taken to represent "barley + *pa*". Cr IV 9a has the notation "3 Lc' 5, L 71", which rules out the possibility that Lc' 5 is a ligatured barley ideogram. I suggest that we are confronted with one of many monograms, and that it should be read as *ti/pa*. It will be shown below that this monogram refers to a kind of labour.

The second question raised near the opening of this section will be dealt with in the next.

V. The payment of Minoan labour

The script has a number of ideograms which can only represent labourers. Such are L 99, L 99', L 109, L 122, L 125, L 126, Lc 55 (Figure 5). These occur not infrequently in lists containing shorthand notation or words which may involve other references to labourers. To bring the evidence into proper sequence, the pertinent texts must be analyzed in sequence. One record of the same class (HT 27) is too damaged to reconstruct.

Notation	Symbol	Notation	Symbol
L 99		L 122	
L 99'		L 125	
L 109		L 126	
Lc 55			

Figure 5 — Labourer ideograms

Document HT 100

This can be rendered as follows:

HT 100 (heading broken off)

	Lc 55	58* (labourer + *ka* symbol)
	Lc' 5	4*
	sadi	12
	ki	2
	L 66	5
	L 125	16 (labourer symbol-women)
kuro		97
$sara_2$		
	millet	$5^1/_2$
	figs	$2^2/_5$

(rest of text not of interest; it concerns amounts of wine and oil, sometimes added to the daily pay-rations but not forming part thereof.)

N.B.* From the way in which the scribe notes these digits in two superimposed rows, the figures, which are damaged, must be reconstructed in this fashion.

It will be noted that the symbol Lc' 5, the meaning of which was doubted above, occurs in an enumeration containing symbols for labourers; as a total count of heads is made, Lc' 5 should be taken

as indicating some sort of individuals to be included in the allocation of food following the second heading, *sara*$_2$.

The number of individuals is 97, and the amount of millet and figs to be distributed is 7 $^9/_{10}$ full units or 948 khoinikes. This is close enough to indicate a payment of one khoinix per diem for a period of 10 days, if it is accepted that one or more categories receive somewhat less than such normal pay-ration. Two solutions present themselves:

a) categories 2, 4 and 5 (Lc′ 5, *ki*, L 66) receive only $^4/_5$ of a khoinix per diem, thus: $10\times(4 + 2 + 5)\ ^4/_5 + 10\times 86 = 948$

b) categories 2, 4 and 6 (Lc′ 5, *ki*, L 125) receive only $^9/_{10}$ of a khoinix per diem, as follows:
$10\times(4 + 2 + 16)\ ^9/_{10} + 10\times 75 = 948.$

The latter solution seems the less likely, as it would indicate discrimination against female labour in respect of the basic amount of food. This issue is solved by HT 89.

Document HT 89

This document is of the same kind as the previous one, and can be presented as follows:

HT 89	*a . sara*$_2$.	L 56	
	L 66	23	
	Lc′ 58	22	
	*maimi**	4	
	L 125	13	(labourer symbol-women)
	tara	5	
kuro		67	
	wheat	20	
	figs	6	
	(wine	10**)	

N.B. * L 100 has been rendered *i* as distinct from L 100 = *no*[11]
** Can be disregarded for purposes of calculating daily pay-rations.

Categories 1 (L 66) and 4 (L 125) also occur on document HT 100 discussed above; the first of these categories was included in those receiving reduced pay, either $^4/_5$ or $^9/_{10}$ of a khoinix per diem.

Here 67 people receive a total of 26 full units, or 3120 khoinikes, whereas at full pay (one khoinix per diem) 3350 such sub-units

[11] For this distinction, cf. C. H. Gordon, Evidence for the Minoan Language, Ventnor 1966, Pl. XI; E. Peruzzi, Le iscrizioni minoiche, Firenze 1960, 35ff.

would have been required for fifty days. The difference amounts to 230 khoinikes or $^{23}/_{5}$ per diem. This figure can be divided by the number (23) of those of the first category (L 66), but not by any other figure or combination of figures. Consequently, of the solutions discussed under HT 100, a) is correct. In other words, the categories in question are L 66, *ki* and Lc′ 5, and they receive only $^{4}/_{5}$ of a khoinix per diem.
The measurement of millet in one-fifth units (= 24 khoinikes), to which reference has been made in the preceding section, becomes understandable if such a sub-unit corresponds with a payment for thirty days to these 'underpaid' categories. The reason why this sub-unit is used for measuring millet but not wheat may be that it is frequently associated with one of these categories, Lc′ 5.

Document HT 88

This is a very simple document in a perfect state of preservation. Its contents can be simplified as follows:

HT 88	*adu*		
	Lc 55	20	(labourer + *ka* ideogram)
	ta$_2$*k*^{w}*a*	6	
	figs, *kikina*	7	
	kiro		
	6 names, each with numeral 1		
	kuro	6	

It appears that the amount of figs cannot be divided by 20 + 6, which might be the aggregate of heads to be paid. Two constructions are feasible. The first involves the deduction of 6 from 20, leaving 14 people to deal with. At a rate of 1 khoinix per diem, the amount of figs corresponds to 60 days' payment for that amount of labourers (840 khoinikes ~ 60 × 14). However, this seems an unlikely reconstruction; why list first twenty labourers, then deduct 6 and pay only those left? The alternative interpretation does not present such a problem.

If the entry *ta*$_2$*k*^{w}*a* 6 corresponds with the six names recorded under *kiro*, and assuming that reference to names or functions indicates status, it may be taken that such people earn more than anonymous labourers. If such bonus is set at x khoinikes per diem, the following simple equation emerges:

$$20 + 6 + 6x = \frac{840}{y}$$, y being the number of days.

This leads to $x = 1^1/_3$ for $y = 30$; in other words, the bonus consists of $^1/_3$ of a khoinix per diem. Other constructions are possible — e.g. for $y = 28, 15$ or 14—but these lead to a disproportionate bonus, raising the pay of the *kiro* people to five, respectively 31 and 35 times standard payment. On the other hand a bonus of one-third seems reasonable. The residual doubt will be eliminated by the analysis of the next document.

Document HT 94

This account is of the same type as HT 88, only more complex, as will be seen from the following simplified presentation of the text:

94a *kiro*
5 names, each with numeral 1
kuro 4 + (= 5)*
L 35
3 (4) names (damaged)**, second name shows numeral 1

94b *kapa*

L 99	61	(labourer ideogram)
L 35	20	
a	7	
L 126	18	(labourer ideogram-women)
ta	4	
kuro	110	
$sara_2$		
millet	4 + (= 5)*	
figs	$3^7/_{12}$	
damaged entry	11	
millet	$^2/_5$	
figs	$^2/_5$	
missing entry		
missing ideogram	$^1/_4$	
figs	$^1/_5$	
part tablet missing		

N.B. * Taking into account the standard notation of the digits in two superimposed rows, it appears that in both cases we have to read 5. In the first case this is confirmed by the preceding number of entries.

** In the missing part of the text, room could be found for a fourth name. The question whether to read three or four will be further considered below.

From that part of the text on face b which is headed by *kapa* (apparently an enumeration of heads including two labour symbols) it may be deduced that those listed under *kiro* on face a) are not included; for no corresponding category of five is mentioned. This arrangement is different from that of HT 88, but in that case no total was added. The three or four names under the heading L 35 on face a) are presumably included in the number 20 listed after the same symbol — which may be taken as a professional denomination — in the *kapa* list on face b).

The first clue to the text is that the payment record headed by $sara_2$ on face b) is subdivided into three parts, the second of which starts with numeral 11. This number corresponds with the aggregate of 7 *a* people and 4 *ta* people. It must be assumed that the first part of the $sara_2$ payment list deals with all persons not paid according to the second part. Obviously, other constructions remain theoretically possible, but none leads to any systematic subdivision of the payment list.

It is not intented to describe here all the author's futile attempts to solve the question, but to explain the only approach to the calculation recorded in the text which was found feasible.

The eleven persons in the second part of the pay list receive $^2/_5$ of millet and $^2/_5$ of figs; a ratio of 1:1. If this is compared with the millet/figs ratio in the first part — 5 against $3^7/_{12}$ — it is apparent that the eleven get relatively more of the subsidiary commodity, figs, and therefore that they are of lower status. As such, they may be expected to receive a total payment lower than normal. From HT 89 and 100 we have concluded that some categories receive only $^4/_5$ of a khoinix each. The amount recorded here is $^4/_5$ or 96 khoinikes which, however, cannot be divided by the number of people, 11.

Here we should pause to consider that the five individuals listed under *kiro* on face a) are not included in the counting of heads; consequently, they must have been assigned to the groups of anonymous labourers. If we take it that one of the *kiro* people is joining the eleven *a* and *ta* people, their total becomes twelve, and 96 khoinikes suffice for a ten days' rationing of twelve "$^4/_5$ individuals".

Obviously, if this is used as a working hypothesis it follows that the *kiro* person in question does not receive his or her due, and that we shall have to look for a correction of that state of affairs. Also if the second part of the pay list records payments lower than normal, it is to be expected that the first part contains the normal

payments and, moreover, that this should apply to the *kiro* and L 35 individuals as well.

Turning to that issue, we first have to appreciate .

a) that the normal payment should deal with 110 minus 11, that is 99 inclusive of the three or four mentioned under L 35 on face a); and

b) that it should also deal with the other four of the five *kiro* individuals assigned to the working parties under a).

This leads by conclusion to a total of normal payments for $99 + 4 = 103$ people. The amounts listed correspond to 1030 khoinikes, exactly sufficient for a ten days' payment.

This is encouraging, but it should be checked, as the *kiro* people have not yet received their due, and neither have the L 35 named individuals who — we should expect — receive a similar bonus. It follows from HT 88 that *kiro* people receive a bonus of $^1/_3$ of normal pay, and it might be assumed that this holds irrespective of the basic payment of their assigned jobs. This consideration eliminates the need to consider separately the one *kiro* assigned to the party of eleven.

We are still in doubt as to the number of L 35 individuals, whether there are three or four; consequently, the next or third section of the pay list on HT 94b should deal with the bonuses for either 5 + 3 or 5 + 4 named individuals. This entry first lists $^1/_4$ unit, the commodity sign having been lost. This corresponds to 30 khoinikes or 10 days' additional payment of one-third of a khoinix per diem for 9 people, assuming the number of L 35 individuals mentioned on face a) to be four, not three.

The text ends with a final entry of "figs $^1/_5$". After three entries on the pay list — basic payment, reduced payment, and additional payment — it seems that the only other item still worth mentioning is the saving resulting from employing cheap labour. As we have seen, this involved twelve people receiving $^4/_5$ of the full unit. Normal pay would require 10×12 khoinikes, or 1 such full unit; saving $^1/_5$! The fact that this entry follows immediately after the entry of $^1/_4$ might indicate that the heading of the third part of the pay list has indicated "bonuses and savings".

This reconstruction — and it might be repeated that no other combination of the pertinent numbers leads to any acceptable solution — indicates the following information additional to what was found before:

a) the *kiro* people do not belong to the hired labour force; their pay is that of the labour to which they are assigned with a bonus of $^1/_3$ of a khoinix per diem;
b) some (professional) individuals belonging to the hired labour receive equal treatment with the *kiro* folk;
c) two other categories (*a* and *ta*) have been added to the cheap labour force.

It may be said that the construction analyzed above is complex, but so is the relevant text. However, we have a check in the distribution of the pay rations over the commodities millet and figs. Some system corresponding to the various categories of personnel should emerge. It has already been pointed out that the cheap labour force receives those commodities in a 1:1 ratio. If we now assume that female labour receives similar treatment, although at full rate, the following picture is obtained.

	millet	figs
full normal pay list (103):	600	430 khoinikes
for female labour (18):	90	90
rest (85):	510	340, ratio 3:2

For the named individuals 30 khoinikes, or $^1/_3$ per individual per diem, of an undisclosed commodity are added; obviously, they are treated preferentially over the anonymous group. Their pay then consists of millet $^1/_3 + {}^3/_5$, figs $^2/_5$, total $1^1/_3$ khoinikes in a ratio of 7:3. This leads us to the following arrangement of the pay-system:

cheap labour	$^4/_5$	khoinikes p. d.,	ratio millet/figs 1:1
female labour	1	khoinix p. d.,	ratio millet/figs 1:1
male labour	1	khoinix p. d.,	ratio millet/figs 3:2
supervisors	$1^1/_3$	khoinikes p. d.,	ratio millet/figs 7:3

HT 22

The upper part of this tablet is missing, the remaining lists:

HT 22	wheat $^1/_{30}$	230
	L 35	113

L 35 has been disclosed as indicating some special labour, and, moreover, those belonging to that denomination, but mentioned by name, are entitled to receive a bonus of one-third of a khoinix per diem. This document, therefore, seems to record a two days' pay for 113 persons including six of the named category. Conse-

quently, the missing upper part of the tablet should have contained six names, perhaps preceded by the entry "*kiro* — L 35" as on HT 94. The text is of the same category as HT 108 in which the number of persons follows the amount of cereals available for distribution.

VI. Additional information

In the preceding section the Minoan pay system has been explored. Because of its complicated structure HT 94 did yield the extra information as to the different ratios of millet and figs to which the various categories of personnel were entitled or, perhaps, for which they contracted. It would be of direct interest if some of the other documents discussed would allow a similar breakdown of the pay-ration. This has indeed been possible and, moreover, categories common to HT 89 and HT 100 appear to have been treated identically in both documents. The results have been arranged in Table III. Records indicating payments either in cereals or figs have not been included, as these are of no interest in this context.

Quite remarkable is the distinction between the two categories of women, L 125 and L 126; pictographically the only difference is that the first have the pickaxe over their shoulders, whereas the others hold it in front. One would be inclined to think that the difference indicated resting and working; it is therefore puzzling that the treatment should be so much better in the first instance.

The information available does not allow a decision as to whether we have to do with a superimposed payment system or a record of labour contracts. Nevertheless, the wine ratios seem to point to the latter possibility. If wine is included, the amounts increase with a better ratio between cereals and figs, but the *sadi* category shows that there is no fixed relation between these two factors. It seems possible that the cereals/figs ratio had become a custom[12], but that there was a certain contractual freedom with regard to the 'extras' like wine and oil which were not always added. It may be observed that certain categories of personnel who receive similar treatment with regard to the cereals/figs ratio also have a like entitlement to wine. But this does not rule out the possibility of bargaining, for even freedom to contract tends to become standardized by custom. In this respect it might be noted that the high cereals/figs ratio of

[12] But the category Lc 55 receives only figs on HT 88, L 35 only wheat on HT 22.

the *sadi* category is offset by a lower wine ratio, an indication, perhaps, of contractual freedom.

Table III

Payment (per diem) of labourers

Symbol	Basic pay (khoinikes)	Ratio (cereals/figs)	Wine (added)	Evidence
L 66	$^4/_5$	1:1	$^2/_{10}$	HT 89, HT 100
Lc′ 5	$^4/_5$	1:1	$^2/_{10}$	HT 100
ki	$^4/_5$	1:1	$^2/_{10}$	HT 100
a	$^4/_5$	1:1	none	HT 94
ta	$^4/_5$	1:1	none	HT 94
Lc 126	1	1:1	none	HT 94
Lc 55*	1	3:2	$^3/_{10}$	HT 100
L 35	1	3:1	none	HT 94
L 99	1	3:1	none	HT 94
Lc 58	1	4:1	$^4/_{10}$	HT 89
maimi	1	4:1	$^4/_{10}$	HT 89
sadi	1	9:1	$^3/_{10}$	HT 100
Lc 125	1	cereals only	$^5/_{10}$	HT 89, HT 100
tara	1	cereals only	$^5/_{10}$	HT 89
supervisors* (= ta_2k^wa)	$1^1/_3$	(7:3)	(none)	HT 94

* On HT 88 only figs are listed

The 'supervisors' receive a less favourable ratio than the Lc 125 category; this is due to the circumstance, which emerged in the previous section, that these people obtained a bonus in addition to the pay of the category of labour to which they are assigned. On HT 89 they only receive figs like the others. Consequently, in Table III the relevant figures have been given in parentheses.

As to the names of these 'supervisors' recorded in the *kiro* lists, that of *kupa₃nu* occurs twice in the list of HT 88; the same phenomenon may be noted on HT 122. The latter list has on face a) some names followed by numerals higher than one. It might be that in these cases the entries do not mention personal names; but functionaries; this, however, does not seem to apply to *kupa₃nu* which is mentioned twice as one unit. If it is a personal name, it should be

a frequent one. On the other hand, in an enumeration including the labourer symbol L 99, HT 119 has the plural entry *kupa$_3$natu* 7, so the word seems there to indicate a functionary or professional class.

As to the words used in the pay lists, the following observations may be made. The word *sara$_2$* appears above the record of commodities distributed to various categories of persons, as on HT 11, 32, 105, and perhaps also on HT 28, 93 and 99. Other texts, notably those of HT 18, 34, 90, 101, 114, 121 and 125, do not enumerate the persons connected with the *sara$_2$* of commodities recorded. It is, however, not excluded that the headings of these records refer to categories of staff listed on other tablets. For instance, the heading *sara$_2$ k^{w}ak^{w}aru* on HT 93 might refer to the *k^{w}ak^{w}aru* listed on HT 111 or HT 122. Various categories of HT 102 also appear in other lists. An extensive cross-check of names may throw more light on the question whether the term *sara$_2$* can be connected with the payment of these other cases as well.

With a single exception, the word *sara$_2$* is followed by one or more commodity signs. The exception is HT 105 with the following simple content:

kapa-, L 99 234, *sara$_2$* 235.

Although we do not understand the word *kapa*, which also occurs as a heading in the list of working people to be paid on HT 94 (but also — as a personal name? — in the distribution list[13] of HT 8), the part missing after that word might explain the difference between the numerals. The entry "*sara$_2$* 235" might be read as "paid (or to be paid) labourers 235".

Of equal interest is the *kapa*-headed list of HT 102 which has *sara$_2$* wheat 976 followed by different entries of which the next two list wheat as well. As a total is added, the three entries without a commodity sign must also relate to wheat. The point here is that, besides the *sara$_2$* distribution, others were made, including those to the woman labour category L 122. It seems, therefore, that *sara$_2$* conveys an idea subordinate to that of payment or distribution.

In his commentary to the Oxford edition of the material[14] Brice called the word *kiro* a "versatile" word. We now know that it is used, inter alia, to indicate individuals entitled to a bonus, a context which would also involve the notion of 'extra'. This seems to

[13] Discussed in the preceding report

[14] op. cit. 5

accord with its meaning in the account on HT 123a[15]. The peculiar feature here is that the total (*kuro*) of the first commodity (olives) comes to $93^{1}/_{4}$, whereas the total of the final *kiro* entries comes to $6^{3}/_{4}$, making a grand total of one hundred, which figure cannot be accidental.

The meaning of 'extra' would seem to fit in most accounts with the notable exception of HT 1, in which record, incidentally, we find *kupa$_3$nu* followed by the numeral 109[16].

In the Linear B records *ta* appears as a denominator of personnel[17], as on HT 94: the denominator *da*, however, is lacking in the Linear A texts. Palmer suggested that *ta* stood for a class of women; on HT 94 the entry *ta* follows that of the women labourers, but their pay is calculated separately and together with that for the preceding category *a*. The conclusion is permissible that three categories of men were listed first, followed by two categories of women.

No attempt has been made to analyse the additional allocation of oil (L 89) because it is not excluded[18] that oil was assessed by measures different from those used for the cereals and figs; one reason for thinking so is that it seems not infrequently that oil is so expensive as to be out of proportion with the basic pay, if measured with the same standards.

VII. Summary of Results

Following on the allocation of values for fraction symbols in the Linear Script A, application of these values to the texts has revealed the standard units used for measuring wheat, comprising a medimnos of 120 khoinikes, and a hamina, sekteus and triakonteus. Another cereal, probably millet, was measured by the medimnos, the hamina, and a third unit of twenty-four khoinikes. This last could have been used for measuring thirty days' rations for people who got only $^{4}/_{5}$ of a khoinix per diem.

The pay system involved various categories of labour which were differently treated. Calculations could be made of both the amounts

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[15] Discussed in the preceding report

[16] Notwithstanding the numerals the plural (?) *kupa$_3$natu* of HT 47 and 119 is not used, perhaps indicating that the text records a contract between the name in the heading and the others listed.

[17] cf. Palmer op. cit. 116

[18] cf. the author, B. I. C. S. 18, 1972

and the subdivisions of cereals and figs, and also of the addition of wine for these various categories.

These conclusions led to some reflections on the significance of the words *sara*$_2$ and *kiro*.

Erratum

Mr. R. M. Pinkerton of the Department of Humanity of the University of Edinburgh kindly drew my attention to an error appearing on page 41 of the preceding paper in this series. The comment under I, 2^0, c, should be replaced by:

". . . . is possible; as with I, 2^0, a, however, it leads to $e + f = 2$, quod non".

The system is therefore untenable and, as Mr. Pinkerton agrees, the error in presentation, for which the author apologizes, does not affect the outcome of the analysis.