Establishing the West-Ugric Language Family with Minoan, Hattic and Hungarian by a Decipherment of Linear A

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Abstract: - This paper develops a feature-based similarity measure to visually compare script symbols from different alphabets and syllabaries and then uses that similarity measure within a novel algorithm to develop a new phonetic grid for Linear A. The phonetic grid is then used to develop an English-Minoan-Uralic dictionary of basic words and grammatical suffixes and prefixes. The dictionary is then used in translating twenty-eight Linear A and one Eteocretan inscription. The proposed algorithm could likely be modified to decipher other unknown languages and could become a widely used tool in computational linguistics.

Key-Words: - computational linguistics, Cretan script family, decipherment, Linear A, similarity measure

1 Introduction

In spite of numerous attempts, Linear A (see Godart and Olivier [14] for a collection of documents), the main Minoan script, remained undeciphered for over a century since its discovery in Knossos by Evans [10]. In contrast, Linear B, one of its descendant scripts, was solved in 1953 when Michael Ventris and John Chadwick showed it to be an early form of Greek [39].

The breakthrough in deciphering Linear B was in matching Linear B symbols with corresponding Cypriot syllabograms and their phonetic values. The substitution of Cypriot phonetic values into Linear B yielded ancient city names [5]. Therefore, we also considered the similarities between Linear A and other alphabets besides Linear B and the Cypriot syllabary. In particular, in a previous study on alphabet evolution we identified the Old Hungarian alphabet to be distantly related to Linear A (although closer related to Cretan Hieroglyphs) [32]. The spatial and temporal gaps between the Linear A and Old Hungarian scripts prompted a search for an intermediary alphabet, which we found in the Carian alphabet [1]. Section 2 describes a feature-based similarity measure to identify all possible connections between Linear A and other syllabaries and alphabets with known phonetic values.

Instead of looking at the Linear A script, other scholars focused on the Pre-Greek vocabulary of Greek to identify the Minoan language. R. Beekes devoted decades of study to Greek etymologies [3] with special attention to Pre-Greek words, about which he wrote a separate book [4]. He came to the conclusion that Pre-Greek cannot be Indo-European.

Naturally, we considered a study of Pre-Greek also essential for our decipherment of Linear A. To our surprise, we could link hundreds of Pre-Greek words with the Ugric branch within the Uralic language family. Section 3 of this paper presents the list of words that seem to be cognates in Pre-Greek and Ugric. This implies that the Minoan language is an Ugric language.

The Hattic language [29] is generally considered to be a language isolate. Hence some form of Proto-Hattic seems to be a likely source of Minoan, because it fits well with the known data. In particular, Proto-Hattic may have been the language spoken by Southern Anatolian farmers in the 7th millennium BC, and it is different from Indo-European and Semitic languages that already have been tried and failed to fit the Linear A inscriptions except for a few words that may be cultural terms and borrowings.

Unfortunately, the Hattic language is poorly understood. The Hittite documents that occasionally include Hattic words and sentences are the primary source of the Hattic language [29]. Besides these written documents, the Hattic language may also be partially reconstructed from Pre-Hittite words, similarly to the hints about the Minoan language that can be gathered from an analysis of Pre-Greek words [4]. Section 4 shows

that Hattic is also an Ugric language.

Section 5 presents an algorithm that finds the syllabic values of the Linear A symbols. This is a major break from the traditional approach of reading Linear A with Linear B phonetic values. That method leads to some intriguing but mixed results. On one hand, using Linear B phonetic values, Cyrus Gordon [15] found some words of Semitic origin, including *kuniso,* which means "wheat" in Semitic languages. On the other hand, using Linear B phonetic values too, Gareth Owens [27, 28] found words of Indo-European origin, such as *Ida-mate*, which he interpreted as the name of a mother goddess after whom Mount Ida in Crete was named. Although at first glance such readings are exciting results, the fact that only a few words instead of entire sentences can be read in this manner after decades of trying suggests that these words are at best only borrowings into the Minoan language.

Section 6 uses the Linear A phonetic values, which are derived in Section 5, to build an English-Uralic-Minoan dictionary. This dictionary contains both root words and some common conjugation elements (both suffixes and prefixes).

Section 7 uses the dictionary of Section 6 to translate twenty-eight Linear A documents from the GORILA document collection (the acronym is for the initials in reference [14]: Godart and Olivier, *Recueil des Inscriptions en Linéaire A*).

Section 8 considers an Eteocretan inscription. The Eteocretan language is thought by several researchers to be a descendant of Minoan, but translating the inscriptions has been difficult. Section 8 gives a translation of one of the Eteocretan inscriptions.

Section 9 presents some related work and discussions.

Finally, Section 10 gives some conclusions and directions for future work.

2 Comparison of Alphabets and Syllabaries Using a Feature-Based Similarity Measure

2.1 Feature-Based Similarity Functions

The main idea of a feature-based similarity function for symbol pairs can be described abstractly as follows.

Let $S = \{s_1, \ldots, s_n\}$ be any alphabet or syllabary with n symbols, and let $F = \{f_1, \ldots, f_m\}$ be any set of m elementary features. In this paper, an *elementary feature* is any feature that is always either present or not present in a symbol.

Let $T: (S, F) \rightarrow \{true, false\}$ be a feature testing function from the cross product of S and F to the Boolean values *true* and *false*. For any pair of symbol s_i and feature f_j, the value of $T(s_i, f_j) = true$ if and only if s_i contains f_j.

Let $W: F \rightarrow R$ be a weight function from the feature set F to the rational numbers R. For convenience, let $w_i = W(f_i)$ be the weight of the i^{th} feature. Then the *weighted similarity function* between two symbols s_i and s_j is the following:

$$sim(s_i, s_j) = \sum_{k=1,\ T(s_i,f_k) = T(s_j,f_k)}^{m} w_k \qquad (1)$$

In words we can say that the similarity of two symbols is the sum of the weights of the features that they both have or both lack.

Naturally, the above abstract idea allows many cases depending on the chosen set of features and the weights are assigned to them. Below we develop a concrete set of examples by extending a feature set suggested in Revesz [34].

2.2 A New Elementary Feature Set

Below we propose an elementary feature set with thirteen features that can be used to describe any symbol of an alphabet or syllabary.

Feature 1. The symbol contains some curved line.

Feature 2. The symbol encloses some region.

Feature 3. The symbol has a slanted straight line.

Feature 4. The symbol contains parallel lines.

Feature 5. The symbol contains crossing lines.

Feature 6. The symbol's top is a wedge ∧.

Feature 7. The symbol's bottom is a wedge ∨.

Feature 8. The symbol's right side is a wedge >.

Feature 9. The symbol contains a stem, that is, a straight vertical line that runs across the middle.

Feature 10. The symbol's bottom has two legs.

Feature 11. The symbol's bottom has three legs.

Feature 12. The symbol contains a hair, a small line extending from an enclosed space.

Feature 13. The symbol contains two triangles.

For convenience, let us denote the above thirteen features by the following symbols, respectively:

(O \ || × Λ V > | / \ /|\ - Δ^2

We will also introduce the convention that we highlight in red the features that a symbol contains and leave black the features that it lacks. Then every symbol can be described by a properly colored list of the above thirteen symbols. For example, the symbol 𐊱 in the Linear A syllabary can be described by the list:

(O \ || × Λ V > | / \ /|\ - Δ^2

Here O is red because the symbol contains an enclosed space, which is a triangle. Two sides of that triangle are slanted straight lines. Hence \ is also red. The top and the right side of the symbol end in wedges. Hence Λ and > are also red. Finally, the symbol has a hair because the triangle is an enclosed space from which a little line protrudes downward. Hence - is also red. It can be verified that the symbol lacks all the other features. For example, it does not have a stem, a straight vertical line that runs through the middle. (The symbol contains a straight vertical line, but that is on the left side and not in the middle.)

Proceeding in the above manner, we can analyze a set of Linear A symbols as shown in Table 1. Similarly, the Carian alphabet can be analyzed as shown in Table 2, and the Old Hungarian alphabet as shown in Table 3. In the table the earliest attested forms of some letters are marked with a * symbol, while the more commonly known forms are written below those symbols. In particular, *𐊠 is a version of 𐊠 from the Constantinople Old Hungarian inscription from 1515 (see Hosszú [19], page 193) and *𐊲 is given by Aethicus, an 8th century writer, in a manuscript now held at Oxford University (Hosszú [19]). In addition some Old Hungarian letters are omitted.

2.3 Comparison Between Alphabets

If we assume for simplicity that all the thirteen features have a weight of 1, then we can use the similarity function of Equation (1) to compare the Linear A symbol 𐊱 with the first letter of the Carian alphabet 𐊠 as follows:

$$sim(𐊱, 𐊠) = 13$$

because the two symbols contain the same set of features. Table 4 shows a matrix that contains the results of a pairwise comparison of every Linear A symbol in Table 1 with every Carian alphabet letter [1] in Table 2.

Table 4 shows that along the highest similarity values occur along the main diagonal. The main diagonal suggests a simple one-to-one mapping between the Carian alphabet letters and the Linear A symbols.

Similarly, Table 5 compares the Linear A syllabary and the Old Hungarian alphabet letters. Table 5 also implies a one-to-one function between the two sets of symbols.

Table 1. A feature analysis of selected Linear A symbols.

𐊱	𐊵	𐊷	𐊹	𐊺	𐊼	𐊾	𐊿	𐋀	𐋁	𐋂	𐋃	𐋄	𐋅	𐋆	𐋇	𐋈	𐋉	𐋊	𐋋	𐋌	𐋍	𐋎
(	(	(	(	(	(	(	(	(	(	(	(	(	(	(	(	(	(	(	(	(	(	(
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
\	\	\	\	\	\	\	\	\	\	\	\	\	\	\	\	\	\	\	\	\	\	\
||	||	||	||	||	||	||	||	||	||	||	||	||	||	||	||	||	||	||	||	||	||
×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ
V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
>	>	>	>	>	>	>	>	>	>	>	>	>	>	>	>	>	>	>	>	>	>	>
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Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2

Table 2. A feature analysis of the Carian alphabet letters.

a	b	β	d	ε, λ	g	i	j	k	k	λ	n	ŋ	p	q	r	ʃ	ʃ		t	t	w	z
(	(	(	(	(	(	(	(	(	(	(	(	(	(	(	(	(	(	(	(	(	(	(
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
\	\	\	\	\	\	\	\	\	\	\	\	\	\	\	\	\	\	\	\	\	\	\
‖	‖	‖	‖	‖	‖	‖	‖	‖	‖	‖	‖	‖	‖	‖	‖	‖	‖	‖	‖	‖	‖	‖
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	V	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ
V	V	V	V	V	V	V	V	V	Λ	V	V	V	V	V	V	V	V	V	V	V	V	V
>	>	>	>	>	>	>	>	>	>	>	>	>	>	>	>	>	>	>	>	>	>	>
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-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2

Table 3. A feature analysis of the Old Hungarian alphabet letters.

a	p	b	t d	g	f	ɟ i, j	k	l	r	n	λ ŋ	m	j	ʃ	ʃ	s	t ʒ	ø e	u, v u	z
(	(	(	(	(	(	(	(	(	(	(	(	(	(	(	(	(	(	(	(	(
O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
\	\	\	\	\	\	\	\	\	\	\	\	\	\	\	\	\	\	\	\	\
‖	‖	‖	‖	‖	‖	‖	‖	‖	‖	‖	‖	‖	‖	‖	‖	‖	‖	‖	‖	‖
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ	Λ
V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V	V
>	>	>	>	>	>	>	>	>	>	>	>	>	>	>	>	>	>	>	>	>
|	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|	|
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-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2	Δ^2

Finally, Table 6 compares the letters of the Carian and the Old Hungarian alphabets. Table 6 also implies a one-to-one correspondence between the two alphabets. The one-to-one correspondence between the two alphabets is such that letters with similar phonetic values correspond to each other. For example, Carian 𐊠 corresponds to Old Hungarian 𐲀 where both of them have the phonetic value /a/. Similarly, Carian 𐊡 and Old Hungarian 𐲁 have phonetic value /b/ and /p/, respectively. In that case the correspondence is not perfect, but both /b/ and /p/ are labial sounds. The other pairs of corresponding letters are also similar with the exception of the following pair: Carian 𐊫 /t/ and Old Hungarian 𐲫 /ø/. Although these two letters are phonologically different, the Carian symbol could be related to Carian 𐊬 /ý/, whose phonetic value is close to /ø/. Hence it is possible that the Carian and the Old Hungarian letters had a common origin with a sound value of either /t/ or a vowel close to /ø/, but the Carian phonetic value changed over time for some reason, probably by some influence from the Greek alphabet.

The existence of such one-to-one mappings suggests an evolutionary relationship among the Linear A syllabary, the Carian alphabet, and the Old Hungarian alphabet. In particular, Linear A seems to be an ancestor of the Carian and the Old Hungarian alphabets. In addition, some alphabet that is intermediate between Linear A and Carian seems to be the ancestor of Old Hungarian.

Table 4. Linear A symbols compared with the Carian alphabet letters.

	𐊠 a	𐊡 b	𐊢 β	𐊣 d	𐊤 ε	𐊥 g	𐊦 i	𐊧 j	𐊨 k	𐊩 λ	𐊪 n	𐊫 ŋ	𐊭 p	𐊮 q	𐊯 r	𐊰 ʃ	𐊱 ʃ	𐊲	𐊳 t	𐊴 t	𐊵 w	𐊶 z
𐊷	13	9	6	9	6	8	7	5	10	11	8	8	9	8	7	8	8	7	8	10	6	10
𐊸	9	13	10	11	10	10	6	7	8	11	10	6	7	8	9	10	7	9	10	7	8	8
𐊹	6	10	13	10	11	11	10	10	7	8	9	6	6	9	10	9	8	10	9	8	9	7
𐊺	9	11	10	13	10	10	9	9	10	9	12	8	9	10	11	10	9	11	10	9	10	10
𐊻	7	9	10	9	12	10	9	9	8	9	8	8	9	10	11	10	9	9	8	9	10	10
𐊼	8	10	11	10	9	13	10	8	9	10	9	8	8	9	8	11	8	8	7	8	7	9
𐊽	8	7	10	9	8	10	13	9	8	8	8	10	7	12	9	10	11	9	8	11	8	8
𐊾	7	7	10	9	10	8	9	13	6	7	10	9	7	8	11	6	8	11	10	7	10	8
𐊿	11	7	6	9	8	8	7	7	12	9	8	8	11	8	9	7	7	6	6	9	8	12
𐋀	9	9	8	7	8	10	7	7	6	11	6	6	7	6	7	7	5	5	6	7	6	10
𐋁	8	10	9	12	9	9	8	10	9	8	13	9	8	9	10	9	10	12	11	8	9	9
𐋂	8	6	7	8	7	7	10	8	7	8	9	13	6	11	8	9	12	10	9	12	7	9
𐋃	8	6	7	8	7	9	8	8	9	6	7	5	13	7	8	7	7	6	5	6	7	9
𐋄	8	8	9	10	9	9	12	8	9	8	9	11	8	13	10	11	12	10	9	12	9	9
𐋅	7	9	9	11	12	8	9	11	8	7	10	8	9	10	13	8	9	11	10	9	12	9
𐋆	8	10	9	10	9	11	10	6	9	10	9	9	8	11	8	13	10	8	7	10	7	9
𐋇	7	7	8	9	8	8	11	9	8	7	10	12	7	12	9	10	13	11	10	11	8	8
𐋈	7	9	10	11	10	8	9	11	8	7	12	10	7	10	11	8	11	13	12	9	10	8
𐋉	8	10	9	10	9	7	8	10	7	8	11	10	6	9	10	7	10	12	13	8	9	7
𐋊	8	6	7	8	9	7	10	8	7	8	7	11	8	11	10	9	10	8	7	12	9	11
𐋋	7	7	8	9	10	8	9	9	8	7	8	8	9	10	11	8	9	9	8	9	12	10
𐋌	9	7	6	9	8	8	9	7	8	9	8	10	9	10	9	10	9	7	6	11	8	12

Table 5. Linear A symbols compared with the Old Hungarian alphabet letters.

	a	p	b	t	g	f	ɟ	k	l	r	n	ŋ	m	j	ʃ	ʃ	s	t͡s	ø	v	z
	12	8	6	9	7	7	5	10	10	7	8	8	9	8	9	10	7	8	9	6	11
	10	12	10	11	11	7	7	8	10	11	10	6	7	8	11	7	9	10	7	8	8
	7	9	13	10	12	9	10	5	7	9	9	7	6	10	8	8	10	9	8	9	7
	10	10	10	13	11	9	9	8	8	11	12	8	9	10	9	9	11	10	9	10	10
	9	9	11	10	12	10	8	7	8	10	9	7	8	9	10	8	8	7	8	7	8
	8	6	9	7	9	13	9	6	6	7	8	10	7	12	9	11	9	8	11	8	8
	6	8	10	9	9	9	13	6	6	9	10	8	7	8	5	9	11	10	7	10	8
	9	9	5	8	6	6	6	13	10	8	7	5	10	7	8	6	6	7	6	7	9
	10	10	8	7	9	7	7	8	12	9	6	6	7	6	9	5	5	6	7	6	10
	8	10	10	9	9	9	9	8	10	11	8	8	9	10	9	9	9	8	9	10	10
	9	9	9	12	10	8	10	7	7	10	13	9	8	9	8	10	12	11	8	9	9
	9	5	7	8	6	10	8	5	7	6	9	13	7	11	8	12	10	9	12	7	9
	8	8	6	9	7	7	7	11	7	7	8	6	13	8	7	7	7	6	7	8	10
	9	7	9	10	8	12	8	7	7	8	9	11	8	13	10	12	10	9	12	9	9
	9	9	9	10	10	10	6	7	9	10	9	9	8	11	12	10	8	7	10	7	9
	8	6	8	9	7	11	9	6	6	7	10	12	7	12	9	13	11	10	11	8	8
	8	8	10	11	9	9	11	6	6	9	12	10	7	10	7	11	13	12	9	10	8
	9	9	9	10	8	8	10	7	7	8	11	9	6	9	8	10	12	13	8	9	7
	10	6	8	9	7	11	7	6	9	7	8	12	7	12	9	11	9	8	13	10	10
	7	9	9	10	8	8	10	7	8	10	9	7	8	9	6	8	10	9	8	13	9
	11	9	7	10	8	8	8	9	10	10	9	8	10	9	8	8	8	7	10	9	13

Fig. 1. A hypothetical evolutionary tree of the Cretan Script family. This evolutionary tree extends the one given in Revesz [32] by adding the Carian alphabet where a missing link was hypothesized to exist.

Table 6. Carian alphabet letters compared with the Old Hungarian alphabet letters.

	a	p	b	t	g	f	ɟ	k	l	r	n	ŋ	m	j	ʃ	ʃ	s	ts	ø	v	z
a	12	8	6	9	7	7	5	10	10	7	8	8	9	8	9	10	7	8	9	6	11
b	10	12	10	11	11	7	7	8	10	11	10	6	7	8	11	7	9	10	7	8	8
β	7	9	13	10	12	9	10	5	7	9	9	7	6	10	8	8	10	9	8	9	7
d	10	10	10	13	11	9	9	8	8	11	12	8	9	10	9	9	11	10	9	10	10
g	9	9	11	10	12	10	8	7	9	10	9	7	8	9	10	8	8	7	8	7	8
i	8	6	9	7	9	13	9	6	6	7	8	10	7	12	9	11	9	8	11	8	8
j	6	8	10	9	9	9	13	6	6	9	10	8	7	8	5	9	11	10	7	10	8
k	9	7	7	10	8	8	6	11	7	8	9	7	10	9	8	8	8	7	8	7	9
λ	12	10	8	9	9	7	5	8	12	9	8	8	7	8	11	10	7	8	9	6	11
ε	7	11	11	10	10	8	10	7	9	12	9	7	8	9	8	8	10	9	8	11	9
n	9	9	9	12	10	8	10	7	7	10	13	9	8	9	8	10	12	11	8	9	9
ŋ	9	5	7	8	6	10	8	5	7	6	9	13	7	11	8	12	10	9	12	7	9
p	8	8	6	9	7	7	7	11	8	7	8	6	13	8	7	7	7	6	7	8	10
q	9	7	9	10	8	12	8	7	7	8	9	11	8	13	10	12	10	9	12	9	9
ʃ	9	9	9	10	10	10	6	7	9	10	9	9	8	11	12	10	8	7	10	7	9
ʃ	8	6	8	9	7	11	9	6	6	7	10	12	7	12	9	13	11	10	11	8	8
	8	8	10	11	9	9	11	6	6	9	12	10	7	10	7	11	13	12	9	10	8
t	9	9	9	10	8	8	10	7	7	8	11	9	6	9	8	10	12	13	8	9	7
t	10	6	8	9	7	11	7	6	8	7	8	12	7	12	9	11	9	8	13	10	10
w	7	9	9	10	8	8	10	7	7	10	9	7	8	9	6	8	10	9	8	13	9
z	11	9	7	10	8	8	8	9	11	10	9	8	10	9	8	8	8	7	10	9	13

2.4 A Revised Evolutionary Tree of the Cretan Script Family

The Carian alphabet is a script evolutionary missing link that was conjectured by Revesz [32] to have existed somewhere in western Anatolia as a common ancestor of the Cypriot syllabary and the Old Hungarian alphabet. This situation is illustrated in Fig. 1.

3 Minoan is an Ugric Language

In this section we consider the relationship between the Minoan language as recorded in Linear A [14, 41] and Cretan Hieroglyphs [26, 42] and the Uralic language family. The Uralic language family consists of a Finno-Ugric branch and a Samoyedic branch. The Finno-Ugric branch is further divided into a Finno-Permic and an Ugric branch [18]. The Ugric branch is composed of the Hungarian, Khanty and Mansi languages [18]. Linguists have studied the Uralic languages for over two hundred years and identified sets of words that characterize the nodes of this family tree (see Honti [17]).

Minoan, the language of Linear A, is an unknown language. Nevertheless, ancient Greek preserves many words from the Minoan language. Beekes [4] collected in a dictionary all the non-Indo-European vocabulary of ancient Greek. While Beekes [4] often identifies the non-Indo-European words of ancient Greek as having unknown origin, we have found corresponding cognate words within the Uralic language family for many of them. We give some examples of these cognate pairs in Tables 7, 8 and 9, which show some apparent cognate ancient Greek and Uralic, Finno-Ugric and Ugric word pairs. In Tables 7, 8, and 9 the similar consonant sounds are highlighted by red, inserted glide consonants are highlighted by blue, and omitted sounds are indicated by underscores. The Hungarian words and their cognates in Tables 7 and 8 are based on the Hungarian etymological dictionary of Zaicz [43]. The Hungarian words and most of their Khanty and Mansi cognates in Table 9 are based on Honti [17].

Table 7. Ancient Greek and Uralic cognate words.

English	Hungarian	Other Uralic	Greek
hide (n.)	bőr (skin)		βυρσα
tail	far	pir^{Khanty} (behind), purdā^{Yurak} (turn back)	_ουρα
weave	fon (braid), fonal (yarn)		υφαινειν
cooked	főtt		οπτος
boil	főz		επιζειν
cook	főz		πεσσειν
blow (wind)	fúj	pŏγ^{Khanty}, pow^{Mansi}	πνειν
saw (n.)	fúr (drill) > fűrész		πριων
wave	hab	kump^{Khanty}	κυμα
die (v.)	hal	kāl^{Mansi}, koule^{Finnish}	εκλειπειν
burial mound	hal (die) > halom[1]		κολωνη
snow	havu > hó		χιων
boy	here (scrotum)	kar^{Khanty} (male)	κορος
sinew	_ín	tɛn^{Mansi}	τενων
kettle	láb (leg) > lábos (pot)		λεβης
piece	mar (bite)	murta^{Finnish} (break)	μερος
go (intrans.)	megy < *mene	miń^{Mansi}, mun^{Zyrian}, mene^{Finnish}	βαινειν
egg	mony		ωον
wash (hand)	mos (wash) > mosdik (wash self)		νιζειν
eye	szem	silmä^{Finnish}	οφ-θαλμος
sea	tó (lake)	tu^{Zyrian} (rise), tulis^{Zyrian} (spring)	θαλασσα
road	út	āχt^{Mansi}, ŋut^{Yurak}	οδος

Table 8. Ancient Greek and Finno-Ugric cognate words.

English	Hungarian	Other Finno-Ugric	Greek
brain	agy	anzêl^{Mari}	εγ-κεφαλος
fang	agyar	ańśar^{Khanty}, ańśer^{Mansi}	γναθος
ebb (s.)	apály	šupal^{Zyrian} (dry out)	παλιρροια
father-in-law	após	op^{Mansi}, appi^{Finnish}	πενθερος
gleam (s.)	csillog (v.)	šŭlpi^{Khanty} (v.), śülγ^{Mansi} (v.)	σελας
moon	csillag (star)		σεληνη
trumpet	csont (bone) > csülök (bone piece)		σαλπιγξ
gleam	ég		αυγη
freeze (v.)	fagy	palji^{Mansi}, palella^{Finnish}	πηγνυνα
brick	fal (wall), cf. pala (rock split)	pato^{Finnish} (levy), cf. pala^{Finnish}	πλινος
city	falu	palva^{Finnish}	πολις
torch	fény (light), fejér (white)	päju^{Sami} (white)	πανος
boy	fiú	püw^{Mansi}	παις
angry	haragos	χor^{Mansi} (quarrel)	χαλεπος
bite	harap	kurćći^{Zyrian}	χαραγμα
come	jön	jö^{Khanty}, ji^{Mansi}	ιεναι
(sacrifice) fat	ken (oil v.)	куя^{Erzya} (fat)	κνισα
tie	köt	kät^{Mansi}, kytke^{Finnish}	εκδειν
tunic	köt (tie) > kötény (apron)	kät^{Mansi}	χιτον
kick	lök (shove), cf. rúg	lykkää^{Finnish} (push)	λακτιζειν
big	magas (tall), nagy (big)	naź^{Zyrian} (proud), mägi^{Estonian} (mountain)	μεγας
delay (intrans.)	múlik (pass time)	mal^{Mansi} (pass time)	μελλειν
nose	orr		ρις
mountain	orr (nose) > orom		ορος
throw	repít		ριπτειν
loin	segg (bottom)	säŋ^{Mansi}	οσφυς
many	sok	šaw^{Mansi}	συχνος
dry (adj.)	száraz	sor^{Khanty}	ξηρος
put	tesz	täị^{Mansi} (weave)	τιθεναι
tyrant	tőr (dagger) > törvény (law)	tir^{Votyak} (ax)	τυραννος
light (subj.)	világ	bæggjo^{Sami} (light v.)	φεγγος

Table 9. Ancient Greek and Ugric cognate words. (The Ugric word list is from Honti [17].)

English	Hungarian	Other Ugric	Greek
bough	ág	taw^{Mansi}	ἀκρέμων
loin	ágyék	ońćī^{Mansi} (bottom)	οσφυς
make	alkot	alt^{Mansi} (join)	εργαζεσθαι
meadow	alom (bed of straw)	ilem^{Khanty} (grass in shoe)	λειμων
across	általal	ulti^{Khanty}, ūltta^{Mansi}	δια
sea	_ár (flood)	lar^{Khanty} (floodplain)	θα-λασσα
daughter	_ara (daughter-in-law)	_år^{Mansi} (maternal relative)	κορη
mound	domb, cf. tomp (*bottom > waist)	tōmp^{Mansi}	τυμβος
sharp (adj.)	él (knife edge)	ēlmi^{Khanty} (knife edge), iĺmet^{Mansi} (same)	τομος
fasten	enyv (glue)	ejem^{Khanty} (glue), iľem^{Mansi} (glue)	δειν
mulberry	eper (strawberry)	äperjek^{Mansi}	μορον
fat	faggyú (tallow)	polt^{Khanty}	πιμελη
tiresome	fárad (tired, v.)	powremat^{Mansi} (tired, v.)	βαρυς
loose (v.)	fejt	päči^{Khanty} (open), pišt^{Mansi}	απαλλασσειν
land	fedél (cover) > föld	päntel^{Mansi} (cover)	πεδον
axe	fokos	poγ^{Khanty} (needle's eye)	πελεκυς
sprinkle	folyik (flow)	păli^{Mansi} (flow out)	παλυνειν
fabric	foszlik (get threadbare)[1]	posl^{Mansi} (tattered cloth)	υφασμα
up	fel	pĕt^{Khanty} (tall)	επι
cork	fúl (prick)	pul^{Khanty} (stick underground), pulp^{Mansi}	φελλος
grass	fű	pam^{Khanty}, pom^{Mansi}	ποα
smoulder	füst	poseŋ^{Khanty}, posim^{Mansi}	τυ-φεσθαι
decay, *ruin*	fülik		φθορα, _ολεθρος
sting	gyakik		δακνειν
way	hág (climb) > hágó (mount. Pass)	χonχ^{Khanty} (climb), kaj^{Zyrian} (rise)	κελευθος
fever	hagymáz	kańt'^{Khanty} (sick)	καυμα
hair	haj	χåj^{Mansi}	κομη
bend (s.)	hajol (v.)	χojt^{Mansi} (v.)	κοιλον
rouse, *excite* (v.)	hajt	χujt^{Mansi}	κινειν
mound	hant	χomes^{Khanty}, khåmśel^{Mansi}	χωμα
split (v.)	hasad	kün-kaśmāt^{Mansi}	δι-χοστατειν
swan	hattyú	kŏteŋ^{Khanty}, kotaŋ^{Mansi}	κυκνος
seven	hét	tapet^{Khanty}	επτα
fat (adj.)	hízik (fatten)	katem^{Khanty}	γαστρωδης
near (adv.)	hozzá (to it)	kūt'eŋ^{Khanty}	εγγυθειν
young	ifjú	äj^{Khanty} (young)	γονη
with	íz (joint) > izom (muscle)	jäsen^{Finnish} (joint), jöt^{Khanty} (joint)	συν
good	jó	jim^{Khanty}, joms^{Mansi}	ευ-
anger	kedv (mood)	kĕnt^{Khanty}, känt^{Mansi}	κοτος
be sick *of* (dat.)	keshed	käńt^{Khanty} (lose weight), kańś^{Mansi}	αχθεσθαι
out of (prep.)	ki	küm^{Khanty}, kün^{Mansi}	εκ
track	kisér (accompany)	kŭś^{Khanty}	ιχνοσκοπειν
barley	köles (millet)	kolas^{Mansi} (millet)	κριθη
easy (task)	könnyű	kene^{Khanty}, kinne^{Mansi}	ακονιτι
weeping	könyörög (beg) könny (tear s.)	kēnγ^{Mansi} (cry)	κλαυματα
whet (v.)	köszörül	kesiŋ ku^{Mansi} (w. stone)	ακναν
generous	laza (loose)	laćet^{Mansi} (loose)	ελευθερος
watch	les	lāśi^{Khanty}, läć^{Mansi}	φυ-λασσειν
ride	ló (horse)	loγ^{Khanty} (horse), low^{Mansi} (horse)	ελαυνειν
sprout	maláta		βλαστημα
wet (v.)	márt (dip)	măra^{Khanty}, mur^{Mansi} (sink)	βρεχειν
suitable	méltó	mel^{Khanty}	εμμετρος
deep (adj.)	mély	mĕl^{Khanty}, mäl^{Mansi}	βαρυς
bride	menyül (as a bride)	meń^{Khanty}, miń^{Mansi}	νυμθη
tale	mese, cf. monda (said)	mańt'^{Khanty}	μυθος
movement (go)	mét-háló (moving-net)		βασις
clothes	meztelen (without cloth)	mäš^{Mansi} (dress)	ιματια

English	Hungarian	Other Ugric	Greek
smile	mosolyog	mus^{Mansi}	μειδιαν
at (prep., dat.)	-nál/nél		εν
laugh	nevet	mäveńt'^{Mansi}	μειδιαν
toponym ending	-nyék		-να
lead (metal)	_ólom	_olna^{Khanty}, wōlem^{Mansi}, wulnê^{Mari}	μολυβδος
in addition, adv	olt (graft), cf. ad (give)	alt^{Khanty} (add to), alt^{Mansi} (add to)	ετι
whip	_ostor	wašter^{Mari} (wand) > _aśter^{Mansi}	μαστιγουν
wait	óv (protect)	ūmetöl^{Mansi}	μενειν
crash (s.)	rokkan (v.)	råγ^{Khanty} (cave in), räγ^{Mansi} (sink, ebb)	αραγμος
kick	rúg, cf. lök (push)	ruŋk^{Khanty} (wade)	λακτιζειν
squeeze	sajtó (press n.), cf. sajtol (squeeze)	šojle^{Khanty} (goes down)	θλιβειν
dark	sötét	šätep^{Mansi} (get dark)	σκοτος
bake	süt	šit^{Mansi}	σιτοποιειν
jump (v.)	szánguld (speed)	såγel^{Khanty}, šōm^{Mansi}	σκιρταν
reef	szalu (stranded)		στελλειν
leg	szár, cf. lábszár	sur^{Khanty}, sor^{Mansi}	σκελος
sick	szédül (dizzy)	sǎje^{Khanty} (dizzy)	ασθενης
wedge	szeg (nail)	süŋ^{Khanty}, säŋk^{Khanty}, (< *sajβe)	σφην
dry *up*	szik	śäχ^{Mansi} (salt)	ισχναινειν
song	szó (word)	sǎw	ασμα
blond	szőke	säŋ-ki	ξινθος
fur	szőr	šär^{Mansi} (horsetail)	εθειρα
diviner, augur	táltos	tolt^{Khanty}	τερατοσκοπος
contrive	tekint (look at, consider)	täγen^{Khanty} (remember, keep in mind)	τεχνασθαι
chamber	tér (space)	tarimt^{Khanty} (lies on ground)	θαλαμος
err, lose, mistake	téved	tĕp^{Khanty}, tip^{Mansi}	σφαλλεσθαι
lamp (oil)	tidó		δολος
throat	torok	tur^{Khanty}, tor^{Mansi}	δερη^{1}
torch	tűz (fire)	tüt^{Khanty}, tāwt^{Mansi}	δας
hate	utál	aγet^{Khanty} (vomit), ajt^{Mansi} (vomit), *akte	εχθειν
woman	ük (ancestor w.)	ēke^{Mansi}	γυνη, cf. Γαια
female (s.)	üsző (cow)	ĕs^{Khanty} (female animal)	θηλεια
rotten	záp, cf. _áporodik	saim^{Mansi}	σαπρος
shrink	zsugorodik	śuŋker^{Mansi}	συναγειν
crack (split) (v.)	zug (crack, n.)	suŋ^{Khanty}	σχιζειν

The ancient Greek words are from the ancient Greek etymological dictionary of Beekes [3, 4]. The associations of the ancient Greek and the Uralic cognates are our work. There were some earlier dictionaries of Greek and Hungarian by J. Aczél in 1926 and more recently by Varga [37], but they completely ignored Finno-Ugric linguistics. Their dictionaries lack any etymological considerations and list words that are not true cognates but medieval or later borrowings. Their dictionaries also contain several false cognates. Nevertheless, they deserve some credit for bringing the issue of larger than expected similarities between the Greek and the Hungarian vocabularies to attention.

Tables 7, 8 and 9 have some striking implications. Clearly, the Ugric word cognates are the most remarkable because the Ugric words are unique to the Ugric branch according to Honti [17]. While there are strong Greek and Hungarian connections because Greek missionaries and merchants frequently visited Hungary, there is no similar relationship between Greek and Khanty or Mansi. Hence we have to suppose that Minoan is a previously overlooked Ugric language. The only logical assumption can be that Minoan separated from the Ugric branch and came to Crete before the arrival of proto-Greek speakers sometime around 1450 BC, when the Linear B supplanted the Linear A writing according to the archeological record.

The author's previous decipherments of the Phaistos Disk [30] and Cretan Hieroglyph inscriptions [31] also suggest that the Minoan language was Finno-Ugric. That proposal was received with some skepticism on a geographic ground because it was difficult to imagine how the Minoans could have arrived to Crete from any previously proposed Finno-Ugric homeland. This situation has led us to the consideration of the Hattic language of Anatolia, as described below.

4 Hattic is an Ugric Language

Usually a language family spreads over a connected area. Hence it looks strange that Minoan culture existed primarily in Crete, while Khanty and Mansi live on the eastern side of the Ural Mountains. However, the gap between these two areas can be explained if Minoans migrated to Crete from the north, probably the eastern or northern costal areas of the Black Sea via Anatolia, that is, present day Turkey. If there was such a migration through Turkey, then it also had to occur in very ancient times. According to archeologists in those ancient times, the Hattic culture occupied most of northern and central Turkey [29]. This naturally raises the question whether Hattic is also related to Minoan and whether it could also be an Ugric language. In this section, we consider this issue because if there is a relation between Minoan and Hattic, then Hattic could also help to reconstruct the Minoan language.

Linguists generally consider Hattic to be an language isolate. The only exception that we are aware of is that recently, Alexey Kassian [29] suggested some of the following language similarities between Hattic and the Yeniseian languages, Ket and Kott:

alef$^{\text{Hattic}}$ (tongue) ~ alup$^{\text{Kott}}$ (tongue)

kap$^{\text{Hattic}}$ (moon) ~ qīp$^{\text{Ket}}$ (moon)

While the above word similarities are interesting, it weakens the case that neither word occurs in both Yeniseian languages. Yeniseian languages may have borrowed these words from the Uralic languages. In fact, we can find more word parallels between Hattic and the Uralic languages. Table 10 lists a few examples, where PFU means Proto-Finno-Ugric.

The list in Table 10 is more than the mere verisimilitude of a few pairs of words. Instead, Table 10 reveals regular sound changes, and suggests new natural etymologies of words that previously had an unknown origin.

Among the regular sound changes, we can mention the change from Uralic m to Hattic p. Another regular sound change is the dropping of Uralic word initial v in Hattic. Both of these regular sound changes are attested at least three times.

Regarding new etymologies consider for example kanál$^{\text{Hungarian}}$ (spoon), which Zaicz [44] lists as a word of unknown origin. Proto-Finno-Ugric word initial kV regularly changes to Hungarian hV where V is a back vowel. Similarly, we can assume that Hattic word initial ḫV derives from kV where V is a back vowel. With this assumption, *kana$^{\text{Proto-Hattic}}$ (food) > ḫana$^{\text{Hattic}}$ (food) can also be assumed. Then kanál can be analyzed as a compound word:

kanál < *kana$^{\text{Proto-Hattic}}$ (food) + nyél$^{\text{Hungarian}}$ (handle).

That is, kanál$^{\text{Hungarian}}$ (spoon) can be understood to be a food-handling instrument.

Similarly, kupál$^{\text{Hungarian}}$ (unshell) seems to involve hitting the shells of seeds in order to crack them and thereby open them. That hitting is similar to hitting a nail. Hence in the Hattic language, it is added to kur-kupal$^{\text{Hattic}}$ (nail, peg). Since kur$^{\text{Hattic}}$ in itself means 'to stay' the combination of kur-kupal$^{\text{Hattic}}$ seems to describe 'an object that stays in place after hitting,' which is a good definition of a 'nail' or a 'peg.'

Considering grammar, Table 2 lists some striking similarities between the Hattic and the Hungarian noun cases as well as some noun-to-adjective transforming suffixes. Note that in the genitive case example:

wūr-un katte$^{\text{Hattic}}$ (king of the land)

where katte$^{\text{Hattic}}$ means 'king,' the possessor—the land—seems to get the genitive case ending un$^{\text{Hattic}}$, which is similar to the nak/nek$^{\text{Hungarian}}$ genitive case ending for the possessor, i.e.,

föld-nek királya$^{\text{Hungarian}}$ (king of the land).

The expression Arinn-iti$^{\text{Hattic}}$ is translated as 'she from Arinna.' In our opinion, this expression contains the agglutination of two separate suffixes. The first suffix is the *locative noun case* suffix *it and the second is a *noun-to-adjective forming* suffix *i. Both of these have Hungarian parallels.

The *locative noun case* suffix in Hungarian is –Vtt and can be found in words such as ott$^{\text{Hungarian}}$ (there), hanyatt$^{\text{Hungarian}}$ (over), mindenütt$^{\text{Hungarian}}$ (everywhere), előtt$^{\text{Hungarian}}$ (in front of) etc. These words can be used as prefixes, which seems to be the case in the expression *a ta niwāš*$^{\text{Hattic}}$, which may be best translated as 'he there sits.' The –Vtt suffix is also used with the names of some old towns that already existed during the Roman Empire, as for example in: Győr-ött, Pécs-ett, Székesfehérvár-ott and Vác-ott. Interestingly, while the locative cases of these old town names preserve the –Vtt suffix, newer towns tend to have the later *superessive noun case* –en/on suffix. The common *noun-to-adjective forming* suffix in Hungarian is -i, which is sometimes still added to the –Vtt suffix.

Table 10. Hattic and Uralic cognate words. Some frequent sound changes are indicated in red.

Hattic	**Uralic**
alep (tongue)	läppä[Finnish] (tongue)
alep (word)	lupaus[Finnish] (promise, word)
anna (woman)	nē[Mansi] (woman)
anti (to stay)	jenti[Mansi] (to stay alive)
apa (five)	pōχi[Mansi] (palm)
araz (earth)	raχt[Mansi] (mud)
arinna (fountain)	ér[Hungarian] (small creek)
ašaḫ (evil)	áskál[Hungarian] (machinate)
aya (to give)	anna[Estonian] (to give)
dukaram (scooper)	jōχtnė[Mansi] (scooper)
Eštan (sun god, day)	isten[Hungarian] (god) šōt[Mansi] (luck) sāti[Mansi] (perform magic)
ḫārkim (wide)	khår[Khanty] (wide)
ḫa- (among, between)	χalt[Mansi] (among, between)
ḫaipinamul (virility)	khum[Mansi] (man) p/m
ḫan (sea)	vōŋkę[Mansi] (hole) cf. Lake Van in Turkey
ḫana (food)	kenyé-r[Hungarian] (bread) -r[Hungarian] noun form. suffix χant[Mansi] (remaining food) kanál[Hungarian] (spoon) näl[Mansi] (handle) nyél[Hungarian] (handle)
ḫanti-psuwa (cook)	pånsli[Mansi] (to cook)
ḫapalki (iron)	kupál[Hungarian] (unshell)
ḫil (to pour)	kholiti[Mansi] (to pour)
ḫu-kuru (to look)	kārtiŋ[Mansi] (to stare)
ḫut (to get free)	χot-liṅmi[Mansi] (to loosen)
išpel (evil man)	vėsmėli[Mansi] (to envy) p/m
itā (this way)	et'e[Mordvinian] (this)
jaḫtu (sky)	nuŋkėt[Mansi] (above)
ka- (on, to the)	kēt[Mansi] (in)
kaita (grain)	kuśä[Mansi] (grain)
karkar (to scrape)	khåuri[Mansi] (to scrape)
katakumi (witchcraft)	kirt-ēkwä[Mansi] (witch)
kazue (cup)	kusu'[Mansi] (cup)
kinawar (copper)	kami[Mansi] (copper money) kwɣ̄r[Mansi] (iron)
kip (to protect)	χūptėl[Man.] (protective cover)
kap[Hattic] (moon)	joåŋ-khėp[Mansi] (moon)
kušku (moon god)	kiška[Selkup] (star)
kur (to stay)	χūl'ti[Mansi] (to stay)
kur-kupal (peg, nail)	kēr-l'iχ[Mansi] (nail) kupál[Hungarian] (unshell)
kuwa (to catch, grab)	χa̋pėji[Mansi] (to catch) el-kap[Hungarian] (to catch)
kuwapi (whereto)	hova[Hungarian] (whereto)
Lēlwani (weather g.)	lėl[Mansi] (soul, breath) lélek[Hungarian] (soul)
munamuna (stones)	muŋi[Mansi] (egg, scrotum)
nuwa (to go)	mini[Mansi] (to go)
pakku (hammer)	fokos[Hungarian] (axe)
paru (bright, shining)	*feér[Hungarian] (white)
pinu (child, son)	pieni[Finnish] (little) pijo[Mordvinian] (grandchild) pǫu[Mansi] (boy, son)
puluku (leaves)	pul[Mansi] (berry)
purulli (spring fest.)	pūrlili[Mansi] (to feast)
pušan (to blow on)	piššėmi[Mansi] (to blow)
šḫap (god, deity)	*śeppä[PFU] (clever)
šaḫiš (kind of tree)	såχtiŋ[Mansi] (tall straight tree)
šail (master, lord)	isand[Estonian] (lord)
šaki (heart)	šåm[Mansi] (heart)
šep (footwear, shoes)	čemču'rä[Mansi] (shoe) p/m
šul (to release)	śolėχti[Mansi] (to run)
tāuwa (to fear)	tärmä'l[Mansi] (to scare)
taḫ (to put, to sit)	*teke[PFU] (to make, to put)
tawar (to rule)	ōtėr[Mansi] (ruler)
tewū (to pour)	ta$^{\gamma}$ɻlti[Mansi] (to pour)
Taru (storm god)	tōrėm[Mansi] (god, sky)
tittaḫ (big, great)	tal'ėχ[Mansi] (top) t/l tető[Hungarian] (roof)
tu (to eat)	tɻ[Mansi] (to eat)
tu- (in, inside)	tar-[Mansi] (across)
tūḫul (four)	čete[Nganasan] (four) tet[Selkup] (four)
tur (to defeat, to beat)	tir[Votyak] (battle axe, labrys) tőr[Hungarian] (weapon)
uktūri (everlasting)	akw-…-tā̋rėmnė[Mansi] (id.)
un- (you)	näu[Mansi] (you)
ura (well, spring)	ér[Hungarian] (small creek)
ureš (smith)	kēr[Mansi] (iron) kū̋r[Mansi] (forge) ūr-khor[Mansi] (red) vörös[Hungarian] (red)
uwa (to enter)	be-[Hungarian] (into)
ūk (just as, how)	így[Hungarian] (so, thus)
wēl (house)	*palɣe[PFU] (village)
wa-paḫ (eagle)	vɔj[Mansi] (to take, to grab) jūs-vɔj[Mansi] (eagle) pākw-turuj[Mansi] (black eagle)
wuna (mortality)	vana[Estonian] (old) vener[Zyrian] (old) vén[Hungarian] (old)
wūr (land, country)	föld[Hungarian] (land)
Wuru-šemu (sun god)	forró-szemű[Hu.] (hot-eyed)
wūti (long)	vastag[Hungarian] (wide)
zar (sheep)	zerge[Hungarian] (chamois)
zas-ḫai (dream)	uśśi[Mansi] (ghost) khujji[Mansi] (sleep)
zik (to fall)	zuhan[Hungarian] (to fall)

For example, *Pécs-ett-i hírek*[Hungarian] means 'news about and from Pécs.' Given the above parallels, we suggest that Arinn-iti[Hattic] can be better translated as 'from inside Arinna.'

We suspect that the –ili suffix also may be also broken up into –il and –i. That is, ḫatti-l may mean 'as a Hatti,' while ḫatti-l-i may mean 'like someone who is a Hatti.' The latter phrase may better describe a Hittite who spoke in the Hattic language.

Table 11. Hattic-Hungarian noun case parallels.

Noun Case or Adj. Former	**Hattic**	**Hungarian**
Ablative *from* *from land*	 tu/du wūr-tu	 tól/től föld-től
Allative *to* *to gods* *among/between* *among gods*	 ḫa ḫa-wāšḫap	 hez/hoz istenek-hez közé istenek-közé
Dative *to* *to king* *Poss. 3rd SG* *his/her school*	 ja katte-ja	 nak/nek király-nak ja iskolá-ja
Essive *as a* *as a lion* *in Hattic lang.*	 al/ili takkeḫ-al ḫatti-li	 ul/ül oroszlán-ul hatti-ul
Genitive *'s* *earth's king*	 un wūr-un katte	 nak/nek föld-nek királya
Illative *into* *into house*	 pe/pi pe-wēl	 ba/be ház-ba
Locative *in/inside* *in Arinna* *there* *he there sits*	 *it *Arinn-it *ta a ta niwāš	 Vtt Arinna-itt ott ő ott ül
Adj. former *~ from* *from inside A.*	 *i Arinn-it-i	 i Arinna-itt-i
Adj. former *~like* *Hatti-like*	 š ḫatt-uš	 s hatt-is

In Table 11, we translated takkeḫ-al[Hattic] (as a lion), based on takkeḫ[Hattic] (lion), while [29] translated it as 'hero.' We suggest that there is no major semantic difference between these two translations because someone who fights as bravely as a lion can be considered a hero.

Table 11 puts in parallel the Hattic dative noun case and the possessive third person singular case. These two cases have a semantic similarity because the receiver of a gift (dative case) becomes the new possessor of the gifted object (possessive case).

Hattic expresses the collective plural by a wā[Hattic] prefix. The Uralic languages use various suffixes for the noun plural. However, we suggest that the Hattic prefix may be interpreted by the following Uralic words: puu[Finnish] (tree), pu[Zyrian] (tree), -pä[Mansi] (tree), and fa[Hungarian] (tree). It is natural to assume that the concept of 'tree' represents the grouping of separate items together. Even today 'family tree' represents a set of individuals who are related together. Note the p/f change from apparent *pu[Proto-Uralic] to fa[Hungarian] (tree). Hence a p/w change may be also possible between the same root word and wā[Hattic]. Hence a possible etymology of the Hattic word for 'gods' is the following:

wā-šḫap[Hattic] ~ the family of gods, i.e. gods

wā-zari[Hattic] ~ the human family, i.e. people

The Hattic verb conjugation is little known, but it was identified that the Hattic past tense marker is –n. Although the regular past tense marker in Hungarian is –t, the past tense marker –n also seems to occur in a few irregular verbs. For example,

lő-n[Hungarian] (he/she/it became)

where –n is the irregular third person singular past tense marker. Contrast that with the following:

ve-tt[Hungarian] (he/she/it bought)

which has the regular past tense marker. The infinitive forms of these two verbs are 'lenni' and 'venni', respectively. The similarity of these two infinitive forms makes the conjugational differences more surprising.

The Hattic personal pronouns also have Uralic parallels. In particular, the Hattic and the Hungarian third person singular personal pronouns are similar to each other:

a[Hattic] (he/she) ~ ő[Hungarian] (he/she)

Due to the above vocabulary and grammatical similarities, we propose that Hattic is also an Ugric language.

5 The Phonetic Values of Linear A

Section 2, Fig. 1 and the chronology of the archeological data imply that the Linear A syllabary is an ancestor of the Linear B syllabary, the Carian alphabet, and the Old Hungarian alphabet. The Linear B syllabary is known to contain (almost exclusively) CV type syllables, where C is some consonant and V is some vowel. However, some Linear B symbols represent single vowels. Therefore, it is reasonable to assume that the Linear A syllabary also contains mostly CV type syllables and some vowels.

Then the main puzzle is how a syllabary with CV type syllables could evolve into an alphabet. One straightforward-looking assumption is that most CV syllables have their vowel dropped over time. That would mean several syllables of the form CV_1, CV_2, …, CV_n with *n* different vowels would evolve into the same consonant C.

That means that if a Linear A syllable s_i *corresponds to* a Carian alphabet letter a_j, with phonetic value C, then s_i likely has a phonetic value CV for some V. Alternatively, if a_j represents some vowel V, then s_i represents the same (or similar) vowel V.

In the above we did not define the term '*corresponds to.*' By that we mean that the pair s_i and a_j, have a high similarity score, which can be found shaded along the diagonal of Table 4 or 5. For example, we saw that:

$$sim(\text{𐊀}, \text{𐊠}) = 13$$

Here the Linear A symbol 𐊀 corresponds to the Carian alphabet letter 𐊠 as reflected in Table 4. Since 𐊠 has phonetic value /a/, by the above we can assume that 𐊀 also has the phonetic value /a/.

As another example, the following pair also appears along the diagonal of Table 4:

$$sim(\text{𐊗}, \text{𐊢}) = 13$$

while along the diagonal of Table 5 the following pair appears:

$$sim(\text{𐊗}, \text{𐊹}) = 13$$

Here the first pair implies that the Linear A symbol 𐊗 has phonetic value /dV/ because the Carian letter 𐊢 has phonetic value /d/. In contrast, the second pair implies that 𐊗 has phonetic value /tV/ because the Old Hungarian letter 𐊹 has phonetic value /t/.

```
1  Algorithm FindSyllabicValue(s, T)
2  s  /the input Linear A symbol/
3  T /the input threshold for similarity/
4
5  /Find a matching alphabet letter from Carian,
6   Old Hungarian and Cretan Hieroglyph./
7  a = FindClosest(s, Carian)
8  if sim(a, s) < T then
9     a = FindClosest(s, OldHungarian)
10    if sim(a, si) < T then
11       a = FindClosest(s, CretanHieroglyph)
12    end if
13 end if
14
15 if sim(a, si) >= T then
16   if Vowel(Sound(a)) then
17      return(a)
18   else   /Sound(a) is a consonant/
19     while w = GetNextUralic(s) != NULL do
20       if w[1]=a and Vowel(Sound(w[2])) then
21          return(w[1-2])    /CV type syllable/
22       end if
23       if Vowel(Sound(w[1])) and w[2]=a then
24          return(w[1-2])    /VC type syllable/
25       end if
26     end while
27   end if
28 end if
29
30 /Now try Cypriot and Linear B/
31 a = FindClosest(s, Cypriot)
32 if sim(a, s) >= T then
33    return(Sound(a))
34 else
35    a = FindClosest(s, LinearB)
36    if sim(a, s) >= T then
37       while g = GetNextGreek(s) != NULL do
38          if g[1] == Sound(a) then /acrophone/
39             u = GreekToUralic(g)
40             return(u[1-2])
41          end if
42       end while
43    else    /not an acrophone/
44       return(Sound(a))
45    end if
46 end if
47
48 if Ligature(s) != NULL then
49      return(Ligature(s))
50 end if
51
52 return("no syllable found")
```

Fig. 2. An algorithm to find Linear A syllabic values.

The above may be due to the Minoan language not distinguishing between voiced and unvoiced stop sounds, be they alveolar /d/ or /t/, bilabial /b/ or /p/, or velar /g/ or /k/. Hence we will also not distinguish these sound pairs in the syllabic grid that we develop below. The grouping of the above pairs is supported by the fact that the Mansi language does not use the /b/ and the /d/ consonants (see Kulonen [20], p. 5, and the online Mansi dictionary [22]).

To the velar group /g/ and /k/, we also add the velar /x/, which is present in Mansi. To the bilabial group /b/ and /p/, we also add /f/, /v/ and /w/. Usually, the /f/ sound in Hungarian words of proto-Ugric origin is derived from words with an original /p/ sound. The Minoan cognates of these words also likely had a /p/ sound instead of the /f/ sound.

In addition, we do not distinguish among the sibilant fricatives /s/, /ʃ/ and /z/ in our syllabic grid. While these may have been distinguished in the Minoan language, they change frequently among themselves. Hence until we obtain a detailed knowledge of the Minoan language, these sounds can be treated as a group.

Finally, we also group together the /l/ and /r/ sounds, which were also not distinguished in the Linear B script.

Ugric languages contain a number of palatalized consonant sounds. These are in a separate column headed with the /j/ sound. Palatalized sounds include /ʎ/ as in the Hungarian word 'lyuk' /ʎuk/ meaning 'hole.'

We distinguish only the following four vowels in our grid: /a/, /e/, /i/ and /u/. In particular, the vowel /o/ is assumed to be absent from the Minoan language, as it is absent in Etruscan, which is

Table 12. The proposed Linear A phonetic grid. The number preceding each Linear A letter is the GORILA [14] classification number for symbols common in Linear A and Linear B (1-180) or just for Linear A (above 300). Legend: ~ similarity between symbols, Car. = Carian, Cr. H. = Cretan Hieroglyph, Cyp. =Cypriot, Old. Hung. =Old Hungarian.

	a	**e**	**i**	**j (palatalized)**	**u (o)**
	712 𐘒 ~ Car. 𐊠 a	55 𐘕 ~ Car 𐊨 ɛ	13 𐘝 ~ O. Hung. 𐳀 i, j	17 𐘞 j ~ O. Hung. 𐳀 i, j	26 𐘦 ~ Car. 𐊵 u 29 𐘩 ~ Car. 𐋉 w
j	344 𐘸 ai/aj (a and i/j ligature?)	24 𐘣, A363 𐘤 ~ Car. 𐊣 j jēker[Mansi] (root)	6 𐘁 ~ O. Hung. 𐳀 i, j jég[Hungarian] (ice)		314 𐙐 ~ Car. 𐋊 j jó[Hungarian] (river)
k **g** **x**	44 𐘘 ~ Cyp. 𐠚 ga 60 𐘜 ~ O. Hung. 𐳆 k hattyú[Hungarian] (swan) χoten[Mansi] (swan)	57 𐘖 ~ O. Hung. 𐳇 k kät[Mansi] (tie) köt[Hungarian] (tie, knit)	67 𐘧 ~ Lin B ki kürt[Hungarian] (horn)		28 𐘪 ~ CH. 𐙂 k kom[Mansi] (man) kum[Selkup] (human)
m			73 𐘹 ~ Lin B mi		23 𐘫 ~ Lin B mu
n	37 𐘃, 45 𐘛 ~ Lin B ma μέγας[Greek] (big) nagy[Hungarian] (big)	27 𐘯 ~ Car. 𐊯 n nyél[Hungarian] (handle)	30 𐘱 ~ Lin B ni 34 𐘄, 310 𐙎 ~ O.Hu. 𐳃 n in[Yurak], íj[Hungarian] (bow) íny[Hungarian] (gum, palate)	41 𐘵 ŋ ~ Car. 𐊯 n kēr-ńäs[Mansi] (trident) 81 𐘆 ŋ ~ O. Hung. 𐳄 n madár[Hungarian] (bird)	80 𐘡 ~ Lin B ma nyúl[Hungarian] (hare) numolo[Mord.] (hare)
p **f** **w** **v**	10 𐘇 ~ Car. 𐊰 β fa[Hungarian] (tree) 54 𐘗 ~ Car. 𐋉 w vászon[Hungarian] (fabric)	8 𐘔 ~ Lin B a αξινη[Greek] (axe) fejsze[Hungarian] (axe) păćt[Mansi] (axe)	40 𐘏 ~ Lin B 𐘲 wi	344 𐘶 p^j ~ O. Hu 𐳁 p pihe[Hungarian] (feather)	69 𐘬, 648 𐙓 ~ Cyp. 𐠬 pu
r **l**	38 𐘀 ~ O. Hung. 𐳋 l láb[Hungarian] (leg) áll[Hungarian] (stand)	39 𐘁 ~ Lin B pi πέτομαι[Greek] (fly) légy[Hungarian] (fly)	50 𐘍 ~ Cyp. 𐠛 li lintu[Finnish] (goose) 53 𐘂 ~ Lin B ri	77 𐘨 ~ Car. 𐊭 i ~ O. Hung 𐳅 ʎ 78 𐘮 ~ O. Hung 𐳅 j lyuk[Hungarian] (hole)	59 𐘐 ~ Car. 𐊲 r *ruŋke[Uralic] (chew)
s **ʃ** **z**	56 𐘕 ~ O. Hung 𐳈 z szalag[Hungar.] (ribbon)	4 𐘋 ~ Cyp., Lin. B 𐘥 se sövény[Hungarian] (bush) 7 𐘓 ~ O. Hung. 𐳏 s esik/eső[Hungarian] (fall/rain) 301 𐘉 ~ Car. 𐊴 ʃ serény[Hungarian] (busy)	47 𐘌 zi ~ Lin. B 𐘳 swi csillag[Hungarian] (star)		58 𐘑 ~ Lin. B su sodor[Hungarian] (roll) 122 𐘟 ~ CH. 𐙅 z szúr[Hung.] (prick)
t **d**	31 𐘎 ~ O. Hung. 𐳌 t taw[Mansi] (bough)	16 𐘊 ~ CH. 𐙀 d tő[Hungarian] (tree trunk) tyvi[Finnish] (tree trunk)	37 𐘅 ~ Lin B ti	3 𐘇 ~ O. Hung. 𐳉 ɟ gyökér[Hungarian] (root)	1 𐘀 ~ Cyp. ta tee[Estonian] (road) *utu[Hungarian] (road)

related to Proto-Hungarian (see Alinei [2]). Presumably, the /o/ and /u/ vowels separated at a later time. We also do not distinguish between long and short vowels.

Our algorithm to find the syllabic value of a Linear A symbol is shown in Fig. 2. The algorithm $FindSyllabicValue(s,T)$ takes as inputs some Linear A symbol *s* and a similarity threshold value *T,* which we set to *12*. Our algorithm uses the following auxiliary functions:

- $sim(s,a)$ – Given two symbols, this function returns a value between *0* and *13* according to the degree of similarity between the symbols *s* and *a*. This function is the same as in Section 2.
- $FindClosest(s,A)$ – Given the symbol *s* and an alphabet or syllabary *A*, this function returns $a \in A$ such that $sim(a,s)$ is the maximum. If there are two or more symbols that have the same maximal similarity value, then the one that is earlier in the standard ordering of the symbols in A is returned.
- $Sound(a)$ – Given a symbol *a*, this function returns the phonetic value of *a*.
- $Vowel(p)$ – Given a phonetic value *p*, this function returns *true* if *p* is a vowel. Otherwise, it returns *false*.
- $GetNextUralic(s)$ – Given a symbol *s*, every call of this function with the same *s* as input searches further in the Uralic, Finno-Ugric and Ugric vocabulary lists of Zaicz [44] and returns the next word *w*, which is appropriate to describe the meaning of the symbol *s*. Since this function requires sophisticated artificial intelligence to recognize the meaning of symbols, we allowed here human judgment to tell whether a word is appropriate or not. If the vocabulary search has reached the last word, that is, no word is found appropriate, then the function returns NULL as a special value.
- $GetNextGreek(s)$ – This is like the previous function except now the ancient Greek vocabulary of Beekes [3] is considered.
- $GreekToUralic(g)$ – Given a Greek word *g*, this function translates it to a Uralic word *u*. We assume that the encoding of these words is in the International Phonetic Alphabet (IPA) form. Therefore, *u[i]* refers to the i^{th} sound and not necessarily to the i^{th} letter of the word *u*.
- $Ligature(s)$ – Given the symbol *s*, this function returns the concatenation of two symbols a_1 and a_2 from the Carian, Old Hungarian and Cretan Hieroglyph alphabets that may be composed to yield a symbol that is similar to *s*. If no such pair of symbols is found, then the function returns NULL.

In Lines 8-13, we find the Carian letter *a,* which has the largest similarity score to *s*. If the similarity score is less than the threshold *T*, then we search for the most similar letter in the Old Hungarian and then the Cretan Hieroglyphs alphabet. The preference order of these three alphabets follows from Fig. 1, which implies a script evolutionary tree where the Carian alphabet is the closest to Linear A, the Old Hungarian the second closest, and the Cretan Hieroglyphs is the third closest. If we find some *a,* whose similarity to *s* greater than or equal to the threshold *T*, then there are two cases:

1. If the best match is with a vowel, then the phonetic value of the Linear A symbol is assumed to be the same vowel (Lines 16-17).

2. If the best match is with a consonant C, then we assume that occurs in either a CV or a VC type syllable. We identify the meaning of the Linear A symbol. For example, some symbols can be identified to be a symbol for a bird. Then we search for a Uralic word for the meaning of the symbol. If the Uralic word begins with the same consonant C and continues with a vowel, or it starts with a vowel and continues with the same consonant C, then the algorithm returns the first two sounds of the Uralic word as the syllabic value of *s* (Lines 18-28).

In case the above does not yield a CV or a VC type syllable, then the algorithm searches the Cypriot and the Linear B syllabary for an above threshold similar symbol *a*. If the search is successful for Cypriot, then the algorithm returns phonetic value of the Cypriot syllable (Line 33). For the Linear B, the algorithm tests whether the meaning of a is a Greek word *g* that starts the same way as the Linear B syllable's phonetic value. If there is a match, then the symbol was possible to read in Greek acrophonically in Linear B times. Therefore, it was also likely read acrophonically in Minoan in Linear A times. Hence the algorithm translates the Greek word *g* into a Uralic word *u* and returns its first two sounds *u[1-2]* as the syllabic value of *s* (Line 40). If there is no match, then the symbol was likely already so abstract at the transition time from Linear A to Linear B that it

was not read acrophonically but simply memorized as a symbol that needs to be read in a certain way. Hence in that case the algorithm returns the syllabic value of Linear B (Line 44).

If *s* can be recognized as the ligature of two symbols a_1 and a_2 from the Carian, Old Hungarian or Cretan Hieroglyph alphabets, then the algorithm returns the concatenation of these two symbols (Line 49). Finally, when none of the above cases apply, then we return an error message.

We note that taking the first syllable using the acrophonic principle is a method that could be misleading when there are several words with different beginning syllables to describe the meaning of a symbol [9]. However, we use the acrophonic principle only in a limited sense because we search only for words that begin with a particular consonant C and further limit the vocabulary search to (Proto)-Uralic, Finno-Ugric and Ugric words. With these restrictions, the probability of getting a valid conclusion is much higher than in a typical application of the acrophonic principle.

Table 12 shows the Linear A phonetic grid that we obtained by following the above procedure. In the next section we will use this phonetic grid to decipher some Linear A texts. In Table 12 the phonetic values that are obtained by the use of Line 44 are highlighted in blue, while the phonetic values obtained using the other cases are highlighted in red. Since 80 𐘐 seems to be a picture of a hare, its value may have been /nu/ originally. Perhaps 45 𐘍 is a something tall and an ancestor of 37 𐘅. Hence they are grouped together.

As an example of the use of the algorithm, suppose that we input the Linear A symbol 𐘃. This symbol also occurs with minor variations in Linear B with the phonetic value of /a/. Since apparently this symbol shows an axe, which in Greek is αξινη that also starts with /a/, the symbol was read acrophonetically in Linear B. Therefore, it was likely read also acrophonetically in Linear A. Since Minoan is related to the Ugric languages, and the word for axe is *păćt* in Mansi and *fejsze* in Hungarian, which are cognates, the Minoan word for axe also likely began with /pe/. (The Proto-Ugric word initial /p/ regularly changes to /f/ in Hungarian.) Hence the algorithm returns /pe/ as the syllabic value of 𐘃, which is placed in the row for /p/ and the column for /e/ in Table 12.

6 A Dictionary for Linear A

Linear A inscriptions usually divide words by a single dot. Hence it is very easy to identify words that occur in texts. The problem is that words rarely occur in their root forms. Instead they are conjugated by the rules of the Minoan grammar. The rules of this grammar can be perceived only by looking at a large number of words. When several words have the same beginning but different endings in the Linear A scripts, then we can suspect that the same root word is conjugated in different ways. By a careful observation of these conjugated forms, it can be observed that the grammar of the Minoan language is similar to Ugric grammar, similarly to what we observed in Section 4 regarding the Hattic language.

In Table 13, we took the words that we found in twenty-eight Linear A documents. The Linear A words using the standard Linear A characters [14] are listed in the second column of Table 13. Their transliterated form using the syllabic grid of Table 12 appears in the third column of Table 13. The transliterated forms are compared with the dictionaries for Uralic, Finno-Ugric and Ugric as listed in Zaicz [44]. We always search for the closest matches, where the consonants belong to the same group (the groups that we also used in Table 12) and the vowels are also similar, with possible changes among the back vowels as a group and among the front vowels as another group. The words that we found most phonetically similar to the Linear A transliteration are listed in the fourth column of Table 13.

Next we translate the words in the fourth column to English and list these translations in the first column. If there are several synonyms, then we choose one unique English word as the meaning of the Linear A word. We present Table 13 sorted by the first column in alphabetical order to make the dictionary easily searchable.

One interesting aspect of Linear A is that there seem to be some possible spelling variations of the same word. That may be because the different scribes used slightly different spelling rules or the different spellings may reflect different Minoan regional dialects. For example, consider the word for 'light,' which could be written by both 𐘃 𐘐 and 𐘃 𐘔. These two words are transliterated according to Table 12 as *fe-nu* and *fe-ne*, respectively. Both of these transliterations are close to the Hungarian word *fény*, which means 'light.' It is possible that in this case the ending vowel varied by dialects or the ending vowel was omitted by convention and hence it did not matter whether the last syllable is an *nu* or an *ne*. The dictionary in Table 13 is used in the translation of some Linear A inscriptions in Section 7.

Table 13. A Minoan etymological dictionary with Uralic, Finno-Ugric and Ugric cognate words.

Meaning	**Word**	**Transliteration**	**Uralic, Finno-Ugric and Ugric Cognates**
ACC		-mu	-mø[Mansi] (accusative suffix, singular case)
ADV. suffix -ly		-nu -nu-pu	-an/en[Hungarian] (ADVERB suffix)
air			LOGOGRAM
all		fe	pussen[Mansi] (all) bout[Sami] (all)
all stars		fe-es-ki-se	cf. *all+stars* *fa+kaskus > *fakskus > faskus
ancestor			LOGOGRAM
ancestor (father)		ʃe se	esi-isä[Finnish] (ancestor), isä[Finnish] (father) äs'[Mansi] (mother's father) ős[Hungarian] (ancestor)
ancestor[2]		ku-ke	cf. old
and		es	és[Hungarian] (and) os[Mansi] (and)
big, great		ŋ-u-se na-es	naʒ[Zyrian] (proud) nagy[Hung.] (big, great)
blow		pu-j	fúj[Hungarian] (blow) pow[Mansi] (blow) pŏγ[Khanty] (blow)
cave		lu-ji-ku lu-ji-xa lu-ku	*loβkke[PFU] (cave) lyuk, luk[Hung.] (cave, hole)
chief queen		fe-ta-ta-xa-i	cf. *head, queen* *fő+kattahhi > *főkttahhi > főttahhi
chief star		fe-es-ki	cf. *head, star* *fő+kasku > *főksku > fősku
cloud		pa-ji-λ-ji-ŋ pa-ji-u-λ fe-lu-na	pälеŋ[Khanty] (cloud) pejel' [Mordvinian] (cloud) felleg[Hungarian] (cloud)
come		je-na j(i)	jön[Hungarian] (come) jö[Khanty] (come) ji-/jäj-[Mansi] (come) jõudma[Estonian] (reach, come, arrive at)
create		ku-ji-lu	kuoriuta[Finnish] (hatch <egg>) kooruma[Estonian] (hatch <egg>) kül[Khanty] (stand up) käl[Mansi] (rise, land on shore) kel[Hungarian] (rise), ki-kel[Hungarian] (hatch <egg>), cf. *out* keletkezik[Hungarian] (come to be)
Dan		du-ŋ	river name: Duna[Hungarian] (Danube), Dnieper, Dniester, Don tin-jā[Mansi] (name of a river) taŋri[Mansi] (push)
day		ke-ti	xötal[Mansi] (day)
down		le lu lu-e λ	le[Hungarian] (down) alla[Estonian] (under, below, down) lewäl[Mari] (lower part)
earth			LOGOGRAM
every			cf. *all*
fire			LOGOGRAM
flow		pa-λ-ti	pol'ćīt[Mansi] (splashes water) folyik[Hungarian] (flow)

fly (down)		se-ku	sēγėmi[Mansi] (<god's spirit> fly down) segít[Hungarian] (v. help) čangoďe[Mordvinian] (v. help)
gleam	 	se-le-u-ne ʃe-le-ga	csillan[Hungarian] (v. gleam) šŭlpī[Khanty] (gleam, shine) csillog[Hungarian] (v. gleam) śülγ[Mansi] (gleam, shine) σέλας[Greek] (light, glow, beam) etym. unclear [3] Σελήνη[Greek] (Moon goddess) from σέλας [3]
go		mu-ŋ-i	mene[Finnish] (go) men[Hungarian] (go) min[Mansi] (go) mun[Zyrian] (go, travel)
god (sun god)		se-te-na	sāti[Mansi] (perform magic) isten[Hungarian] (god)
grow		se-sa	sūsi[Mansi] (grow) sás[Hungarian] (sedge)
happy		ri-ku	rikolt[Hungarian] (squawk, yell) ârvuk[Sami] (happy, lively)
head	 	fe pu	fő[Hungarian] (head, chief)
heat		fe-wa-le	fül[Hungarian] (heat up, warm up <weather>) pöl[Mansi] (burn) puv[Zyrian] (boil)
high		ke-ɟ-de	hegy[Hungarian] (mountain) kuiju[Yenisei] (mountain top) χoj[Yurak] (mountain top)
IMP. mood *(indefinite case)*	 	ji-nu je-ŋ je-in ji-mi-ji je ɟ-ke ɟ-ŋ wa-ŋ s-e-na	-jen[Hungarian] (IMP., 3rd person, sing.) *-jemi[Hungarian] (IMP., 3rd person, plural) -jenek[Hungarian] (IMP., 3rd person, plural) >*jek j commonly varies with the verb root end as follows: d + j > ɟ; g + j > ɟ; n + j > ŋ; ŋ + j > ŋ; ʃ + j > ʃ ʃ; s + j > ss; z + j > zz; t + j > ʃ ʃ **or** ss;
INF. form		-nu-ji	-ni[Hungarian] (INFINITIVE verb form)
INSTR. case		-al	-øl[Mansi] (instrumental case) -val/vel[Hungarian] (instrumental-comitative case)
king		ai	åtėr[Mansi] (ruler, god, king)
king			LOGOGRAM
Kitana		ki-ti-je-ŋ	Kitana
light	 	fe-nu fe-ne	fény[Hungarian] (light) bæggjo[Sami] (shine) päju[Sami] (white)
look		te-ki	*täkke[Proto-Ugric] (look) tekint[Hungarian] (look) täγen[Mansi] (remember)
louse	 	pa-ri-ku	LOGOGRAM perk[Zyrian] (louse) pērk[Mansi] (worm, insect) féreg[Hungarian] (worm, insect)
love		se-ri	szerelem[Hungarian] (love) sir[Mansi] (mood, condition, habit, gender) sir[Khanty] (clan)

mother		na na-e	anya[Hungarian] (mother)
mountain			cf. *high*
Moon		"star queen" "star head"	cf. *star* + *queen* > Kasku[Hattic] (Moon goddess) cf. *star* + *head* > Moon
NOUN plural		-ke -xa	-k/ak/ek[Hungarian] (NOUN plural)
NOUN former		-se	-s[Hungarian] (NOUN forming suffix)
NOUN[as]		j(i)-ne	jernė[Mansi] (NOUN suffix equiv. to "as") gyanánt[Hungarian] (equivalent to "as")
now		in	iń[Mansi] (now) cf. Zaicz [44] under 'ez' in[Khanty] (now) nyt[Finnish] (now) nüüd[Estonian] (now) ma[Hungarian] (today)
oil			LOGOGRAM
old		ji-xa ku-ANCESTOR	eukko[Finnish] (old woman) jükā[Mansi] (woman) ük[Hungarian] (ancestor) kuka[Hattic] (ancestor)
olive			LOGOGRAM
out		ku ku-ji	küm[Khanty] (out, outside) kün[Mansi] (out, outside) ki[Hungarian] (out, outside)
Phaistos		fe-es-tu	Phaistos
POSS. plural		ji	-i/ji[Hungarian] (possessive case plural suffix)
PREP. on		-in -ŋ	-en/on/ön[Hungarian] ("on" suffix)
PRN		-mi	-m[Hungarian] (1st SG, acc/dat/poss. pronoun suffix)
queen		ke-ta-ta-xa-i	katte[Hattic] (king) + *iβkke[PFU] (old woman) kattahha[Hattic] (queen) <mother goddess> *katte[PFU] (reach, invade) > χăt[Khanty] (go elsewhere) hat[Hung.] (reach, affect) > hatalom[Hungarian] (power)
rise		ku-le	*kälä[PFU] (rise, stand up) kül[Khanty] (stand up) käl[Mansi] (rise, land on shore) kel[Hungarian] (rise) kerkib[Estonian] (rise <sun>)
river		ju-su	jušur[Votyak] (river) jä[Mansi] (river) jó[Hungarian] (river)
run		fe-ɟ	pagema[Estonian] (flee) fut[Hungarian] (run) vojl[Zyrian] (run)
see		lu-ta	lát[Hungarian] (see) litobiz[Yenisei] (watch) letampā[Yurak] (protect)
shine			cf. *light*
shine-IMP[3rd SG]		se-su-na	süt[Hungarian] (bake, shine <sun>) + jön[Hungarian] (IMP) > süssön šiti[Mansi] (bake)
spirit		ʃe-pa se-pa	*seppa[PFU] (clever) ashaf[Hattic] (god) szépanya[Hung.] (ancestor mother) σπεος[Greek] (cave) Pre-Greek (Beekes [4])

			ασπαλαξ[Greek] (mole) Pre-Greek (Beekes [4])
spirits		ʃe-wa-ke	cf. *spirit* + *NOUN plural (with* *f/p > w root change)
spring			cf. *well* + *head*
star		ke-es-ki	kiška[Selkup] (star) χus[Khanty] (star) kōńś[Mansi] (star) húgy[Hungarian] (star) kušku[Hattic] (moon god)
star		za-la	csillag[Hungarian] (star)
Sun			cf. synonym: *god*, also *head* + *god* > Sun (god) išti[Mansi] (warm, burn <something>) eshtan[Hattic] (sun, day)
sunlight		p[j]-ai-ku	paike[Estonian] (sun) fény[Hungarian] (light) fehér[Hungarian] (white)
Tamuz		te-mi-zi	Tamuz[Akkadian] (a vegetation god)
Thera		ti-ri	*Tiri > Akrotiri
this		e	e[Hungarian] (this) eťe[Mordvinian] (this) etaje[Zyrian] (this)
toward		ni-ki-ji ni-ke	-nä[Mansi] (locativus suffix) -nek[Hungarian] (towards something) neki[Hungarian] (for him/her)
tree		fe pa	fa[Hungarian] (tree) puu[Finnish] (tree)
trees		fe-ke	cf. *tree* + *NOUN plural*
VERB suffix		-ku	-k/ik[Hungarian] (3rd person, SING. of verbs ending with –ik)
VERB suffix		-j	-j[Hungarian] (3rd person, SING.)
VERB suffix		- -pu	-nø[Mansi] (2nd person, PLURAL)
VERB past		-ti -na	-t/tt[Hungarian] (VERB past tense suffix) -n[Hungarian] (arch. VERB past tense), e.g. teszen, lőn, vagyon
water		es	LOGOGRAM < eső[Hungarian] (rain)
water		wi-se	vesi[Estonian] (water) vesi[Finnish] (water) víz[Hungarian] (water) wit[Mansi] (water)
well		ku-tu	kút[Hungarian] (well) kolo[Finnish] (hole)
willing		ke-su	kissja[Sami] (willing) kész[Hungarian] (willing, ready)
wind		pu-u-ta fe-tu	vot[Khanty] (wind) wōt[Mansi] (wind)
you		ni-e-ni	nēn[Mansi] (you, dual plural) naŋ[Mansi] (you, singular)

7 A Decipherment of Linear A Texts

The majority of the extant Linear A documents contain only one or two symbols. The interesting documents are those that have a larger number of symbols and words and contain not just an itemized list of objects for accounting but entire sentences that reveal the grammar of the Minoan language.

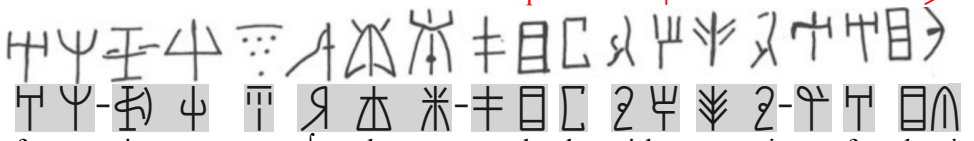
We list below some documents from the GORILA collection [14]. For each document we give its original appearance and its standard Linear A form. Occasionally the standard form is debatable for some symbols that are partially erased or written ambiguously. We indicate these ambiguities in red. Each word of the translation can be found in the dictionary of Table 12.

Fig. 3 gives the translation of four jewelry inscriptions. These inscriptions tend to be longer than most other inscriptions. The first inscription (KN Zf 13) appears on a gold ring. In this case, we wrote both the closest Hungarian and other Finno-Ugric words (last two words) and the English meaning in separate lines. This inscription seems to be an invocation to the Sun Goddess (see Marinatos [23] about the importance of the Sun Goddess in Minoan religion) to shine and gleam happiness on the wearer of the gold ring. This message on a ring could be fitting as a gift for Minoan lovers.

The next three items in Fig. 3 are three hairpins that also contain invocations to some goddess for good fortune and happiness. The gold pin (CR Zf 1) also starts with the word 'shine' but with a slightly different spelling from that on the gold ring. These variations were already discussed in Section 6.

KN Zf 13 (from GORILA 4 p. 153) [gold ring]

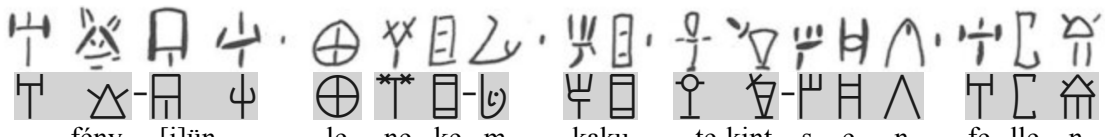
incorrect interpretations: ? ?



fe---ne---je----ŋ	es	ʃe----le----ga---ɟ---ke	lu	ri-ku	se---ri-mu	fe	ke-ti
fé---ny---je----n	és	csi---llo---g----jé--k	le	ri-kolt	sze-re-lem	bout	xö-tal

[Sun] shine-IMP$^{3rd\ SG}$ and [stars] gleam-IMP$^{3rd\ PL}$ down happy love-ACC every day.

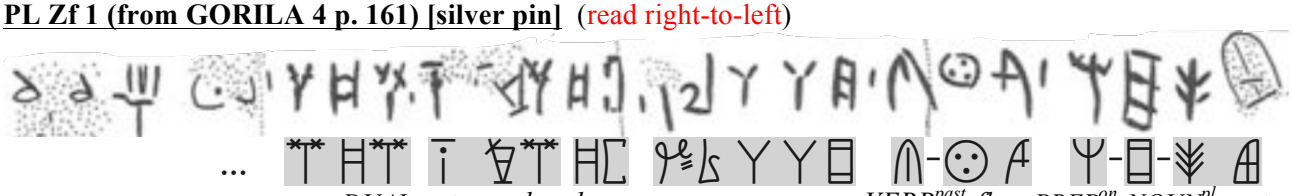
CR Zf 1 (from GORILA 4 p. 147) [gold pin]



fény	[j]ün	le	ne	ke	m	kaku	te-kint---s---e----n	fe--lle---n
shine-IMP$^{3rd\ SG}$		*down*	*toward-PRN$^{1st\ SG}$*			*ancest.*	*look –IMP*	*cloud*

<The Mother Goddess shine down on me, the cloud watch me.>

PL Zf 1 (from GORILA 4 p. 161) [silver pin] (read right-to-left)

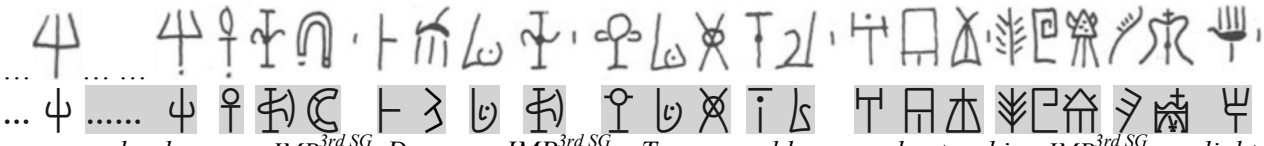


...	*you-DUAL*	*toward*	*down*	*queen*	*VERB^{past}-flow*	*PREP^{on}-NOUN^{pl}-water*

On waters flowed [the] queen down to you ...

<The Mother Goddess rained her blessings on you ...>

KN Zf 31 (from GORILA 4 p. 155) [silver pin]



cloud	*come-IMP$^{3rd\ SG}$*	*Dan*	*go-IMP$^{3rd\ SG}$*	*Tamuz*	*old*	*heat*	*shine-IMP$^{3rd\ SG}$*	*sunlight*

<[Let the] cloud come, [the] Dan [river] flow, old Tamuz bring heat, shine sunlight

wind-NOUN^{PL}	*great*	*sun (god)*	*see VERB$^{3rd\ SG}$*	*down fly*	*king- NOUN^{as}*	...	...

[bring] winds. [The] great Estanu (sun god) sees [you], flies down as a king ... >

Fig. 3. Translation of four jewelry inscriptions.

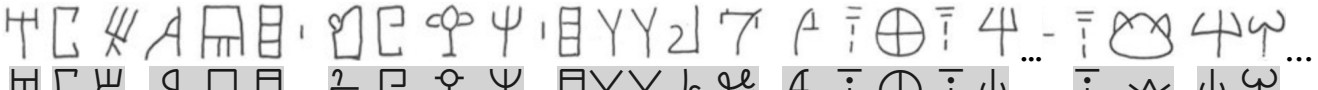
KO Za 1 (from GORILA 4 p. 20)

All cave spirits: wind, ANC. river, spring, cloud rise IMP big!

IO Za 2 (from GORILA 5 p. 19)

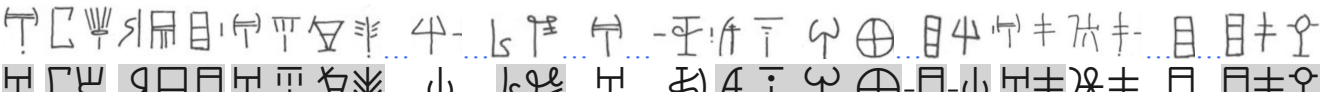
All cave spirits: Moon ... rise IMP big! Cave spirit mother ...

TL Za 1 (from GORILA 4 p. 59)



All cave spirits: Sun, queen cloud IMP big!

PK Za 12 (from GORILA 4 p. 38)

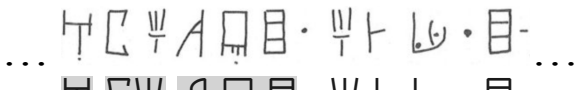


All cave spirits, all stars [and the] shiny queen [Moon] ...cloud-NOUN^{plural}-PREP ^{on} run ... high!
on clouds

SY Za 2 (from GORILA 5 p. 65) using the ordering of lines (a, d, b) proposed by John Younger

All cave spirits willing----ly [receive] olive trees cloud (perfume) oil.
(ADV suffix or VERB suffix 2nd, PL.)

SY Za 1 (from GORILA 5 p. 63)



All cave spirits

SY Za 3 (from GORILA 5 p. 67)

All cave spirits big!

IO Za 3 (from GORILA 5 p. 21)

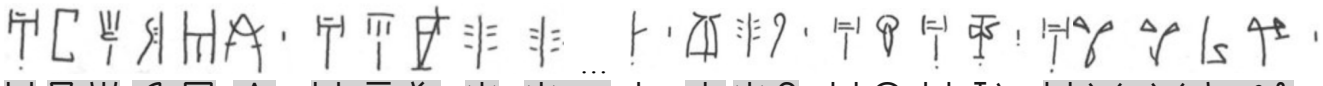
All cave spirits

IO Za 7 (from GORILA 5 p. 29)

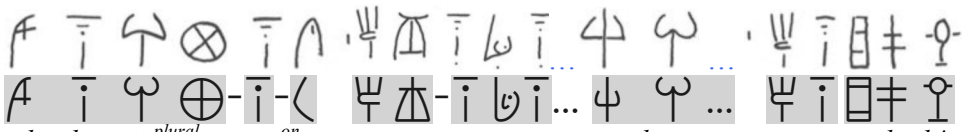
All cave spirits

Fig. 4. Translation of nine Linear A libation formula documents starting with "All cave spirits."

PK Za 11 (from GORILA 4 p. 34)



All cave spirit-INSTR. chief star ancestor gleam down love fa ko fa j chief queen
With all cave spirits päike(se)pai(ste)[Estonian] (sunlight)



cloud-POSS[plural]-PREP[on] rise IMP big out high!
on her clouds

PR Za 1 (from GORILA 4 p. 48)

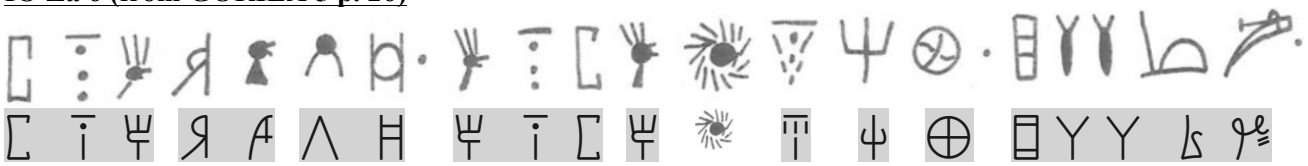
*incorrect ?

Cave ancestor ? chief queen.

PK Za 10 (from GORILA 4 p. 31)

rise IMP

IO Za 6 (from GORILA 5 p. 26)



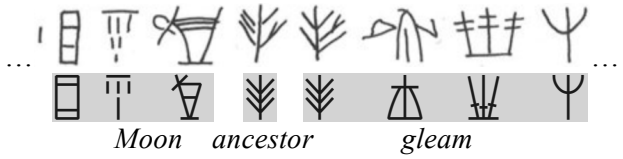
Cave spirit mother [who] create [hatch] out fire, water, air [and] earth, queen.

PK Za 8 (from GORILA 4 p. 26)

*incorrect ?

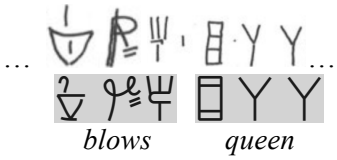
... star [and] Moon ancestor gleam. Blow-V. 3rd SG queen cloud ... old ancestor
Blows

PK Za 15 (from GORILA 4 p. 41)



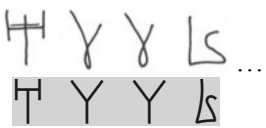
Moon ancestor gleam

PK Za 14 (from GORILA 4 p. 40)



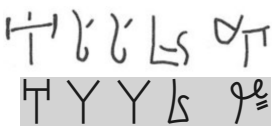
blows queen

PK Za 4 (from GORILA 4 p. 23)



chief queen

IO Zb 10 (from GORILA 5 p. 34)



chief queen

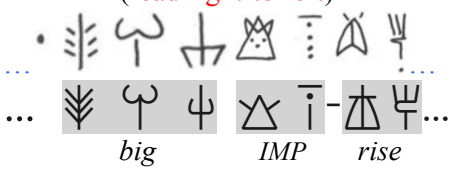
Fig. 5. Translation of nine more Linear A libation formula documents containing the word "queen."

AP Za 2 (from GORILA 4 p. 5)

PS Za 2 (from GORILA 4 p. 21) with b, c, a order of fragments

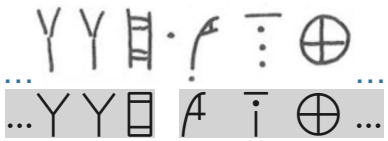
VRY Za 1 (from GORILA 4 p. 61)

(read right-to-left)

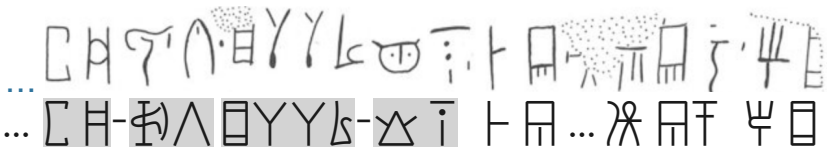


IO Za 9 (from GORILA 5 p. 21)

(1st part read right-to-left)



KN Za 10 (from GORILA 4 p. 9)



KN Zc 6 (from GORILA 4 p. 120) [painted cup]

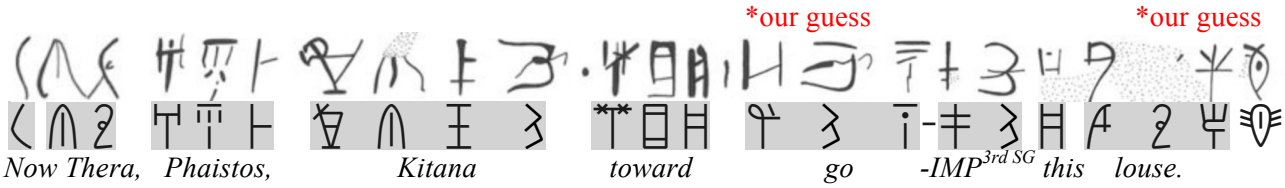


Fig. 6. Translation of some more Linear A inscriptions. The last is from a painted cup.

Another interesting set of inscriptions is called libation documents. Libation documents are found in sacred places, such as in peak sanctuaries and caves. Fig. 4 groups together a set of libation documents that all start with the phrase "all cave spirits." These documents, which are from several different places, show that there was some prayer formula that was widely used by the Minoans. It appears that the Minoans thought of their mother goddess and their ancestors as spirits that dwelled in the caves of large mountains.

Fig. 5 continues with the translation of more libation documents that contain some interesting variations from those of Fig. 4. In particular, the first inscription of Fig. 5 (PK Za 11) shows the variation "with all cave spirits." Here the suffix 𐄁 is used to denote the instrumental case, which is translated as "with."

Fig. 6 shows some more variations of the libation formula. The last inscription (KN Zc 6) is a cup from Knossos with painted symbols inside. The painted symbols are somewhat different from the standard forms or significantly eroded. Hence in the case of two symbols, we indicate our interpretation by a red *. This inscription seems to be an ostracon with the command "This louse go to Thera, Phaistos, Kitana now." For greater emphasis the scribe also drew a logogram of a louse at the end of the sentence. This message may have been a kind of curse by someone at Knossos, the center of power in northern Crete, towards the adversary towns of Thera (on the island of Santorini), Phaistos (southern Crete), and Kitana (eastern Crete).

The Linear A documents translated above range from jewelry inscriptions, through religious inscriptions, and to curses. These documents show an interesting and complex picture of Minoan life that can be gained only by the ability to read their writings. The validity of our translation method is proven by the fact that it works for all these different inscriptions.

Eteocretan EPIOI inscription

**some scholars assume this is a Θ*

Fig. 7. Translation of the EPIOI Eteocretan inscription from Psychro, Crete.

8 Eteocretan a Descendant of Minoan

The Eteocretan inscriptions [40] are thought to be late forms of the Minoan language. These inscriptions are written using Greek letters except for a few letters of the EPIOI inscription, which is shown in Fig. 7. The last three letters of the EPIOI inscription recall can be rewritten into standard Linear A as the word 𐘦 𐘔 𐘟, which in the dictionary of Table 12 is equivalent to the word "big." Curiously, this word occurs as the last word on several Linear A libation documents. For example, the word "big" occurs also as the last word in the documents (KO Za 1) and (SY Za 3), which are shown in Fig. 4.

The other words seem to be Greek. We take the first word to be a proper name, EPIOI or EPIΘI. The second word actually seems to be a short Greek phrase meaning "he's gone." The third word may be a variation of Greek *ανάταση,* meaning revival. The fourth word may be a shortened form of Greek *παρα,* meaning beside/around. The fifth word *σιφ* seems connected to the Minoan word for spirit, which seems cognate to Hattic *ashaf* (spirit) and Proto-Finno-Ugric **seppa* (clever). Therefore, the entire inscription reads:

Epithi is gone and will rise beside the gods…big!

The above inscription indicates a survival of some variant of the libation formula used in Minoan times. Maybe the libation formula was memorized, and the last word of it was enough for people to recall the entire libation formula. The first part expresses the belief that the departed Epithi will be resurrected and then will live near the gods. He will rise "big," which may mean "high" or "great" in the Minoan libation formula, which urges all spirits to rise to eternal life.

The remarkable EPIOI inscription suggests that the people of Crete are descendants of the Minoans as well as Greeks. The Eteocretan language and script were primarily Greek but with several words and script symbols preserved from Minoan times.

9 Related Works and Discussion

In the study of ancient scripts, Crete plays a major role as the location of origin of Cretan Hieroglyphs [7, 25, 26, 43], Linear A [14, 42] and Linear B [5, 10]. Arthur Evans already proposed the spread of these Cretan scripts to Cyprus because of their resemblance to the later Cypro-Minoan and Cypriot syllabaries [10].

Recently, Revesz [32] noted further resemblance between the Cretan scripts and the Greek, Old Hungarian (native '*Rovásírás*') [12, 19, 38], Phoenician, South Arabic and Tifinagh alphabets. By using phylogenetic algorithms, Revesz [32] gave a hypothetical evolutionary tree for all the above-mentioned scripts, collectively named the *Cretan Script Family*. Revesz [32] also illustrated the hypothetical spread of these scripts on a map of the Eastern Mediterranean and Black Sea areas.

The evolutionary tree suggests that the Cypriot syllabary and the Old Hungarian alphabet have a common immediate ancestor, which was putatively located in western Anatolia. From western Anatolia, the writing spread to the northern Black Sea area, where Hungarians are first mentioned in written history, and to Cyprus in the Eastern Mediterranean. The Carian alphabet (see Adiego [1]) is now shown to be a member of the Cretan Script Family and the likely missing link between the Cypriot and the Old Hungarian scripts, as shown in Fig. 2.

Earlier alternative hypotheses regarding the origin of Old Hungarian include the Old Turkic (Orkhon) origin hypothesis by Sebestyén [35] and the Phoenician origin hypothesis elaborated in Hosszú [19]. More precisely, Hosszú [19] presents an encyclopedic study about Old Hungarian and its Steppean and Carpathian-Basin relatives, which collectively can be referred to as the *Rovas group*. Chapter 4 of Hosszú [19] gives a genealogy or derivation of all Old Hungarian and related Rovas symbols from twenty Phoenician letters, four Old Turkic (Orkhon) ideograms and the Greek letter Φ.

In contrast to Hosszú [19] and Sebestyén [35],

our previous study (Revesz [32]) placed Old Hungarian and Phoenician in two separate branches of the Cretan Script Family. Hence any similarity of these two alphabets is only due to their common origin. Forrai [12] and Varga [38] also questioned the assumption that Old Hungarian is derived from Phoenician or Old Turkic, but they did not specify a Cretan origin of Old Hungarian.

Western Anatolia was strongly influenced by the Minoan culture. In the early and middle Bronze Age, Miletus was a Minoan colony. In the late Bronze Age, Miletus became a Carian city. By the 8th century BC, Miletus came under Greek influence and itself established many colonies in the Black Sea region (Gabrielson et al. [13], Tsetskhladze [36]). The above historical outline suggests the following chain of events:

Minoan writing spread first to western Anatolia, where it influenced the development of the Carian alphabet [1], which spread with Milesians and other Carians to various groups of people who lived on the northern shores of the Black Sea at that time. Early Hungarians were either included among those groups of people, or they acquired the writing when they arrived to the northern Black Sea region.

The spread of writing in itself does not imply any language relationships. However, our earlier translations of some Cretan Hieroglyph inscriptions as Finno-Ugric texts, already suggested that Linear A also records a Finno-Ugric language. That means that the adaptation of Linear A to Hungarian may have preserved more faithfully the phonetic values than the adaptation of Linear A to Linear B did.

If the recognizability of the symbols as representations of concrete objects or actions is lost, then they could be adopted without any significant phonetic change. However, when the symbols are still recognizable, then they are more likely to be adopted with a phonetic change that is suitable to the adopting language. For example, as we saw in Section 5, the Linear A symbol 𐘂 was adopted in Linear B with the phonetic value of /a/ because the word for axe is αξινη in Greek. In contrast, according to Table 12, the Linear A

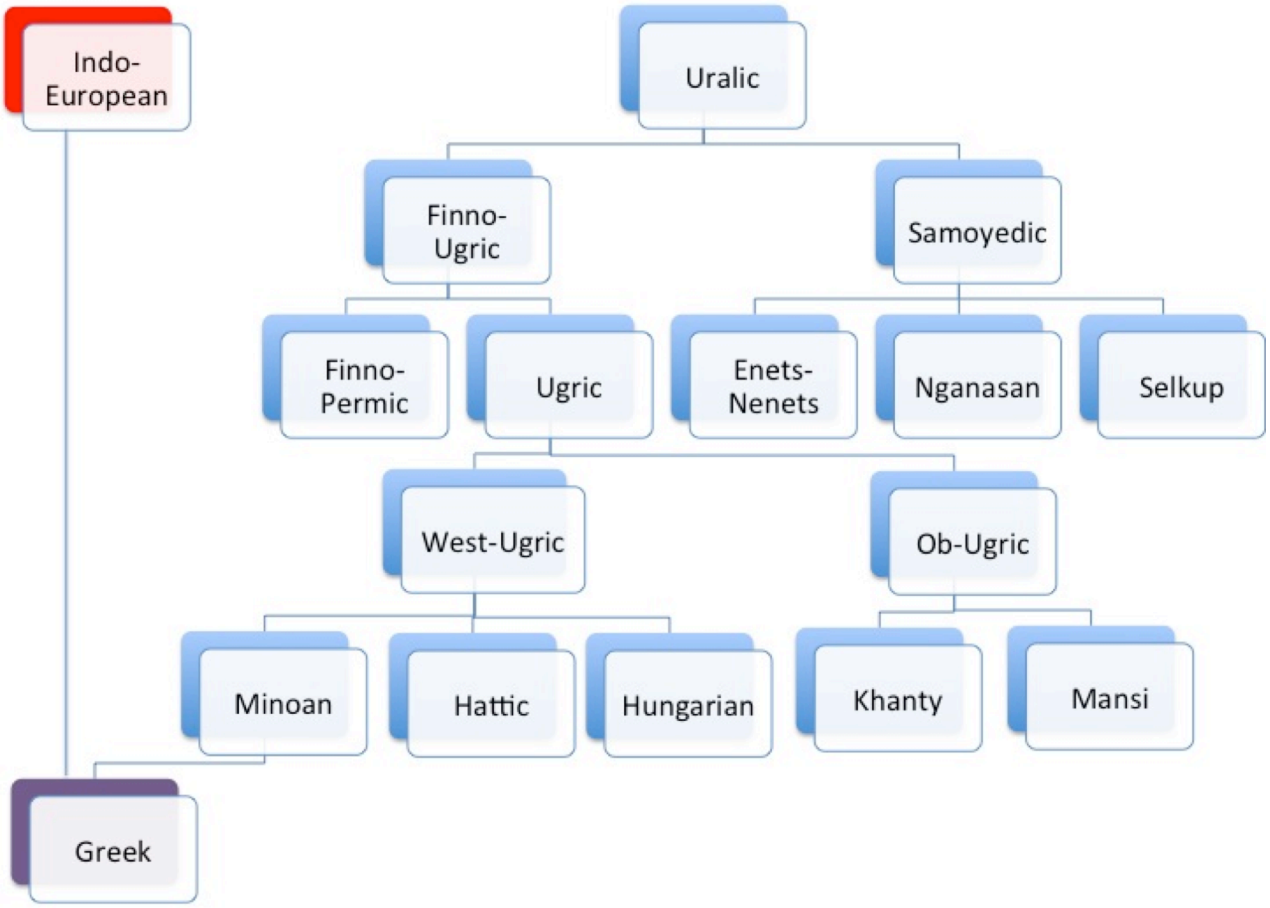


Fig. 8. The Uralic language family tree (blue) is extended by splitting the Ugric branch into a West-Ugric and an Ob-Ugric sub-branch. The West-Ugric branch contains Minoan, Hattic and Hungarian. The large Indo-European language family (red) includes the Greek language (purple), which also has a Minoan ancestry. The language families are not illustrated in full and many branches are omitted.

symbol 𐀲, which seems more abstract and unclear as to what it represented originally, was adopted in Linear B as /ri/ without a change to the Linear A phonetic value.

The above relationship between Linear A and Linear B explains why the approach to read Linear A using the Linear B sound values does not work in general, although there are some cases when it seems to work. In particular, Cyrus Gordon [15] and others identified some Linear A words that may be connected to Semitic languages, mainly the names of commercial products. Those cases where the Linear B sound values seem to work are composed of letters that are generally more abstract in form and hence better preserve the Linear A phonetic values.

The Uralic language family tree needs to be revised, as shown in Fig. 8. While the traditional classification of languages follows a strict tree paradigm, languages can have several ancestors. As we saw in Section 3, Greek borrowed many words from Minoan. Therefore, Greek can be considered to be a descendant of both Proto-Indo-European and Proto-Uralic and contains many ancient words from both language families.

There were many other attempts to solve Linear A. Among these attempts we mention a few of the more interesting proposals. Giulio M. Facchetti [11] claims a link between Minoan and Etruscan. Mario Alinei [2] also presents some connections between Etruscan and Hungarian. Since we placed both Minoan and Hungarian into the West-Ugric language branch of the Uralic language family (see Fig. 8), the works of Alinei and Facchetti both suggest that Etruscan may be a West-Ugric language. The connection between Minoan and Etruscan needs to be further explored.

Hubert La Marle [24] argues that the Minoan language is Sanskrit based on a phonetic reading of Linear A, which is similar to that of Linear B with only a few changes. According to La Marle, one accounting tablet adds up 12 nomads, 12 houses, 6 cave lodgers, 24 boats, 5 barrels, and 3 "these ones" and 4 pieces of wood into a total of 66. It is not clear why one would add up these items.

Graham Campbell-Dunn [6] argues that the Linear A symbols show some resemblance to an African sign system, and claims that some Linear A inscriptions can be read as a Niger-Congo language. Like many other authors, Campbell-Dunn relies on his own eyes for establishing similarities between pairs of symbols instead of a mathematical similarity measure, making his claimed resemblances also questionable.

Stuart Harris [16] also uses the Linear B sound values for the Linear A symbols, except the traditional vowel columns are split up into several columns with related vowels. Harris' translations of Linear A into Finnish rely on a large amount of additions to the text. For example, Harris' translation of the Linear A document (IO Za 2) starts with the Linear A transliteration:

a ra ko ta jä ha …

and extends it using the red letters into Finnish as:

akka rauhan: koitar jäi hauan …

In addition, Sam Connolly [8] offers a Latin, Gia Kvashilava [21] offers a Proto-Georgian, Gareth Owens [28] a Proto-Indo-European, and Fred C. Woudhuizen [41] a Semitic translation of some Linear A inscriptions.

The above examples exhibit a range of creative thinking and exploration about the decipherment of Linear A. Nevertheless, the examples also show that attempting to translate Linear A using Linear B values leads to confusing and contradictory results. The algorithmic identification of the syllabic values of Linear A is a major contribution of this paper. The algorithm relies on a mathematical similarity measure and is less likely to be misled as easily as human eyes can be. In the future, our algorithmic approach could be adapted to the solution of other yet unsolved scripts.

10 Conclusions and Future Work

Today ever fewer languages remain isolates as researchers with ever more sophisticated tools are able to find connections among languages that previously seemed unrelated. These new findings, these new connections, will hopefully increase among peoples a sense of connectivity and a greater appreciation of each other's cultures.

Another deeper goal of our research was to help uncover historical knowledge. Now that the Minoans can speak for themselves, historians may better understand their culture, from its beginning through its flourishing to its demise. Perhaps such an understanding may hold a historical lesson for all of us.

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