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LINEAR A METROGRAMS

1. Introduction

The metrograms of the Minoan Linear Script A express the fractional values of a unit of measurement. Unlike those of Linear B, in Linear A each fraction refers directly to a standard measure[1], either of weight (mainly metals), of dry capacity (wheat, olives, figs, etc.) or of liquid capacity (oil, wine, etc.).

The complete edition of GORILA[2] makes possible a careful reexamination of the numerical fractions. They will be indicated by capital letters, as on GORILA 5, p. XXVII. The signs (with the number of attestations as simple signs) are as follows:

J ∠ (114), E 7 (58), D ☡ (23), K ⊤ (22), B + (21), A ‡ (14), H λ (14), L^2 ◖= (9), F ≠ (8), W ++ (6), X ⧺ (5), L^3 ◖≡ (3), L^4 ◖≣ (2), L ◖ (1), Y ᚦ (1).

Besides simple metrograms there are composite forms. It is difficult to reconstruct the value of Minoan fractions because there are few "totalled texts"[3] bearing metric signs well enough preserved.

If θ represents a simple metrogram and ϑ a composite one, we have two hypotheses:

Hypothesis 1: $0 < \theta < 1$ et $0 < \vartheta < 1$

Hypothesis 2: $\theta_1 \neq \theta_2 \neq \theta_3 \ldots \neq \theta_n \neq \vartheta_1 \neq \vartheta_2 \neq \vartheta_3 \ldots = \vartheta_n$ (each θ always has a value different from any other θ; a ϑ never has the value of a θ).

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1 For instance, cf. D. A. Was, "Numerical Fractions in the Minoan Linear Script A", Kadmos 10, 1971, 37, note 5, as well as E. L. Bennett, Jr., "Linear A Fractional Retractation", Kadmos 19, 1980, 17.

2 L. Godart – J.-P. Olivier, Recueil des inscriptions en linéaire A, voll. 1–5, 1976–1985.

3 The group 81-02, which here I read *ku-ro*, is generally accepted as indicating the total.

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2. Examination of HT 9a[4].

This tablet (Fig. 1) is perfectly preserved (face A, at least), and represents the starting-point. The listed entries are followed by such quantities:

5+JE+10+4+2+2+J+2+J+4+E = 31+JE.

This equation can be reduced to:

2J+E = 2 (1)

However, according to the note on GORILA 1, p. 19, at first the scribe calculated the total as 30+JE and wrote it, but later corrected it to 31+JE. Lowering the total to 30+JE, we obtain:

2J+E = 1 (2)

To solve this equation with two unknown quantities, we need another datum, but, unfortunately, none survives.

Before such a shortage of data, I assume that the fraction 1/2 was represented by either J or E, the two most commonly used metrograms. Therefore I suggest

Hypothesis 3: J aut E = 1/2.

Coming back to the equations (1) and (2), four possible ways are opened:

(1a): 2J+E = 2	et	J = 1/2
(1b): 2J+E = 2	et	E = 1/2
(2a): 2J+E = 1	et	J = 1/2
(2b): 2J+E = 1	et	E = 1/2.

Hence the following solutions are drawn:

(1a): J = 1/2	E = 1	quod non
(1b): J = 3/4	E = 1/2	
(2a): J = 1/2	E = 0	quod non
(2b): J = 1/4	E = 1/2.	

Since (1a) and (2a) are not acceptable, only these values remain:

E = 1/2 J = 3/4 aut 1/4.

3. Examination of HT 8

The general heading of HT 8 (Fig. 1) comprehends the word 46-07 (place-name?), the logogram A617 (probably to be read: OLEUM

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[4] For the examination of the basic texts I have considered the wide work of D. A. Was about the fractions and the units of measurement in Linear A: Kadmos 10, 1971; 11, 1972; 12, 1973; 14, 1975; 16, 1977; 17, 1978; 20, 1981; Minos 1977, 1980, whence I have sometimes borrowed the methodological scheme. But I differ from Was in the readings of the tablets and in the consequent valuation of some of the metrograms.

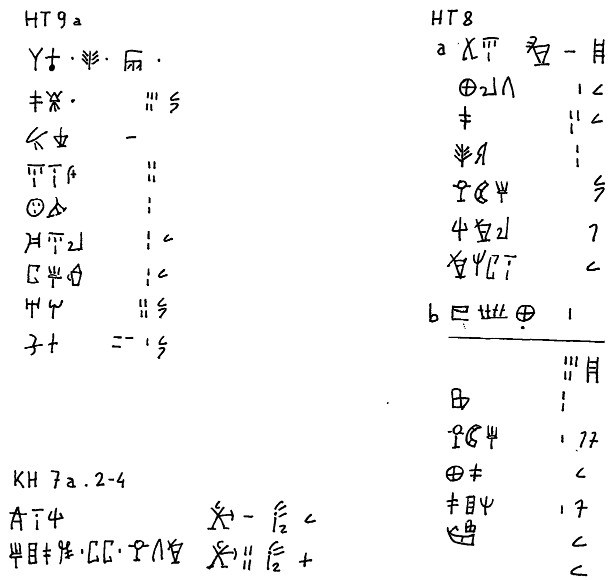

Fig. 1

+KI) followed by the number 10 with the sign AB 56 which ends the heading. Then there is a list of seven entries with the respective quantities. At this point the scribe drew a horizontal stroke in order to divide the texts into two parts.

The second section begins with the numeral 5 preceding the sign AB 56; after this secondary heading we find a list of five entries with the respective quantities. The last entry of the second section is: "A565 J" where the fraction J is written on a smaller scale, next to the right border of the tablet and, at the beginning of a new line (HT 8b.6), another J was traced. Doubtless both larger numerals (10 and 5) opening the different sections of the document have a particular meaning: two possible cases arise:

I. Both larger numerals represent the totals (most strangely indicated at the beginning and without the formula *ku-ro*) of respective lists of oil lots; in which case the sections of the tablet must be examined separately.

II. The larger numerals represent together the total of both lists of entries. Let us imagine (in view of the round figures) two oil stocks distributed to two groups of consignees; in which case the sections of the tablet must be examined jointly.

3.1 Separated analysis

a) The first section of HT 8 provides us with these data:

10 = 1+J+3+J+2+JE+E+J+1.

On the ground of E = 1/2, J = 3/4 aut 1/4 (supra, § 2), we achieve two possible solutions:

E = 1/2 J = 1/4 JE = 7/4 quod non (because the ϑ JE>1)
E = 1/2 J = 3/4 JE = 1/4 acceptable.

b) Let us verify the results in the second section of the tablet.

The only uncertainty is the fraction J at the end of the text (HT 8b.6). There are three admissible possibilities:

1. J at the end of line 5 of HT 8b is not clear enough, so the scribe rewrote it.

2. J of line 6 indicates the amount remaining over after the distribution.

3. J of line 6 indicates the deficit.

Hence we compose three equations:

1. 5 = 2+1+EF+J+1+F+J (rewritten)
2. 5 = 2+1+EF+J+1+F+J+J (remainder)
3. 5 = 2+1+EF+J+1+F+J-J (deficit).

Substituting the acceptable set of a), i.e. E = 1/2, J = 3/4, JE = 1/4, it follows:

1. F+EF = -1/2 quod non
2. F+EF = 1/4
3. F+EF = -5/4 quod non.

Consequently equation 2 (remainder) only is admissible; let us proceed with it.

EF is a composite metrogram (ϑ), so it offers three possibilities, viz.:

EF = E+F aut E-F aut F-E.

That is to say:

EF = E+F = 1/2+F ergo 2F+1/2 = 1/4 ergo F = -1/8 quod non
EF = E-F = 1/2-F ergo F+1/2-F = 1/4 ergo 1/2 = 1/4 quod non
EF = F-E = F-1/2 ergo 2F-1/2 = 1/4 ergo F = 3/8.

But if F = 3/8, then EF = F-E = 3/8-1/2 = -1/8 quod non.

After all that, considering HT 8 separately, we are not brought to any solution simultaneously satisfying every datum of HT 8a-b.1 / HT 8b.3–6 / HT 9a.

3.2 Joint analysis

The three cases (rewritten, remainder, deficit) remarked at the beginning of § 3.1, b remain also valid for the joint analysis where, however, they must be immediately introduced into the calculation. Thereat, simplifying:

4 = E+F+JE+EF+5J (rewritten)
4 = E+F+JE+EF+6J (remainder)
4 = E+F+JE+EF+4J (deficit).

Let us insert the values got from HT 9a (supra, § 2), viz.: E = 1/2 J = 3/4 aut 1/4, examining the composite metrogram JE preliminarly:

1. J = 1/4 E = 1/2
a. JE = J+E = 3/4
b. JE = J-E = -1/4 quod non
c. JE = E-J = 1/4 quod non (because J = JE = 1/4)
2. J = 3/4 E = 1/2
a. JE = J+E = 5/4 quod non
b. JE = J-E = 1/4
c. JE = E-J = -1/4 quod non

Thence the valid sets are: (a) J = 1/4; E = 1/2; JE = 3/4 and (b) J = 3/4; E = 1/2; JE = 1/4: one of those two is the right one.

Combining set (a) and set (b), in turn, with the three functions of HT 8 (rewritten-remainder-deficit) they yield:

set (a)
1a. 2/3 = F+EF (rewritten)
2a. 5/4 = F+EF (remainder)
3a. 7/4 = F+EF (deficit)

set (b)
1b. -2/4 = F+EF (rewritten) quod non
2b. -5/4 = F+EF (remainder) quod non
3b. 1/4 = F+EF (deficit)

At first, considering the case 3b by the usual method applied to the study of composite metrograms (in this case EF), we observe:

3b.I EF = E+F = 1/2+F ergo F = -1/8 quod non
3b.II EF = E-F = 1/2-F ergo 1/2 = 1/4 quod non
3b.III EF = F-E = F-1/2 ergo F = 3/8 sed EF = -1/8 quod non

It follows that the set (b): J = 3/4; E = 1/2; JE = 1/4, is never acceptable.

Let us then apply the datum EF = E+F aut E-F aut F-E to the three cases of set (a).

1a.I EF = 1/2+F ergo F = 1/2 quod non (F = E)
1a.II EF = 1/2-F ergo 1/2 = 3/2 quod non
1a.III EF = F-1/2 ergo F = 1 quod non
2a.I EF = 1/2+F ergo F = 3/8
2a.II EF = 1/2-F ergo 1/2 = 5/4 quod non

2a.III EF = F-1/2 ergo F = 7/8
3a.I EF = 1/2+F ergo F = 5/8 sed EF = 9/8 quod non
3a.II EF = 1/2-F ergo 1/2 = 7/4 quod non
3a.III EF = F-1/2 ergo F = 9/8 quod non

But if F = 7/8 (case 2a.III), then JF (written on HT 58b and composed horizontally like JE which we have verified as = J+E = 3/4) would correspond with J+F = 1/4 + 7/8 = 9/8 quod non. We are then left with case 2a.I: E = 1/2 and F = 3/8.

Thereby we infer: E = 1/2 J = 1/4 F = 3/8.

4. Examination of KH 7a

KH 7a (Fig. 1) is mutilated and a little damaged; it has no totalling formula (*ku-ro*); from the logograms we deduce that it records some alimentary rations distributed to various consignees. The commodity concerned is represented by the composite sign A624, which combines logogram 303 and metrogram D; regarding A303, at least we know that it indicates an item of grocery[5] (a kind of grain) because of its contexts.

Nevertheless, two entries on KH 7a are intact and very interesting. On lines 2–4 we read:

e-na-si Vir 10 A624 J; i-ja-pa-me ta-ta qa-ti-ki Vir 4 A624 B.

The groups that precede the logogram Vir in both cases show the qualifications of these men; therefore the structure is clear: 10 persons receive a quantity J of commodity A624, 4 persons a quantity B.

Hence we deduce the proportion: 10 : 4 = J : B.

But if, as we have already proved, J = 1/4, it follows that B = 1/10.

5. Conclusions

The proposed values take every possible variant interpretation of HT 9a and HT 8 into account: from the admissible results we must conclude that in HT 9a the scribe made a mistake when he added the digit (the right total being 30+JE, see § 2) and that the fraction J (= 1/4) at the end of HT 8 (HT 8b.6) indicates the oil that remained over after the distribution of the fifteen units. The sign AB 56 ⊨ on

5 Is it "millet"? Cf. D. A. Was, l. c. (supra n. 1) p. 9.

HT 8 could be the transaction-sign meaning "consigned, distributed". As regards ϑ (composite metrograms), we observe that the manner of notation is merely additional and that all combinations of symbols (both horizontally and vertically) represent the sum of the components.

EE (metrogram?) = 1/2+1/2 is a hapax written on the archaic tablet PH 12b; an analogous case is JJ, similarly on a fragmentary tablet from Phaistos.

It will be seen from Fig. 2 that I agree with Daniel A. Was on all values, except those that include sign B +.

SIGN	VALUE		
	HERE	WAS	BENNETT
B +	1/10	1/6	1/6
J ∠	1/4	1/4	1/2
E ⅂	1/2	1/2	1/4
F ⅂-	3/8	3/8	1/8
BB + +	1/5	1/12	1/12
JB ∠ +	7/20	5/12	
JF ∠ ⅂-	5/8	5/8	
EB ⅂+	3/5	2/3	
JE ∠ ⅂	3/4	3/4	
JEB ∠ ⅂+	17/20	11/12	
EF ⅂⅂-	7/8	7/8	

Fig. 2