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STATISTICAL DATA AND MORPHEMATIC ELEMENTS IN LINEAR A

1. Introduction

The Minoan Linear Script A offers enough material for cryptanalytic investigations; but what follow are only preliminary steps towards decipherment. A definitive reading of Linear A will be possible only when the language of the Minoan texts is identified.

2. Statistical approach

In a series of studies, Carlo Consani and Marco Federighi¹, starting from the assumption that the reading of signs in Linear A by reference to their homomorphs in Linear B is not yet proven, have obtained statistical results, which can be summarized as follows:

First of all, recalling the imperfection of Linear B for the notation of the Greek language, it is necessary to distinguish clearly between *sign inventory* and *orthographic rules*. It appears that the Mycenaean scribes, for reasons of economy, changed the sign inventory and orthographic rules very little. In fact Linear A and B have much the same number of syllabograms (mostly homomorphs).

The classical Cypriote syllabary has a total of syllabograms comparable with those of Linear A and B, and became a quite satisfactory system of notation for the Greek language through devising important new orthographic rules which supplemented those of the

¹ C. Consani, *Regole grafiche, contesto e tipologia scrittoria*, Studi Classici e Orientali 31, Pisa 1981, pp. 205–225; C. Consani – M. Federighi, *Ricerche sulle proprietà statistiche delle scritture sillabiche*, SCO 34, 1984, pp. 171–188; C. Consani – M. Federighi, *Ancora sulle proprietà statistiche delle scritture sillabiche*, SCO 36, 1986, pp. 17–34.

Minoan and Mycenaean systems². The defects of Linear B are due to inadequate orthographic rules, not to lack of signs.

Linear B became a mixed system of writing, composed of syllabograms and logograms. Standard formulae and simple texts, together with logograms, usually evaded ambiguities.

The authors consider not only absolute and relative frequencies of each syllabogram, but also *binary frequencies* (how many times a sign is followed or preceded by another sign in the words).

In Linear B the transcribed language is rich in closed syllables. In particular, on statistical grounds, it is possible to deduce the orthographic rule of glide /j/ (always noted between /i/ and another vowel) as well as the occlusive + liquid rule (ex.: *po-ro-* = $\pi\rho\omicron-$, with quiescent vowel).

The study of binary frequencies, if applied to Linear A, raises some preliminary problems. An attribution of phonetic values to signs is possible only in a partial and hypothetical way.

However, using the index of GORILA 5, the authors adopt very rigorous criteria of *lemmatizzazione*³. Thus they obtain material comparable with Linear B data.

On the Linear A matrix the positions considered as significant (that is including at least four attestations) are 28; on the Linear B matrix they are 46 for Knossos and 59 for the continent. This implies a greater dispersion in Linear A.

Furthermore these 28 significant positions are distributed on the Linear A matrix in a random way: so we can exclude the presence of orthographic rules like the glide /j/ rule in Linear B, etc. This absence implies that Linear A was a system adequate to note a language rich in open syllables.

3. *Excursus* on the reading of signs A

Louis Godart and Jean-Pierre Olivier⁴ have attempted a scientific reading of some syllabograms, with experimental and approximate phonetic values. The Godart-Olivier method is based upon the at-

² This is true apart from any genealogic connection between Cretan and Cypriote syllabaries.

³ C. Consani – M. Federighi, *Ancora sulle proprietà*, cit., pp. 21–22.

⁴ L. Godart, *La scrittura lineare A*, *Parola del Passato* 21, 1976, pp. 30–47; J.-P. Olivier, "Lire" le linéaire A ?, *Le Monde Grec. Hommages à Claire Préaux*, Bruxelles 1978, pp. 441–449.

tribution of B values to homomorphs in A occurring in tri- or tetrasyllabic words attested in both systems. In such cases we may suppose we have Minoan toponyms or anthroponyms which survived into Mycenaean times.

J.-P. Olivier adopts severe criteria: in fact he rejects any uncertain readings and accepts tetrasyllabic words only; trisyllabic ones are admitted if corroborated by crossed confirmations. In short J.-P. Olivier admits: *su-ki-ri-ta*, *da-i-pi-ta*, *i-ta-ja*, *ki-da-ro*, *i-ja-te*.

L. Godart adds: *se-to-i-ja*⁵, *pa-i-to*⁶.

Both Godart⁷ and Olivier⁸ offer arguments in favour of a reading A08 = *a*, only considering its highest initial occurrence (87 %) and its certain alternation with A57, already read as *ja*.

Therefore fourteen phonetic values are 'confirmed': *a*, *da*, *i*, *ja*, *ki*, *pa*, *pi*, *ri*, *ro*, *se*, *su*, *ta*, *te*, *to*.

With an equal degree of confidence I add: *ke*, *si*.

For A44 = *ke* I have given cogent proofs in a previous work⁹; A41 = *si* can be demonstrated by the following alternations (let us remember that *se* and *su* have been 'confirmed' above): *pi-ta-ka-se* / *pi-ta-ke-si*; *u-ta-i-se* / *u-ta-i-si*; *pa-se-ja* / *pa-si-a*; 79-di-su-ka / 79-di-si-ka and, perhaps, *a-se* / *a-si*; *ja-se* / *ja-si*.

Other, less secure, identifications are: *o*, *u*, *wa*, *ka*, *ko*, *ra*, *re*, *ti*.

For *o*, *u*, *wa* see the quoted works of Olivier¹⁰ and Facchetti¹¹; the other values are founded above all on *a-ra-ko*¹² and *a-ti-ka*¹³, words common to Linear A and B; specifically for *ra* and *re* note: *ra-ti-se* / *re-ti-se*; *da-ta-ra* / *da-ta-re*; *di-ra-di-na* / *di-re-di-na*; *ki-ri-ta₂* / *ki-re-ta₂*, and maybe *a-ra-tu* / *a-re-tu-mi*].

⁵ In my opinion the uncertain reading is limited to the second sign; anyway a reading *to* has a highest probability.

⁶ After the admission of *sē-to-i-ja*, also *pa-i-to* satisfies Olivier's criteria.

⁷ L. c., pp. 43–44.

⁸ L. c., p. 447.

⁹ G. M. Facchetti, Comparable name-lists in Linear A, *Kadmos* 35, 1996, p. 103, n. 7.

¹⁰ L. c., p. 447.

¹¹ L. c., p. 101, n. 6 and pp. 103–104.

¹² Cf. L. Godart, *L'interpretazione e la traduzione dei testi minoici e micenei*, AIΩN 7, Napoli 1985, p. 107.

¹³ B *a-ti-ka* on KN V 831.4 may be compared with A *a-ti-ka-a-du-ko-[mi]* on ZA Wc 2 where *a-ti-ka* has to be considered a separate word: in fact not only A08 (= *a*) has the highest initial occurrence (87 %), but also the group *a-du* (or *a-du-*) is well-known from several Linear A archives; moreover cf. J. Raison – M. Pope, *Le vocabulaire du linéaire A en translittération*, *Études Minoennes I*, Bibliothèque des Cahiers de Linguistique de Louvain 14, 1978, p. 136.

It is also quite certain¹⁴ that *qa* (AB16) / *qe* (AB78) and *ma* (AB80) / *mi* (AB13) are isoconsonantal in Linear A too, though we cannot specify (or rather 'confirm') the nature of these consonants. I believe it is certain that A325 is either a graphic alteration, a doublet ('*de*₂') or a syllabogram isoconsonantal with AB45¹⁵. Yet there is no conclusive evidence for a reading A45 = *de*, unless we retain the case of A *di-de-ru* / B *di-de-ro* (like A *qa-qa-ru* / B *qa-qa-ro*)¹⁶.

So in this review we have assembled sixteen 'confirmed' syllabograms (*a, da, i, ja, ke, ki, pa, pi, ri, ro, se, si, su, ta, te, to*) and seven quasi-'confirmed' (*ka, ko, o, ra, re, ti, u, wa*) as well as two isoconsonantal pairs (*qa/qe, mal/mi*).

We have many reasons for 'reading' (all ?) A signs on the grounds of their B homomorphs and, in my opinion, the classical (and only) contrary indication ('*ma*' written on erased '*qe*')¹⁷ can now be discounted¹⁸.

4. The frequencies

Following the excellent *Index des signes* of GORILA 5¹⁹, I have drawn up some tables with the relative and absolute frequencies of each syllabogram. Thus I have obtained 799 different words, composed of a total of 2560 syllables. On the following tables I show the frequencies and the positions of each sign of these words; I have obviously excluded the logograms and the isolated signs.

On the first column I have drawn the signs with their catalogue-number; on the second, third and fourth column I indicate the number of occurrences of the same sign, respectively, in initial, middle and final position in the words; the fifth column gives the total of attestations, the sixth the frequency per mille on the whole 2560 syllables.

Readings like []-01, 01-[-], [-]-01 were not calculated, except the case of very rare signs occurring in these positions only in those

¹⁴ There are *qe-ra₂-u* / *qa-ra₂-wa* and *i-pi-na-ma* / *i-pi-na-mi-na*, both in connected contexts; cf. J.-P. Olivier, l. c., pp. 447–449.

¹⁵ G. M. Facchetti, l. c., p. 103.





















¹⁶ Cf. J.-P. Olivier, l. c., p. 448; this argument is reconsidered in M. Negri, Κρητικά γράμματα, *Minos* 29–30, 1994–1995, p. 91.





















¹⁷ See L. Godart, *La scrittura*, cit., pp. 41–42 and J.-P. Olivier, l. c., p. 449.





















¹⁸ M. Negri, l. c., pp. 93–94.

¹⁹ Furthermore I have considered the words of the three new inscriptions KH 92, ZA Zg 35, MO Zf 1.

| SIGN | INITIAL | MIDDLE | FINAL | TOTAL | PER MILLE |
|-------|---------|--------|-------|-------|-----------|
| 𐀀 01 | 30 | 41 | 9 | 80 | 31,2 |
| 𐀁 02 | 3 | 7 | 18 | 28 | 10,9 |
| 𐀂 03 | 27 | 23 | 9 | 59 | 23,0 |
| 𐀃 04 | 10 | 23 | 31 | 64 | 24,9 |
| 𐀄 05 | 1 | 8 | 3 | 12 | 4,7 |
| 𐀅 06 | 8 | 53 | 39 | 100 | 39,0 |
| 𐀆 07 | 19 | 33 | 13 | 65 | 25,4 |
| 𐀇 08 | 109 | 8 | 8 | 125 | 48,8 |
| 𐀈 09 | 5 | 15 | 19 | 39 | 15,2 |
| 𐀉 10 | 21 | 14 | 3 | 38 | 14,8 |
| 𐀊 11 | 3 | 2 | 1 | 6 | 2,3 |
| 𐀋 13 | 3 | 8 | 7 | 18 | 7,0 |
| 𐀌 16 | 19 | 5 | 4 | 28 | 10,9 |
| 𐀍 17 | 2 | 11 | 13 | 26 | 10,1 |
| 𐀎 21f | 6 | 5 | 3 | 14 | 5,5 |
| 𐀏 22f | — | 1 | — | 1 | 0,4 |
| 𐀐 23 | 2 | 2 | 7 | 11 | 4,3 |
| 𐀑 24 | 2 | 12 | 25 | 39 | 15,2 |
| 𐀒 26 | 13 | 24 | 18 | 55 | 21,5 |
| 𐀓 27 | 6 | 29 | 40 | 75 | 29,3 |

| SIGN | INITIAL | MIDDLE | FINAL | TOTAL | PER MILLE |
|--|---------|--------|-------|-------|-----------|
|  28 | 45 | 36 | 13 | 94 | 36,7 |
|  28b | 2 | — | 1 | 3 | 1,2 |
|  29 | 3 | 5 | 3 | 11 | 4,3 |
|  30 | 4 | 20 | 15 | 39 | 15,2 |
|  31 | 21 | 35 | 12 | 68 | 26,5 |
|  34 | 2 | 4 | — | 6 | 2,3 |
|  37 | 8 | 32 | 36 | 76 | 29,6 |
|  38 | 7 | 2 | 6 | 15 | 5,9 |
|  39 | 17 | 12 | 10 | 39 | 15,2 |
|  40 | 10 | 3 | 6 | 19 | 7,4 |
|  41 | 29 | 22 | 21 | 72 | 28,1 |
|  44 | 1 | 5 | 7 | 13 | 5,1 |
|  45 | 5 | 11 | 9 | 25 | 9,8 |
|  46 | 2 | 1 | 1 | 4 | 1,6 |
|  47 | 2 | 3 | 1 | 6 | 2,3 |
|  49 | — | 1 | 1 | 2 | 0,8 |
|  50 | 5 | 4 | 6 | 15 | 5,9 |
|  51 | 18 | 26 | 12 | 56 | 21,8 |
|  53 | 14 | 30 | 16 | 60 | 23,4 |
|  54 | 7 | 13 | 6 | 26 | 10,1 |

| SIGN | INITIAL | MIDDLE | FINAL | TOTAL | PER MILLE |
|---|---------|--------|-------|-------|-----------|
|  55 | 5 | 23 | 10 | 38 | 14,8 |
|  56 | 6 | 10 | 8 | 24 | 9,4 |
|  57 | 38 | 28 | 42 | 108 | 42,1 |
|  58 | 9 | 22 | 10 | 41 | 16,0 |
|  59 | 24 | 44 | 29 | 97 | 37,8 |
|  60 | 11 | 32 | 33 | 76 | 29,6 |
|  61 | 7 | 2 | 2 | 11 | 4,3 |
|  65 | 2 | 11 | 17 | 30 | 11,7 |
|  66 | 2 | 1 | 8 | 11 | 4,3 |
|  67 | 22 | 32 | 17 | 71 | 27,7 |
|  69 | 15 | 17 | 16 | 48 | 18,7 |
|  70 | 5 | 5 | 3 | 13 | 5,1 |
|  73 | 13 | 31 | 23 | 67 | 26,1 |
|  76 | 1 | 7 | 9 | 17 | 6,6 |
|  77 | 32 | 19 | 17 | 68 | 26,5 |
|  78 | 14 | 4 | 7 | 25 | 9,8 |
|  79 | 6 | 9 | 5 | 20 | 7,8 |
|  80 | 21 | 37 | 17 | 75 | 29,3 |
|  81 | 33 | 30 | 11 | 74 | 28,9 |
|  82 | — | — | 1 | 1 | 0,4 |

| SIGN | INITIAL | MIDDLE | FINAL | TOTAL | PER MILLE |
|---|---------|--------|-------|-------|-----------|
|  85 | 3 | 1 | — | 4 | 1,6 |
|  86 | 3 | — | 1 | 4 | 1,6 |
|  100-102 | 2 | 1 | — | 3 | 1,2 |
|  118 | 2 | 3 | 8 | 13 | 5,1 |
|  123 | — | 2 | 3 | 5 | 2,0 |
|  131a | — | — | 1 | 1 | 0,4 |
|  164a | — | 1 | — | 1 | 0,4 |
|  188 | 2 | — | 2 | 4 | 1,6 |
|  301 | 2 | 11 | 2 | 15 | 5,9 |
|  305 | 2 | 1 | 4 | 7 | 2,7 |
|  306 | 3 | 1 | 2 | 6 | 2,3 |
|  308 | — | — | 1 | 1 | 0,4 |
|  310 | — | 4 | 2 | 6 | 2,3 |
|  312 | 3 | — | 1 | 4 | 1,6 |
|  314 | 1 | 3 | 1 | 5 | 2,0 |
|  315 | — | — | 1 | 1 | 0,4 |
|  318 | 1 | — | — | 1 | 0,4 |
|  319 | — | — | 2 | 2 | 0,8 |
|  320 | 1 | 1 | 1 | 3 | 1,2 |
|  321 | — | — | 4 | 4 | 1,6 |

forms; 01-02-[was not computed if existing 01-02;]01-02-03 *et similia* were not considered if existing 01-02-03; instead I have always computed groups like 01-02-[.], [..]-01-02, etc.

5. Some considerations on the frequencies

5.1. In what follows, we will write the 'confirmed' and quasi-'confirmed' syllabograms (see § 3) in bold-face.

In a scientific study²⁰ we must fix a minimum number of attestations, and we propose a threshold of 39 occurrences (i.e. 1,5 % of the total). So we get 28 useful signs (between brackets their total-initial-final occurrences and the percentages of initial and final position):

01/**da** (80-30-9; 37%-11%); 03/**pa** (59-27-9; 45%-15%); 04/**te** (64-10-31; 15%-48%); 06/**na** (100-8-39; 8%-39%); 07/**di** (65-19-13; 29%-20%); 08/**a** (125-109-8; 87%-6%); 09/**se** (39-5-19; 12%-48%); 24/**ne** (39-2-25; 5%-64%); 26/**ru** (55-13-18; 23%-32%); 27/**re** (75-6-40; 8%-53%); 28/**i** (94-45-13; 47%-13%); 30/**ni** (39-4-15; 10%-38%); 31/**sa** (68-21-12; 30%-17%); 37/**ti** (76-8-36; 10%-47%); 39/**pi** (39-17-10; 43%-25%); 41/**si** (72-29-21; 40%-29%); 51/**du** (56-18-12; 32%-21%); 53/**ri** (60-14-16; 23%-26%); 57/**ja** (108-38-42; 35%-38%); 58/**su** (41-9-10; 21%-24%); 59/**ta** (97-24-29; 24%-29%); 60/**ra** (76-11-33; 14%-43%); 67/**ki** (71-22-17; 30%-23%); 69/**tu** (48-15-16; 31%-33%); 73/**mi** (67-13-23; 19%-34%); 77/**ka** (68-32-17; 47%-25%); 80/**ma** (75-21-17; 28%-22%); 81/**ku** (74-33-11; 44%-14%).

5.2. Initial position. In a syllabic system we should expect vowels to have a high initial occurrence; for example in Linear B *a* and *e* have, respectively, a percentage of about 90 % and 25% in initial position²¹. Among our 28 most common signs this phenomenon may be checked for A08/**a** (87 %), as already seen in § 3.

The same cannot be said for A28/**i** which has 'only' a 47 % like A77/**ka**; and A03/**pa** and A81/**ku** in this position have, respectively, 45 % and 44 %.

²⁰ This analysis is also based on a letter that prof. Michel Lejeune sent to me on 30 october 1991.

²¹ D. W. Packard, Computer techniques in the study of the Minoan Linear script A, Kadmos 10, 1971, p. 53.

On the other hand the equation $A28 = i$ is well founded through the tri- or tetra-syllabic groups (above, § 3) and, excluding A08/a, its 47 % is the highest percentage of initial occurrence.

A10/u is not included in the list of the 28 most common signs, but in all it occurs 38 times, of which 21 are in initial position: a percentage of 55 %.

5.3. Final position. In Linear B 'man' was written *a-to-ro-qo* (ἀνδρωκός), while in classical Cypriote *a-to-ro-po-se* (ἀνδρωπος) with a quiescent final vowel *e* (a new orthographic rule for the notation of final consonants). If Linear A had used such an orthographic rule, statistical data would show a clean preponderance of a vocalic timbre in final position. This is not evident from the list of the above-mentioned 28 syllabograms.

The highest percentages are: A24/ne (64 %), A27/re (53 %), A04/te and A09/se (48 %), A37/ti (47 %), A60/ra (43 %).

6. Morphematic elements

6.1. On Linear A tablets we find neither complex sentences, nor descriptions as in Linear B; short headings include logograms and transaction-signs. The other sorts of documents (above all repeated formulae) are not easily intelligible.

Groups like *a-se* / *a-se-ja* can be interpreted as inflected or suffixed forms, if there are several attestations. The most evident cases are:

6.2. 'Morpheme' -ja (8 pairs)

a-se / *a-se-ja*; *a-ri* / *a-ri-ja*; *a-ma* / *a-ma-ja*; *a-su* / *a-su-ja*; *pa-se* / *pa-se-ja*; *ku-pa* / *ku-pa-ja*; 306-tu / 306-tu-ja; *su-ki-ri-ta* / *su-ki-ri-te-i-ja*.

6.3. 'Morpheme' -re (5 pairs)

pa-ja / *pa-ja-re*; *a-ta* / *a-ta-re*; *du-ra* / *du-ra-re*; *ki-310* / *ki-310-re*; *a-du* / *a-du-re*.

6.4. 'Morpheme' -ti (5 pairs)

da-ku-se-ne / *da-ku-se-ne-ti*; *ri-ru-ma* / *ri-ru-ma-ti*; *ja-ku* / *ja-ku-ti*; *u-na-ru-ka-na-si* / *u-na-ru-ka-na-ti*; *a-ma-wa-si* / *ja-ma-u-ti*.

6.5. 'Morpheme' -ne (4 pairs)

pa-ta / *pa-ta-ne*; *pa-ra* / *pa-ra-ne*; *qe-tu* / *qe-tu-ne*; *ja-sa-mu* / *a-sa-mu-ne*.

6.6. It is very important to observe that *ne*, *re* and *ti* have the highest percentages of final occurrences: respectively 64 %, 53 % and 47 %: they are Minoan suffixes or endings.

However, *-ja*, even if supported by the greatest number of 'inflected' or 'suffixed' forms (8 pairs), is only 38 % final and 35 % initial. This can be explained if we remember the well-known alternation *a-* / *ja-* and the highest initial frequency of *a-* (see § 3).

a- has been recognized as a Minoan prefix with wider linguistic parallels²².

As regards the toponym²³ *su-ki-ri-ta* / *su-ki-ri-te-i-ja* – probably to be read [sugrita] / [sugritehija] or [sugrite'ija] – there appears a morpheme *-i-ja* (with alteration of thematic vowel), not exactly corresponding to *-ja*.

ja-mi-da-re and *si-da-re* (HT 122) which I have identified as probable toponyms²⁴ could be related to *da-re*²⁵ since all these 'localities' would have to be placed near *te-ki* / *te-ke*. Have we here further morphematic elements (*ja-mi-* / *si-*)²⁶?

²² L. Godart, *La scrittura*, cit., pp. 43–44.

²³ Cf. G. M. Facchetti, l. c., p. 100, n. 2.

²⁴ Ibidem, p. 102, group 1b.

²⁵ Ibidem, pp. 101–102, group 1.

²⁶ Cf. Myc. *de-we-ro-ai-ko-ra-i-ja* / *pe-rai-ko-ra-i-ja*.