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1. Materials and methods

1.1 Sources of forms

Variation of different scripts for each of the symbols was assessed and analysed by reviewing the Knossos LB tablets (1) and studies of Linear B in general (2, 3) the Corpus of Linear A (4) (hereafter GORILA), Cypriotic (3, 5-7), Levantine and Phoenician (8-10) and early Greek (9, 11, 12) inscriptions, classifications and correspondences thereof, unless otherwise stated. The source of archaic Greek symbols is (12) and, unless otherwise noted, the Plate and inscription numbering correspond to the photographic material therein. The Vinča symbols are from (13); further analyses from (14), and (15). Different sources adopt very different chronologies but Linear A appears in every case to be the oldest of the five, with first inscriptions in that and its closely related Cretan pictographic dated ca 20th-19th century BC (themselves originating from 3rd millennium Aegean “hieroglyphics” found on seals), while the archaic Greek alphabets are considered to be the youngest, the earliest securely dated surviving inscriptions corresponding to around the 8th century BC (but see below the discussion on chronology). The Cyprominoan, a Linear A related script encoding an unknown language was also considered, although only as a probable intermediate in the Linear C development since, due to its lack of decipherment, few homologues can be established with a high degree of plausibility. I also considered the Carian (16), a remarkable script from Asia Minor which is partly alphabetic and partly syllabic. Unfortunately, for Carian too, there is lack of evidence on the exact value of many of its symbols not least because of scarcity of material and bilingual inscriptions, although some forms have been important in demonstrating D’Arcy Thompson states corresponding to certain phonetic developments.

Only symbols with morphological similarities in three or more deciphered scripts were included in our analyses, to avoid three taxon statements that would be subject to controversy. I also considered several other scripts from the area, dated in the Bronze Age, like the Cretan hieroglyphics, the Phaestos disc, Byblus pseudo-hieroglyphic etc. Symbols from these scripts could not be included to our analyses because of lack of agreement on the

correspondences, commonly accepted decipherment or a substantial corpus that would allow hypothesis testing. I used Times New Roman for Modern Hebrew symbols while standard typesets designed for computer word-processing available on the World Wide Web were downloaded from respective sites as follows: Egyptian hieroglyphics, <http://homepage.mac.com/glenbledsoe/winners/EgyptWeb/hieroChart.html>; Proto-Sinaitic, <http://home.att.net/~kmpope/AncientRoad-Language2.html>; Phoenician, <http://phoenicia.org/alphabet.html#fonts>; Samaritan, <http://www.everywitchway.net/linguistics/fonts/samaritan.html>; Ugaritic, http://reinhold.kainhofer.com/rk_fonts/.

Indo-European roots used in the onomastic analyses are from (17, 18)

1.2 D’Arcy Thompson transformations and tropes

D’Arcy Thompson (19) presented a fully developed theoretical framework on topological transformations for biological organisms. This framework is, in principle, possible to apply in organomena of known morphology in general and as such I have used it here. I call a sequence of D’Arcy Thompson transformation states a D’Arcy Thompson trope (D’AT trope or D’ATT) defined as a sequence of descriptively linked transformations. It has to be noted that a D’AT trope is *not necessarily* representing the historical sequence or systematic relationship but one possible topology of transformations; for multi-step transformations, typically many different D’AT tropes can be reconstructed. Systematic relationships can reliably be studied by phylogenetic algorithms and epistemic frameworks which were employed separately (see below).

1.3 Character coding and systematic analysis.

Each symbol was treated as an individual organomenon and was analysed to simple traits (characters) that is, the simple marks or scratches a scribe would employ to create a semaphore. When in doubt, all lines needing one separate movement of hand were scored separately (see attached matrix). I present the forms as found in the archaeological (stratigraphic) record as well as their outlines. Minor morphological

differences are sometimes considered palaeographically important. Apart from the methodological objections on palaeographic typology, particularly on the lack of correspondences with securely dated strata and its being logically cyclical (see also (20)) I did not find these minor differences to be of any diagnostic value. For example, the angles of the lines of E or whether one of them is protruding have been discussed as typical of certain periods/places. Even if so, in each taxon as a whole there was so much variation as to render these attributes non-diagnostic or systematically valuable.

To avoid controversy, characters were scored as presence absence rather than given different weights (21). The matrix generated (below, section 4) was used to calculate systematic relationships with PAUP* (22) using exhaustive search with parsimony and the distance algorithms. Robustness of relationships was assessed using bootstrap support for 10000 replications and Bremer (23) support (parsimony only). Bootstrap values above 50 and Bremer 1 or more, are considered to show support for any given clade.

2. Onomastic analyses and dating

2.1 Analysis of letter names

Historically, great attention has been paid on the names of the letters of abjads sometimes seen as linked to objects potentially related with the pictograms presented by the letters. This has, in fact, been the centrepiece of the proposed Proto-Sinaitic “decipherment”. The fragility of this approach has been repeatedly criticised (24, 25), a position that I share. It is elementary to find related words to a letter in any language, following an acronymic principle, especially if one looks at broad families like Indo-European or Semitic and Greek is no exception to the rule. Hence an original mnemonic device like “*alphē wetous yemei deltous*” (meaning “the yield of the year fills the books”) for the first four letters, is both easily reconstructed and logically consistent for scripts primarily concerned with palatial archiving. Greek words phonetically similar can be easily found for all letter names if one supposes slightly different ancestral suffices rather than –a, e.g that *delt-a* is related to *delt-os*; similar word variations are often advocated for letter names in other languages and supposedly linked words (10). Adoption of an –a suffix could be a plausible assumption with the letter names modified to become indeclinable and represent the uniqueness of the alphabet symbols. Since final –a designates the determinative state of nouns in Aramaic adopting such a view could further reinforce our view for the Syrian connection.

Having said that however, I am deeply sceptical towards a generalised adoption of such a viewpoint and a more careful analysis of the names shows that when relevant, it was of limited importance. The names of the Greek letters reflect the syllabic values of the related Linear B or Linear C syllabograms and most likely the direct ancestor of the alphabet (from a systematic viewpoint the forms and taxa studied here are related, sharing common ancestors, and not in a parent-offspring relationship as sometimes presented in grammatological treatments). Six symbols names (*ei, mu, nu, ro, o, u*) are simply their syllabic values, five (*beta, zeta, heta, theta, iota*) the value plus the suffix –ta, two the suffix -ppa (related with the labiovelar -k^wa, see *kappa* and *qoppa*), two the suffix -u (*wau* and *tau*), one -ma (see *gamma*) and a further three incorporate small modifications in the form of a single letter

addition (*ksi, pei* and *san*). That leaves, *alpha, delta, labda* and *sigma* in need of a related Greek word which can be found easily in all cases. I see the debate on onomastics however somewhat displaced, since it is invariably offered in a context of monogenic origin theories: if the name makes sense in a language group then the alphabet must come from that language. Words making sense can be found in both Greek and other languages, so it is impossible to construct an argument of priority based on onomastics alone. This is just as well since such arguments miss the broader point of plexis and cultural interchange that emerge as a *sine qua non* condition from the herein presented analyses.

2.2 Dating and concordance with archaeological findings

There is intensive debate on dating of practically all writing systems. 20th-19th century is the usual date for the first inscriptions in Cretan hieroglyphic and its closely related Linear A (26), although hieroglyphic in seals goes back to the well into the third millennium; 17th century (27) for the earliest short inscription or 15th century for the more extended corpus (3) for the earliest certain Linear B inscriptions; 13th century or later for the abjad inscriptions of the Levant. The middle of the 11th century is taken as the arbitrary point for first Phoenician inscriptions (8) and 8th century for first Greek alphabetic ones (12) but individual scholars often have very different views (8). Fortunately no prior chronological information is needed for systematic studies and these dates are given as guidelines only.

Since dating of forms is not necessary for analysis of systematic relationships, I would prefer to leave the details of the historical debate to archaeologists. On the other hand, the broad picture of the currently accepted archaeological record is not at odds with my results. Linear B dates from at least the 15th century with related Linear A and Cretan hieroglyphic much earlier and there was intense trade and other relations between the Aegean and the Levant. These included founding of tradeposts, colonies and/or settlements: as early as the 18th century BC, documents from the Mari culture mention goods from 'Kaptara', apparently gifts to the king of Ugarit, where a group of Kaptaran merchants was based. Kaptara (Biblical Capthor) is taken to mean Crete or the Aegean in

general (28). This is just the earliest of a long list of evidence of interrelationships in the Eastern Mediterranean. The Bible also echoes the memory of Levantine people of Aegean origin, most famously the Philistines (Jeremiah 47:4, Amos 9:7 etc) (29), while similar narratives multiplied in later literature to the point of Tacitus famously suggesting that the inhabitants of Palestine and Judaea were of Cretan origin (30). Although manifold objections can be raised to such narratives, the material record seems unequivocal for intense interchange (28). In such a context, it seems quite plausible that synthetic scripts would emerge. In fact, Linear scripts of Cypriot origin are well known to have been used in Ugarit for writing of Semitic names (5) and it is likely that the alphabet also arose as such a synthesis experiment. The only difficulty can arise by the misclassification of the Bronze Age Levantine scripts, with the inclusion of the Proto-Sinaitic as the ancestor of the Levantine Protolinear that would indicate a local line of development that starts in ca 1500 BC. There is, of course, no way of disproving that some of the numerous other scripts in the area could have influenced the development of some symbols, or that they could have been in turn derived from other scripts, but there is no way to tell based on current evidence if these speculations have any relevance. In the light of the criticisms of the Proto-Sinaitic “decipherment” and theory (25) and the slight and most likely superficial morphological similarities, even if the “decipherment” were accepted, I consider such links unlikely at present.

Having the systematic side of the problem elucidated, there still remain several questions particularly as to the time of invention and spread of the alphabet. Given that Ugarit was destroyed and the area devastated ca 1200 BC probably by the raids of the Sea Peoples, it seems likely that the interaction must have taken place before that time which is consistent with the archaeological findings in the Levant. Importantly no alphabetic inscriptions have been found in Mycenaean palaces also destroyed around that time and the first securely dated alphabetic inscriptions come from the 8th century; the area of the Aegean is supposed to have lived “Dark Ages” between the 12th century LB and the 8th century introduction of the alphabet by Phoenicians. This is however problematic for many reasons. First, there is a heated debate on dating methods mainly based on palaeography, which is based on regularity of morphological change and as such, has been criticised as cyclical (20), a criticism that I share. A significant part of the Greek

inscriptions cannot be dated at all with security (12) and could be much earlier than the 8th century. Secondly paucity of evidence is not evidence of paucity, as can be seen in the example of Aegean writing which according to Herodotos and followers was not thought to have existed before the introduction of the Phoenician; these theories are now discredited after the discoveries of the Linear scripts. In fact it seems that there was not only continuity but also an overlap of Linear B and the alphabet. It is all but impossible that the Linear B-like variants of the alphabetic symbols not present in eastern scripts could have arisen spontaneously particularly since their frequency is highest around the epicentre of the Mycenaean world in the Peloponnesus and Crete (see individual symbol forms). Lastly, use of perishable materials for writing, particularly in the climatological context of wet Aegean winters guarantees that no reliable evidence outside accidentally baked clay tablets or difficult to date graffiti can be found.

In any case, the questions of absolute dating, the spread of the alphabetic principle and the alphabet itself are the domain of history and archaeology and cannot be answered by systematics alone, although the herein presented results suggest that the concepts of “Dark Ages”, and issues of cultural interchange that seems to have been intense, may need revisiting.

3. Symbol forms and D'AT tropes

3.1 Alpha

The first letter of the alphabet had the Greek name *alpha* (α λ φ α) while the Phoenician has been reconstructed as *'alf* (all reconstructed names are from (9, 31)). Morphologically similar symbols can be easily identified in the Vinča signary, Linear A, Linear B (symbols from these two scripts belong to the AB38 group), Linear C and Levantine Protolinear. The latter is effectively an archaic form of Phoenician, or rather Phoenician is a late development of that script; they are separated based on historical reasons (8). Early and late forms of the whole script (Levantine Protolinear and Phoenician) are treated as belonging to one taxon in the morphological analyses (D'AT tropes) under the name Levantine Linear (LL). In any case, I present example Levantine Protolinear forms for reference.

Morphologically similar symbols in Vinča signary, Linear A, Linear B, Linear C and Levantine Protolinear, Phoenician and archaic alphabets, all have the basic plan of two lines drawn in angle, crossed by a third line. There is considerable variation in orientation of the symbol that has been proposed as having palaeographical importance. From a systematic viewpoint, orientation is not diagnostic since within taxa many different orientations and angles can be observed, depending on factors like the direction of writing, scribe and material (figure S1.1). I am generally treating minor differences that are often said to be palaeographically important as equivalent to intraspecific (rather than inter-specific) and hence irrelevant to the level of this study, unless otherwise stated in the relevant symbol analysis.

Leaving the Vinča (where homologies are uncertain, amongst many other difficulties) and Proto-Sinaitic (where morphological similarity even under the proposed decipherment is superficial) aside, (see materials and methods & main text) a simple

D'Arcy Thompson trope (D'AT trope) can describe a plausible topology of transformations linking the various forms (fig S1.2).






















Vinča signary			W 143							
Egyptian										
Linear A		PKZa11a		PKZa8a						
Protosinaitic										
Linear B		Kn1		Kn 19		Kn 57				
Levantine Protolinear		Lachish		Bet Shemesh		Izbet Sartah		Qubur el-Walaydah		el-Khader
Linear C		Inscr. 4 Timarchos								
Phoenician abjad		Ahiram		Nora inscription						
Archaic alphabets		Pithekoussai: Nestor's cup		Dipylon jug		Chalkidic ware, Pl. 5 inscr 7				

Figure S1.1. Morphological variants of symbols that have been proposed as related to, or homologues of, the letter *alpha*. The Egyptian symbol has the value of a glottal stop /ʔ/, similar to the Phoenician, while Linear B symbol AB38 currently has the Ventris value [E] and Linear C the value [A], like the related symbols of the early alphabet.

Semitic languages/scripts do not use vowels in exactly the same way Indo-European ones do so this sound represents a glottal stop in Semitic scripts. The Ventris value of the morphologically related Linear B symbol B38 is currently [E] while the Linear C symbol has the value [A]. It is of course impossible to know what the correct pronunciation of the phoneme represented by the symbol was. Vowels \bar{e} and \bar{a} , were interchangeable in Greek dialect (Doric writes *TAN* for Attic *THN*; see also the discussion of the Naxos vowel system in paragraph 3.8 - *Heta*).

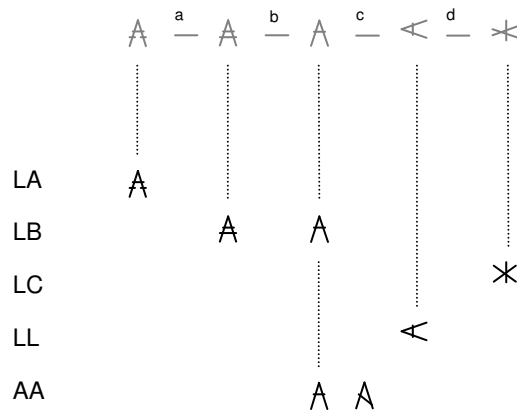


Figure S1.2. A D'AT trope describing transformations of the basic morphology underlying *alpha* and related symbols. (a) lower secondary lines merging to one (b) loss of lower secondary line(s) (c) 90° rotation, (d) crossing of lines meeting in angle. Dotted lines connect forms found in the archaeological record within a particular taxon (in black) with the corresponding D'AT transformation states (in gray). It is important to note that the order of the D'AT trope does not necessarily reflect the order that different forms have arisen historically or their systematic relationship, which can only be recovered in the trees produced by systematic analyses (see main text). It simply provides one of the possible scenarios to help visualise the transformation topology.

3.2 Beta

3.2.1 Beta₁

The Greek name of the symbol is *beta* (βῆτα), while the Phoenician has been reconstructed as *bet*. Two different *beta* forms coexisted in archaic Greek alphabets. The first form, *beta*₁, closely resembling our own symbol B, consisted essentially of a straight line with two curves. The Ventris syllabic value of the related Linear B symbol is [Twe] (Linear A and B symbols belong to the AB87 group), which is consistent with the











Vinča signary		W 152	
Egyptian			
Linear A		HT 126 b.2	 Za 6 a.1
Protosinaitic			
Linear B		Kn, DMG 87	
Levantine Protolinear		Beth Shemesh	
Linear C	-		
Phoenician abjad		Ahiram, Nora	
Archaic alphabets		Boeotia, Pl. 7 inscr. 1	

Figure S2.1.1 Morphological variants of symbols that have been proposed as related or homologues to the letter *beta*. The Egyptian symbol and the Phoenician, correspond to the phoneme /b/ while Linear B symbol has the Ventris value [Twe].

syllabic value being used as part of the later Greek name (becoming *weta*/βῆτα by metathesis). Once more multiple orientations can be observed within taxa and have no systematic value. The morphology is practically unchanged in the case of *beta*₁, in all the Aegean scripts to the alphabet with a linearization of the lower curve in the case of the Phoenician.

The D'AT trope describing a topology of transformations linking the various forms is given in figure S2.1.2

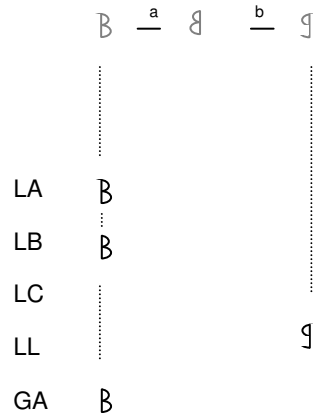


Figure S2.1.2. A D'AT trope describing transformations of the basic morphology of beta and related symbols. (a) catoptric image, (b) Partial loss and linearization of lower curved line. In some Levantine variants, and depending on the writing substrate, more angular forms can be observed. Dotted lines connect forms found in the archaeological record within a particular taxon (in black) with the corresponding D'AT transformation states (in gray).

3.2.2 Beta₂

A second beta form, *beta*₂, survived in local Greek alphabets well into the classical years and has been characterised with the rather unfortunate term “freak” (12). The basic morphology is different from form *beta*₁, consisting of one line with two line extensions, on top and bottom with or without further extensions. This basic plan can also be observed with more curvature, as in the examples of Linear B (group B75), the archaic Cretan symbols and Levantine Protolinear or more linear, as in the case of archaic alphabets. It is important to notice, however, that the writing material and locality seem to play an important role on the degree of curvature. The Ventris syllabic value of the












Vinča signary		Win 208	
Egyptian			
Linear A		HT 93a. 1-2	
Protosinaitic			
Linear B		Kn 60	 Kn 713
Levantine Protolinear		Izbet Sartah	
Linear C			Inscr. 91 Nikokles
Phoenician abjad			
Archaic alphabets		Corinth Pl. 19, inscr. 10	 Gortyn. Pl. 59
			 Corinth, Pl. 21, inscr. 40

Figure S2.2.1 Morphological variants of symbols that have been proposed as related or homologues to the *beta*₂ form found in some alphabets. The Egyptian symbol corresponds to the phoneme *v* but not unlike the Egyptian symbol for *b* it has no morphological similarity to either *beta*₁ or *beta*₂. The Linear B symbol has the Ventris value [We] which is also the value of the Linear C symbol. The curly Levantine symbol is found in the Izbet Sartah ostrakon.

Linear B symbol is [We] the same with the syllabic value of the related Linear C symbol; this is consistent with the syllabic value being used as part of the later Greek name. Once more multiple orientations can be observed within taxa and have no systematic value.

The Linear A symbol comes from GORILA grouping A53, which is in my view polyphyletic, clustering symbols corresponding to different related Linear B symbols.

The D'AT trope describing a topology of transformations linking the various forms is given in figure S2.2.2

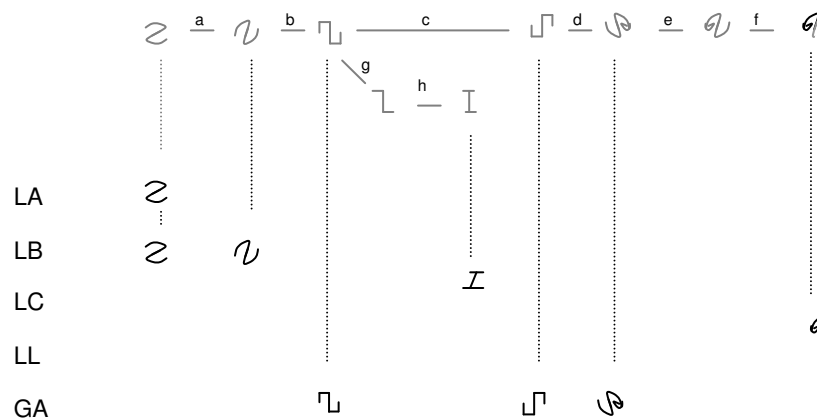


Figure S2.2.2. A D'AT trope describing transformations of the basic morphology of beta₂ and related symbols. (a) slight difference in orientation (b) linearisation, (c) catoptric image (d) increased curvature (e) catoptric image (f) loss of lower sideline (g) Loss of secondary lines, (h) shifting of top and bottom lines. Dotted lines connect forms found in the archaeological record within a particular taxon (in black) with the corresponding D'AT transformation states (in gray).

3.3 Gamma

The Ionic Greek name of this symbol was *yemma* (γάμμα), which is also believed to have been its archaic name, which later became *gamma* (γάμμα). The reconstructed Phoenician name *gaml*. The archaic Ionic name is consistent with the Ventris syllabic value of the














Vinča signary		Win 69		
Egyptian				
Linear A		HT 8a.1		
Protosinaitic				
Linear B		Kn 740		Kn 97
Levantine Protolinear		Beth Shemesh		Izbet Sartah
Linear C				
Phoenician abjad		Nora		Ahiram
Archaic alphabets		Boeotia, Pl. 7, inscr. 1		Korkyra Pl. 46 inscr. 11
				Korkyra Pl. 46 inscr. 13

Figure S3.1 Morphological variants of symbols that have been proposed as related or homologues to the *gamma* form. Linear B symbol has the Ventris value [Je], while the Egyptian and Phoenician correspond to /g/.

related Linear B symbol [Je]/[Ye] (Linear A and Linear B symbols belong to the AB46 group). Different variants related to the initial shape, with the two lines meeting at different angles can be found in different scripts. The Latin letter C comes from such

variants with more open angle than the archaic shapes, like the one from Korkyra shown here in fig S3.1. No early form of [Je]/[Ye] has been preserved in Cypriot; the late form is too derived for a reliable assessment of relationship (see also zeta).

The D'AT trope describing a topology of transformations linking the various forms is given in figure S3.2

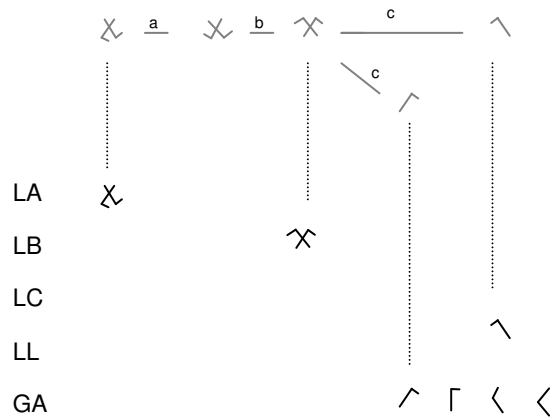


Figure S3.2 A D'AT trope describing transformations of the basic morphology of *gamma* and related symbols. (a) secondary lines face outwards, (b) Symmetric image (c) elimination of one of the two symmetric shapes. Dotted lines connect forms found in the archaeological record within a particular taxon (in black) with the corresponding D'AT transformation states (in gray).

3.4 Delta

The symbol has the Greek name *delta* (δέλτα) while the Phoenician has been reconstructed as *delt*. *Delta* is represented by three lines forming a triangle; sometimes two of them are fused in a curve, as in the Latin D. The Ventris value of the related Linear B symbol is [De] (Linear A and Linear B symbols belong to the AB45 group) which has been incorporated in the later Greek name. The d- line of syllabograms did not exist in Linear C. Symbols encoding the value /d / or / δ/in various scripts are shown in fig. S4.1.















Vinča signary		Win 119				
Egyptian						
Linear A		Ma 1a		HT 31		HT 9a.2
Protosinaitic						
Linear B		Kn 801		Kn 744		Kn 19
Levantine Protolinear		El-Khader		Izbet Sartah		
Linear C						
Phoenician abjad		Nora				
Archaic alphabets		Pithekoussai: Nestor's cup		Boeotia, Pl. 7, inscr. 1		

Figure S4.1 Morphological variants of symbols that have been proposed as related or homologues to the *delta* form. Linear B symbol has the Ventris value [De], while the Egyptian symbol corresponds to *d*. This syllabic line is missing in Linear C.

The D'AT trope describing a topology of transformations linking the various forms is given in figure S4.2

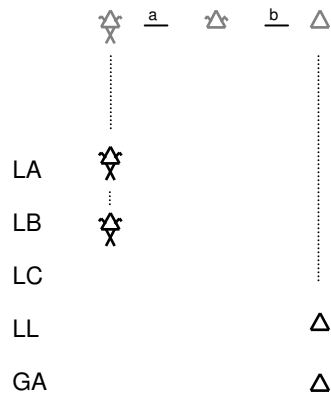


Figure S4.2. A D'AT trope describing transformations of the basic morphology underlying *delta* and related symbols. (a) loss of lower part, (b) loss of attached secondary lines. Dotted lines connect forms found in the archaeological record within a particular taxon (in black) with the corresponding D'AT transformation states (in gray).

3.5 Epsilon

The Greek name of fifth letter and second vowel of the alphabet was *ei* (εἶ) or *e psilon* (ἔψιλόν), while the Phoenician has been reconstructed as *he*. Its basic shape is a straight line with three or four lines meeting with it in angle. The Linear B symbol has a Ventris value [Ai] while the Linear C [E]; the name of the symbol *ei* reflects its syllabic value (for inter-changeability of a and e see notes on *alpha*). The diphthong *ai* has been also pronounced as /e/ in dialect and indeed, modern Greek, but the process was already in place in antiquity (32). Orientation of symbols is not diagnostic. The Linear A symbols belong to GORILA group AB28, which is in my view polyphyletic, as clustering syllabograms related to more than one Linear B symbols (both the B28 and B43 groups). The Linear B symbols belong to the B43 group.

















Vinča signary		Gimbutas 1974: 88						
Egyptian								
Linear A		Kh 59.2		Za 14.1				
Protosinaitic								
Linear B		Pylos An 657		Kn 987		Knossos DMG 43		Pylos, Jn 829
Levantine Protolinear		Ezbet Sartah						
Linear C		154, Isazatha		Hylates, 85		88, Theodoros		
Phoenician abjad		Ahiram, Nora						
Archaic alphabets		Boeotia, Pl. 7, inscr. 1		E	Pithekoussai, Pl. 47, inscr. 3			

Figure S5.1 Morphological variants of symbols that have been proposed as related or homologues to the *epsilon* form. Linear B symbol has the Ventris value [Ai] and Linear C [E], which is the sound for which the Egyptian symbol was sometimes used for. The Phoenician corresponds to the value /h/.

The D'AT trope describing a topology of transformations linking the various forms is given in figure S5.2

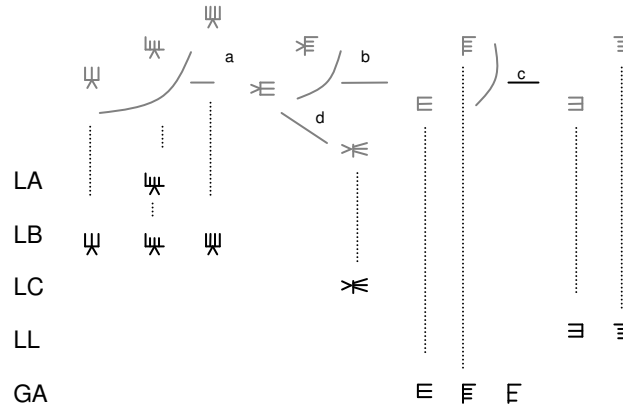


Figure S5.2. A D'AT trope describing transformations of the basic morphology underlying *epsilon* and related symbols. (a) rotation 90°, (b) loss of secondary sidelines, (c) catoptrical image, (d) top and bottom lines meeting at angle of ca 45° with the main straight line. Dotted lines connect forms found in the archaeological record within a particular taxon (in black) with the corresponding D'AT transformation states (in gray).

3.6 Wau (digamma)

The sixth letter of the alphabet was initially named *wau* ($fa\bar{v}$ or $\beta a\bar{v}$, since the sound was in most cases replaced with β) also its reconstructed Phoenician name, but later digamma, from its shape looking like two gammas. The related Linear B (Linear A and Linear B symbols belong to the AB54 group) and Linear C symbols have the value [Wa] that has once more become part of the later Greek name. We are fortunate to have [Wa] symbols from both Cyprominoan and Carian that represent intermediate forms, which is crucial in understanding the transformations of this line that have been extensive. The shape of the symbol in Levantine Protolinear is uncertain.













Vinča signary		Win 62		
Egyptian				
Linear A		HT 128a		HT 85b
Protosinaitic				
Linear B		Kn 191		Kn 238
				Kn 503
Levantine Protolinear	?			
Linear C		139, Onasikretes		Cyprominoan *
Phoenician abjad		Ahiram		
Archaic alphabets		Corinth, Plate 18, inscr. 2		

Figure S5.1 Morphological variants of symbols that have been proposed as related or homologues to the *wau* form. Linear B symbol and Linear C have the value [Wa], while Egyptian and Phoenician symbols correspond to /v/. The Cyprominoan and Carian forms are also given for reference, according to (5, 16)

The D'AT trope describing a topology of transformations linking the various forms is given in figure S6.2

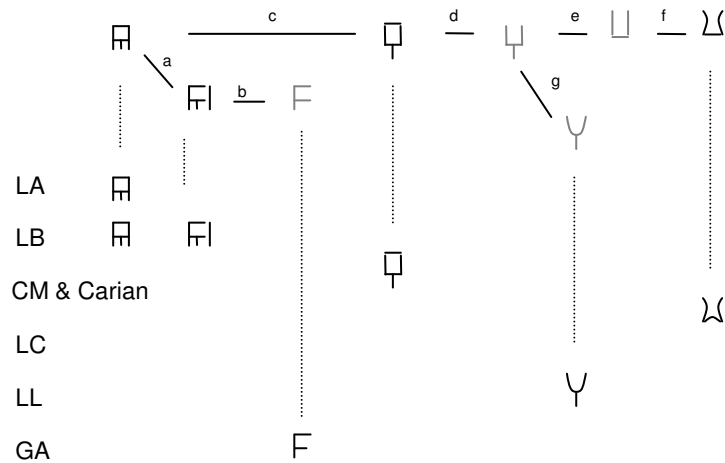


Figure S6.2. A D'AT trope describing transformations of the basic morphology underlying *wau* and related symbols. (a) loss of central and left line, (c) loss of left and right lower lines (d) loss of top line (e) loss of bottom line (f) individual lines assuming curved form, (g) top three lines fused to a single curve. Dotted lines connect forms found in the archaeological record within a particular taxon (in black) with the corresponding D'AT transformation states (in gray).

3.7 Zeta

The Greek name of the letter was *zeta* (ζῆτα) while the Phoenician has been reconstructed as *zai*. The basic shape of zeta consists of three lines. In archaic alphabets these were meeting the central line on top and bottom on approximately their middle, much like the later Roman I. Later the more familiar zig-zag form developed, which is remarkably similar to Linear C [Je]/[Ye]; however, the earliest Linear C form is also quite late and hence is given as a supplementary sign, since there is no way to tell if this is a coincidence. Linear A and Linear B symbols belong to the AB74 group.

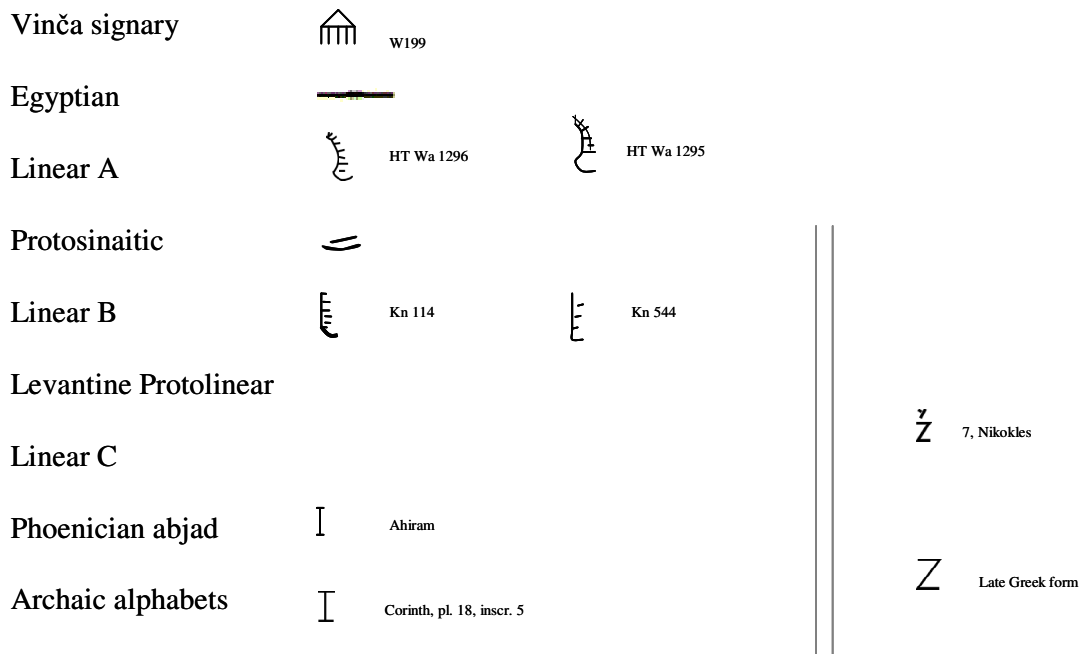


Figure S7.1 Morphological variants of symbols that have been proposed as related or homologues to the *zeta* form. Linear B symbol has the value [Ze], while Egyptian and Phoenician correspond to *z*. On the right hand of the figure the Linear C [Je] and later Greek forms are shown; unfortunately no certain Linear C [Je] exists from early inscriptions and hence the forms are given for reference only.

The Greek name consists of the Linear B syllabic value and the suffix *-ta*, the first of a continuous series of four letters for which name = syllabic value + *-ta*. The D'AT trope describing a topology of transformations linking the various forms is given in figure S7.2

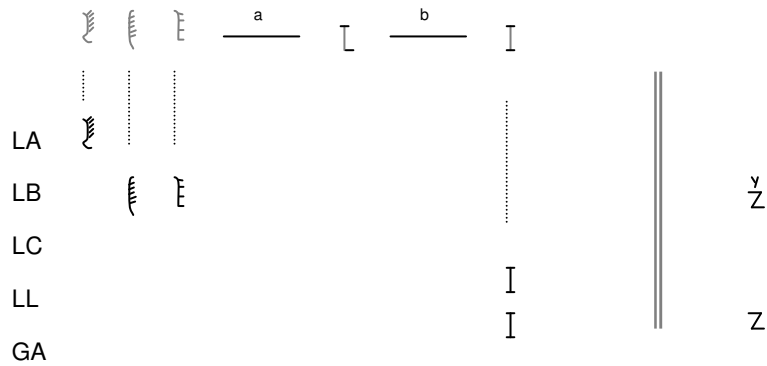


Figure S7.2. A D'AT trope describing transformations of the basic morphology underlying *zeta* and related symbols. (a) loss of side “teeth” apart from top and bottom (b) top and bottom lines drawn symmetrically. Dotted lines connect forms found in the archaeological record within a particular taxon (in black) with the corresponding D'AT transformation states (in gray). The much later Linear C [je] form and its related later Greek alphabetic form are given to the left of the figure.

3.8 Heta

The Greek name of the symbol was *heta* (ἦτα) while the Phoenician has been reconstructed as *het* (with a hard h, as opposed to the softer *h* of *he*). It was one of the most variables in shape in ancient alphabets with forms varying from a rectangular with 1-2 internal lines to just two lines connected by a third in its middle. None of the shapes is diagnostic for a particular script since there is considerable overlap, particularly between the Linear B with Ventris value [Ja]/([Ya]/[Ia]) and later Greek forms. Linear A and Linear B forms belong to the AB78 group. The Linear C form is too simplified with the plain rectangle of some Greek alphabets reduced to a simple curvy shape. *Heta* is a good

















Vinča signary		Gimbutas 1973:13	
Egyptian			
Linear A		HT 7a.2	 Io Za 3
Protosinaitic			
Linear B		Kn 59	 Kn 97
Levantine Proto-linear		Izbet Sartah	
Linear C		Cyprominoan	 Masson, fig. 6.3
Phoenician abjad		Nora fragment	 Ahiram
Archaic alphabets		Boeotia, Pl. 7 inscr. 2b	 Athens, Dipylon jug  Thera, Pl. 62, inscr. 16

Figure S8.1 Morphological variants of symbols that have been proposed as related or homologues to the *heta* form. Linear B, Cyprominoan and Linear C symbols have the value [Ja] while Egyptian and Phoenician symbols correspond to hard *h*.

example of variable rates of change of organomes within organomena (symbols within the script in this case), with the Linear C [Ja] changing drastically, while other organomes (cf. *beta*₁) remain conservative.

Interestingly, this symbol was used to express *ā instead of *alpha*, in the phonetic system of Naxos; this survived also outside Naxos until at least the 5th century when in a Delphi inscription, attributed to Andros, the symbol is employed 15 times for *ā (12). The Naxos vowel system further reinforces the connection of *heta* form to the Linear B [Ja]/([Ya]/[Ia]) which was interchangeable with Linear B [A] (2), in a relationship presumably corresponding to *ha* and *a* of later Greek. In other Ionic alphabets, also psilotic (not pronouncing the /h/ or aspirate), and classical Greek, *heta* denoted the value ē ('ēta), while in western Greek alphabets and Latin it had the value *h* (and the aspirate: *hēta*); for interchange-ability of ā and ē see *alpha*.

The D'AT trope describing a topology of transformations linking some of the various *heta* forms is given in figure S8.2

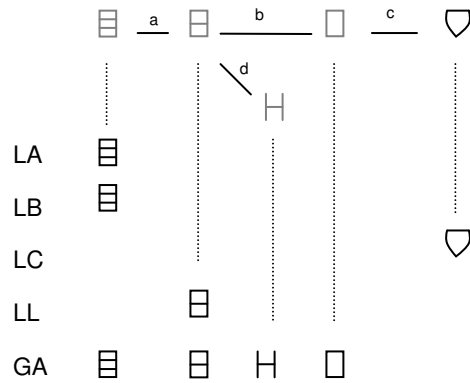


Figure S8.2. A D'AT trope describing transformations of the basic morphology underlying *heta* and related symbols. (a) drawing of only a single middle line (b) angular lines become curves, (c) loss of top and bottom lines Dotted lines connect forms found in the archaeological record within a particular taxon (in black) with the corresponding D'AT transformation states (in gray).

3.9 *Theta*

The ninth letter of the alphabet has the Greek name *theta* (θῆτα) while the reconstructed Phoenician is *tēt*. There are two types in early alphabets, related to two different syllabograms, although one could be forgiven for considering them variants, as, unlike other symbols they converged to the same form. Morphologically, the first form, represented by a circle with a single spot or line inscribed is related to the Linear B syllabogram [Qe], thought to belong to the labiovelar sequence of that script (Linear A and Linear B symbols belong to the AB78 group). The sequence *qe* > *τε* (26) and *θε* is well documented, for example the island Thera is written Qe-ra in Linear B (2). The Linear B symbol consisted of a circle encircling dots, reduced to a line or a single dot in archaic alphabets.

The second form is represented by a circle inscribed by crossing lines. This form is identical with Linear B [Ka], belonging to the AB77 group. The convergence of the two forms with distinct phonetic values may appear strange but is a common phenomenon. In this case it can be explained in terms of a complex linguistic/phonological argument. Here I will present a simplified version. The labiovelar series in Linear B (conventionally represented as [Q-]) ended up through regular sound changes to different sounds and corresponding symbols in later Greek (p, b, p^h, t, d, t^h, k, g^h, k^h; π, β, φ, τ, δ, θ, κ, γ, χ). The [K-] series developed to (k, g^h, k^h; κ, γ, χ) which is of course a perfect subset of the labiovelar products. Hence at some stage the sound(s) represented by the [K-] series was a subset of the sounds represented by the [Q-] series. Under this light it is no wonder that the two morphologically close symbols may have been used interchangeably (see also the note on scribal convenience in relation to Levantine [o]). One of them (crossed lines) predominated the Eastern abjads; in the alphabets both forms coexisted until the [Qe]-like form prevailed. This might have been influenced by the adoption of the circle with vertical line as the Φ (phi) symbol and circle with a horizontal line Θ as the theta, as if the crossed line symbol was split in two. Remarkably, the circle with the crossed lines represents [q] in Carian (16); additionally the same symbol (teth) has been used

consistently by Syrian and Jewish authors to represent Greek T, rather than tau (which was used to represent theta)(33). All this (representation of sounds t^h, t, q, k) taken together suggests that it did indeed represent a sound very close to the sound represented by the labiovelar, which facilitated the confusion / inversion of values.

This is not a rare phenomenon. Speakers of different languages/dialects often invert the correspondences and in the case of Aegean/Levant interaction apart from the inversion of values of t and th sounds / symbols mentioned above there was also an inversion of the kappa (represented by *qoph* rather than its homologue *kaph*) and chi (which is represented by *kaph*) sounds /symbols.















Vinča signary		Win 56		
Egyptian				
Linear A		Za 4.5		HT 111a.2
				HT 9a.3
Protosinaitic	?			
Linear B		Kn 56		Kn 348
				Kn 1
Levantine Protolinear		Izbet Sartah		
Linear C				
Phoenician abjad		Ahiram		Nora
Archaic alphabets		Boeotia, Pl. 7 inscr. 1		Boeotia, Pl. 7 inscr. 2b
				Ionia, Pl. 79, inscr. 9

Figure S9.1 Morphological variants of symbols that have been proposed as related or homologues to the *theta* form. Linear B symbol has the value [Qe], while the Egyptian and Phoenician correspond to /t/. The labiovelar sequence did not exist in Linear C.

From a scribal point of view, the crossing lines of the Levantine scripts may have been influenced by the fact that Phoenician ‘ayin (the homologue of omicron) is sometimes represented by a circle with a dot in the middle; hence the crossing lines may have been a

necessary adaptation to distinguish the two. Samples of symbols from the different scripts are given in fig. 9.1. Outlines of *theta* and related symbols are shown in figure S9.2

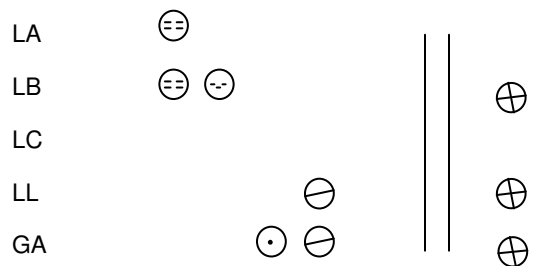


Figure S9.2. Outlines of *theta* and related symbols. To the left of the double line lay the Linear B [Qe] related signs, to the right the [Ka] related symbols.

3.10 *iota*

3.10.1 *Iota*₁

The tenth letter of the alphabet has the Greek name *iota* (ἰώτα) while the Phoenician has been reconstructed as *yod*. The letter was present in two forms, related to different Linear B / Linear C symbols, in archaic alphabets. The first symbol, *iota*₁, is related to Linear B [Jo]/[Io] (belonging to the B36 group) and Linear C [Yo] syllabograms; the former syllabic value has, at any rate, been incorporated in the later Greek name. The Linear B [Jo] and Linear C [Yo] forms are curvy or multi-stroked, which survived in *iota*₁. Samples of these forms are shown in figure S10.1. Note that alphabets that were using the multi-stroked *iota*₁ form had separate arrangement for *sigma* (written like / replaced by the *san*, that is vertically instead of the more familiar horizontal form), which gives an example of changes or status in one part of the organomenon affecting another part.











Vinča signary		Win 11	
Egyptian			
Linear A			
Protosinaitic			
Linear B		Kn 42	
Levantine Protolinear		Lachish	
Linear C		158, Onasitima	
Phoenician abjad		Ahiram	 Nora
Archaic alphabets		Corinth, Pl. 19, inscr 14b	 Dipylon oinochoe

Figure S10.1.1 Morphological variants of symbols that have been proposed as related or homologues to the *iota*₁ form. Linear B symbol has the value [Jo] or [Io], Linear C [Yo], while the Egyptian and Phoenician correspond to /y/.

The D'AT trope describing a topology of transformations linking the various forms is given in figure S10.2

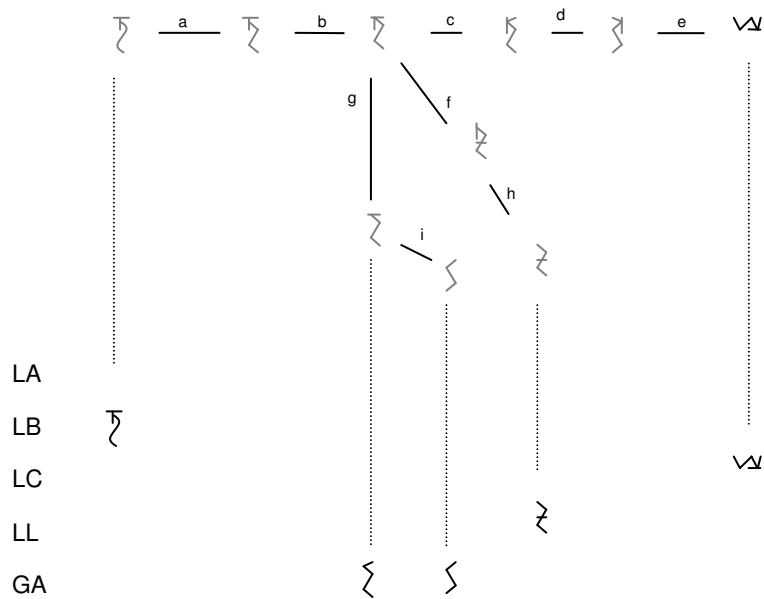


Figure S10.1.2 A D'AT trope describing transformations of the basic morphology underlying *iota*₁ and related symbols. (a) linearisation (b) longer bottom line meeting at the meeting point of top and side lines (c) side line protruding (d) catoptric image (e) 90° rotation (f) top line moved to the middle (g) loss of side line (h) loss of one line. Dotted lines connect forms found in the archaeological record within a particular taxon (in black) with the corresponding D'AT transformation states (in gray).

3.10.2 Iota₂

The second iota form *iota*₂ is related to the Linear B (Linear A and Linear B symbols belong to the AB24 group) and Linear C symbol for [I]. The form is missing in Levantine scripts, not encoding vowels. Samples of these forms are shown in figure S10.2.1.

Vinča signary		Win 1				
Egyptian						
Linear A	𐀓	PH 6.1				
Protosinaitic						
Linear B	𐀓	Kn 1057	𐀓	Kn 341	𐀓	Kn 424
Levantine Protolinear						
Linear C	𐀓	4, Timarchos				
Phoenician abjad						
Archaic alphabets		Pithekoussai: Nestor's cup				

Figure S10.2.1 Morphological variants of symbols morphologically related or homologues to the *iota*₂ form. Linear B and Linear C symbols have the value [I].

The D'AT trope describing a topology of transformations linking the various forms is given in figure S10.2.2

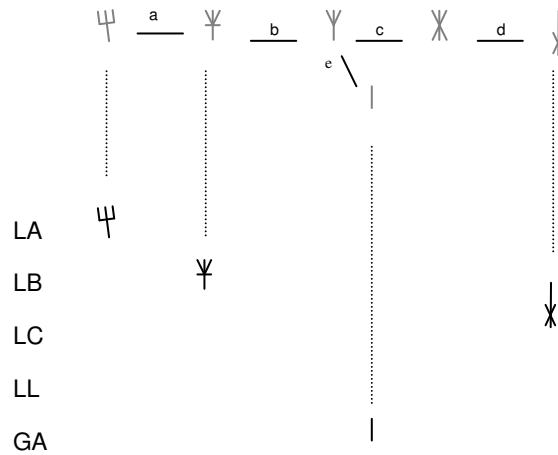


Figure S10.2.2 A D'AT trope describing transformations of the basic morphology underlying *iota*₁ and related symbols. (a) side lines drawn angular to main line (b) loss of crossing line (c) extension of side lines to cross (c) crossing lines moved to the bottom (e) loss of side lines. Dotted lines connect forms found in the archaeological record within a particular taxon (in black) with the corresponding D'AT transformation states (in gray).

3.11 Kappa

The Greek name of the symbol is kappa (κάππα) while the Phoenician name for the related symbol has been reconstructed as *kaf*. This symbol has had one of the most extraordinary sequences of transformations. The morphologically related Linear B form has the Ventris value [Qa] and the Linear C [Ka] as shown in fig 11.1.1. The labiovelar series broke down to different consonants in later Greek (see *theta* above); in Ionic/Eastern Greek κ was also possible (cf. Ionic κοῦ for Attic ποῦ etc.) Remarkably, the name *kappa* (presumably from **ka-k^wa*) appears to have retained the memory of its Linear B related symbol value.











Vinča signary			
Egyptian			
Linear A		TL Za 1a	
Protosinaitic			
Linear B		Kn 226	
Levantine Protolinear	?		
Linear C		85, Hylates	 185, Onasatima
Phoenician abjad		Ahiram	 Nora
Archaic alphabets		Boeotia, Pl. 7, inscr. 1	

Figure S11.1 Morphological variants of symbols that have been proposed as related or homologues to the *kappa*₁ form. Linear B symbol has the value [Qa] and Linear C [Ka] while Egyptian and Phoenician correspond to/k/.

meaning “the Ka that looks like (/comes from) Qa” (see also *qoppa* below). The transformation of Linear B [Q-] syllabogram line to classical $-\pi\pi-$ is well attested (Mycenaean i-*qo* for later Greek ἵππος (2), *hippos*, “horse”). Linear A and Linear B symbols belong to the AB16 group. The D’AT trope describing a topology of transformations linking the various forms is given in figure S11.2.2

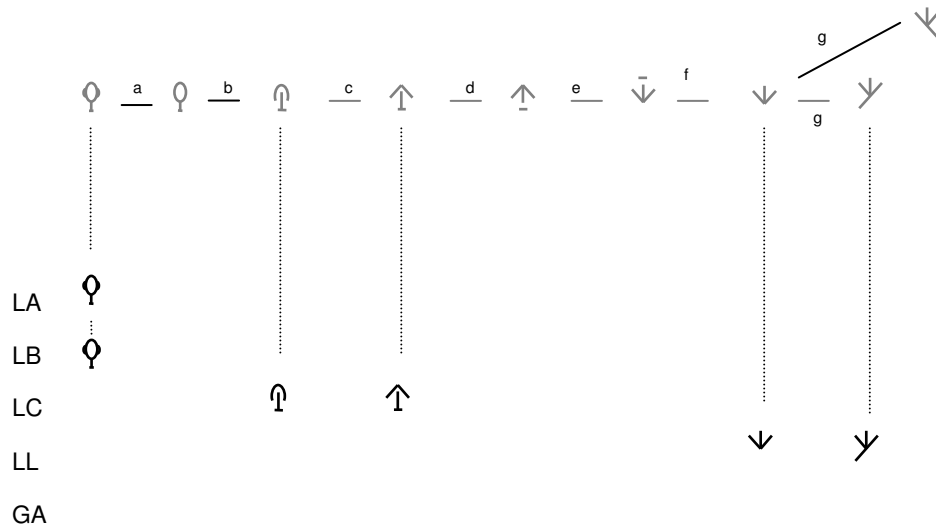


Figure S11.2 A D’AT trope describing transformations of the basic morphology underlying $kappa_1$ and related symbols. (a) loss of side curves (b) opening of uppercircle (c) linearization of upper curved line (d) detachment of lower line (e) rotation 180o (f) loss of upper line (g) extension of one of side line. Dotted lines connect forms found in the archaeological record within a particular taxon (in black) with the corresponding D’AT transformation states (in gray).

3.12 Labda

The Greek name of the symbol is *labda* (λάβδα, also λάμβδα) while the reconstructed Phoenician name is *lamd*. The basic shape of homologues in all related scripts is a line, with another line meeting in angle. In more archaic scripts, the line is more curved or secondary shapes are present. The related Linear B symbol has the Ventris value [La/Ra] while the Linear C value is [La]; the value has been incorporated to the later Greek name. Linear A and Linear B symbols belong to the AB60 group.

Whatever the possible relations of pictograms and names, symbol morphology diverged in the related taxa becoming increasingly linearised as shown in fig. 12.1.

















Vinča signary		Gimbutas 1974:87		
Egyptian				
Linear A		HT 80.1		Kn Zc 7.1
Protosinaïtic				
Linear B		Kn 14		Kn 722
				Pylos Jn829
Levantine Protolinear		Lachish		Qubur al-Walaydah
Linear C		153, Onasitima		402, Timokles
Phoenician abjad		Ahiram		Nora
Archaic alphabets		Pethikoussai: Nestor's cup		Athens, Dipylon jug

Figure S12.1. Morphological variants of symbols that have been proposed as related or homologues to the *labda* form. Linear B symbol has the value [La/Ra] and Linear C [La] while Egyptian corresponds to /l/ and /r/ and Phoenician to /l/.

The D'AT trope describing a topology of transformations linking the various forms is given in figure S12.2

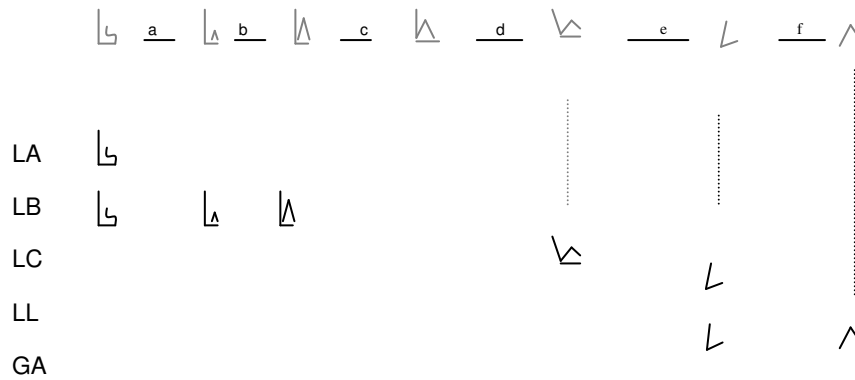


Figure S12.2 A D'AT trope describing transformations of the basic morphology underlying *labda* and related symbols. (a) linearization of secondary lines (b) magnification of secondary lines, (c) fusion of vertical line with secondary lines (e) loss of bottom and side lines, (f) inversion. Dotted lines connect forms found in the archaeological record within a particular taxon (in black) with the corresponding D'AT transformation states (in gray).

3.13 Mu

3.13.1 Mu₁

The Greek name of the symbol was *mu* (μῦ or μῶ) while the Phoenician has been reconstructed as *mem*. There are two forms of *mu* in archaic alphabets. The first, *mu*₁ is less common and corresponds to Linear B and Linear C [Ma] but has later, and to this day, become the dominant form (M), while the second form corresponds to the Linear B [Mu], which gave it its name, and survives in the lowercase Greek *mu* (μ). Linear A and Linear B symbols belong to the AB80 group.











Vinča signary		W192		W148
Egyptian				
Linear A		PYR 1.1		
Protosinaitic				
Linear B		Kn 301		Kn 8133
Levantine Protolinear				
Linear C		347, Eteodamas		Ellowoikos
Phoenician abjad				
Archaic alphabets		Methana, Pl. 33, inscr. 4		

Figure S13.1.1 Morphological variants of symbols that have been proposed as related or homologues to the *mu*₁ form. Linear B and Linear C symbols have the value [Ma] while Egyptian corresponds to /m/. The D'AT trope describing a topology of transformations linking the various *Mu*₁ forms is given in figure S13.1.2

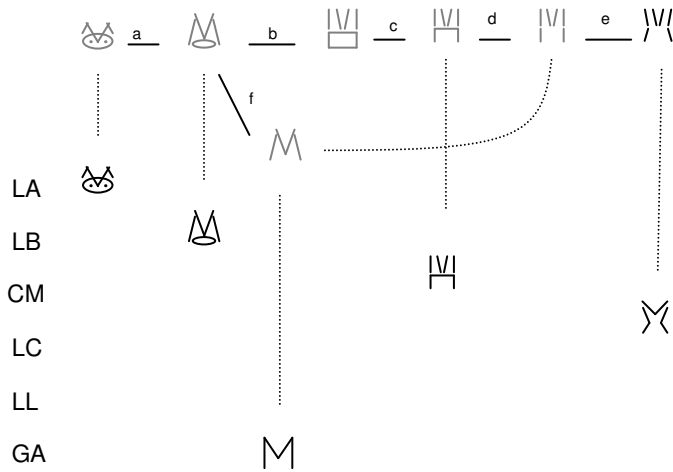


Figure S13.1.2 A D'AT trope describing transformations of the basic morphology underlying *mu*₁ and related symbols. (a) linearization (b) cuneiform linear representation (c) loss of lower "mouth" line (d) loss of middle line (e) angular representation of two side lines (f) lost of lower "mouth/nostrils" circle. The cuneiform representation of Cyprominoan (shown here under CM), with pressing a stylus on soft clay rather than drawing, seems to have played an important role in the development of this symbol morphology. Dotted lines connect forms found in the archaeological record within a particular taxon (in black) with the corresponding D'AT transformation states (in gray).

3.13.2 Mu₂

The second form of *mu*, *Mu*₂, was dominant in several archaic alphabets and has survived in the lowercase Greek μ (*mu*). Its basic shape is a vertical line with a curved or linearised extension. The related Linear B form has the syllabic value [Mu]. Linear A and Linear B symbols belong to the AB23 group.











Vinča signary		Win 49		
Egyptian				
Linear A		Ht 78		
Protosinaïtic				
Linear B				
Levantine Protolinear		Lachish		Beth Shemesh
Linear C				
Phoenician abjad		Ahram		Nora
Archaic alphabets		Boeotia, Pl. 7 inscr. 1		Pithekoussai: Nestor's cup

Figure S13.2.1. Morphological variants of symbols that have been proposed as related or homologues to the *mu*₂ form. The Linear B symbol has the value [Mu] while the Egyptian and Phoenician correspond to /m/.

This form is also important since I can see the equivalence of zig-zag and vertical/horizontal line drawing of forms in the Karatepe inscription (Fig. S13.2.2). This inter-changeability and semantic equivalence has been important not only in the development of *mu*₂ but also on that of *sigma* (see below).



Figure S13.2.2 Variants of the mu_2 form in the Karatepe inscription show that the zig-zag and vertical/horizontal line drawing was semantically equivalent.

The D'AT trope describing a topology of transformations linking the various forms is given in figure S13.2.3

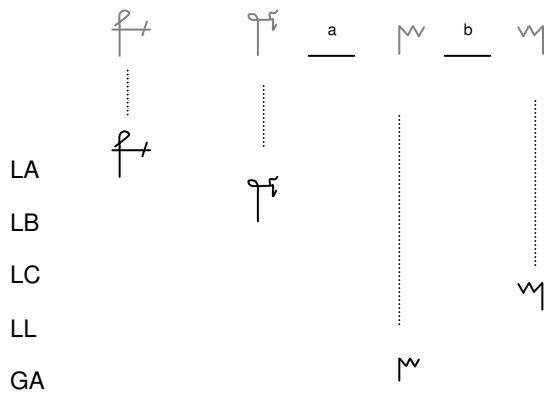


Figure S13.2.3 A D'AT trope describing transformations of the basic morphology underlying mu_2 and related symbols. (a) linearization (b) catoptrical image. Dotted lines connect forms found in the archaeological record within a particular taxon (in black) with the corresponding D'AT transformation states (in gray).

3.14 Nu

The name of the Greek symbol is *nu* (νῦ) while the Phoenician has been reconstructed as *nun*. The symbol history includes some of the most complex transformations. The related Linear B symbol has the Ventris value [Nu] which is the name of the later Greek letter. The Linear A and B baseline is two lines with two semicircles in their midst. In some variants in Knossos, the two semicircles synapse forming a wavy shape. In Linear C (syllabic value [Ne]) the shape is already linearised to a N-like pattern, while in Levantine scripts the side lines were dropped. Linear A and Linear B symbols belong to the AB55 group. Examples of forms are shown in fig. S.14.1.












Vinča signary		Win 209 (vin 130)	
Egyptian			
Linear A		Za 9.1	
Protosinaitic			
Linear B		Kn 384	 Kn 482
Levantine Protolinear		Beth Shemesh	
Linear C		304, Apollo Magirius	
Phoenician abjad		Ahiram	
Archaic alphabets		Pithekoussai: Nestor's cup	 Dipylos jug

Figure S14.1. Morphological variants of symbols that have been proposed as related or homologues to the *nu* form. The Linear B symbol has the value [Nu] while Linear C encodes [Ne], while the Egyptian and the Phoenician correspond to *n*.

The D'AT trope describing a topology of transformations linking the various forms is given in figure S14.2

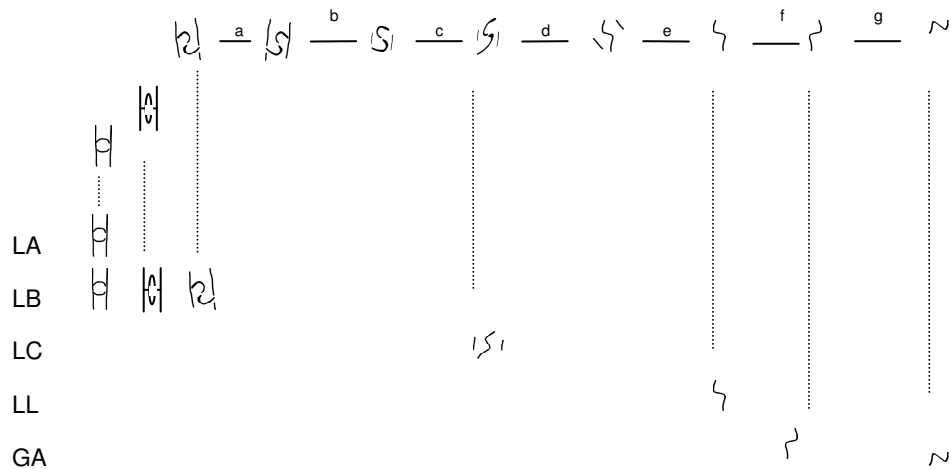


Figure S14.2 A D'AT trope describing transformations of the basic morphology underlying *nu* and related symbols. Starting from a rarer type (or untypical form) of [Nu] from Knossos N-like shapes can be obtained within a few steps. Transformations as follows: (a)catoptrical image (b) sidelines reduced 40%, rotation 20% (c) form skewed horizontally -5°, vertically 45° (d) rotation 45° (e) loss of sidelines (f) catoptrical image (g) form skewed horizontally -20°, vertically -45°. Dotted lines connect forms found in the archaeological record within a particular taxon (in black) with the corresponding D'AT transformation states (in gray).

3.15 Ksi

The Greek name of this letter is *ksi*, ($\xi\iota$ also $\xi\varepsilon\iota$) while the Phoenician has been reconstructed as *semk*. In the archaeological record wide variations can be noted within two extreme variants *ksi₁* and *ksi₂* (variants of the same form) depending on the number of lines in the horizontal and vertical dimensions. Hence, *ksi₁* has three lines on each dimension; related forms are found in the Izbet Sartah ostrakon, Linear C inscriptions, the Etruscan abecedaries and alphabets of Euboea and colonies. The variant is related to Linear B [Si] written with three vertical and two horizontal lines. The other Linear B variant, written with three vertical and one horizontal line is related to the commonest form of archaic alphabets and Levantine scripts, where a rotation has taken place. The form without rotation has survived intact in the Argos alphabet that wrote *ksi* exactly like the Linear B [Si]. Linear A and Linear B symbols belong to the AB41 group.














Vinča signary		Win 42			
Egyptian					
Linear A		Za 26a.1			
Protosinaitic	?				
Linear B		Kn 1		Kn 13	
Levantine Protolinear		Izbet Sartah			
Linear C		16, Timocharis		11, Onasis	
Phoenician abjad				Ahiram	
Archaic alphabets			Bucchero amphora alphabet, Pl. 48, inscr. 20		Argos, Pl. 29, inscr. 30
			Korkyra, Pl. 46, inscr. 16		Sinope, pl. 72, inscr. 63

Figure S15.1. Morphological variants of symbols that have been proposed as related or homologues of the *ksi* forms. The Linear B and Linear C symbols have the value [Si]. There are two extremes in these morphologies, variant *ksi₁*, window-like, with two or three horizontal lines framed by two side-lines and *ksi₂* represented by three lines vertical or horizontal (not diagnostic), sometimes crossed by a single line. These variants can already be noticed in Linear B. The Egyptian combination of symbols denoted /ks/, while the Phoenician probably corresponded to /s/.

The D'AT tropes describing topologies of transformations linking the various forms of ksi_1 and ksi_2 are given in figure S15.2. 1 and 2

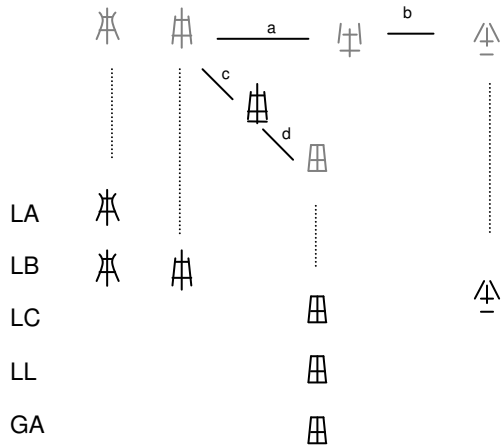


Figure S15.2.1 A D'AT trope describing transformations of the basic morphology underlying ksi_1 and related symbols. (a) shifting of sidelines (b) side-lines drawn in angle, (c) third horizontal line added, (d) lines merged into window-like shape. Dotted lines connect forms found in the archaeological record within a particular taxon (in black) with the corresponding D'AT transformation states (in gray).

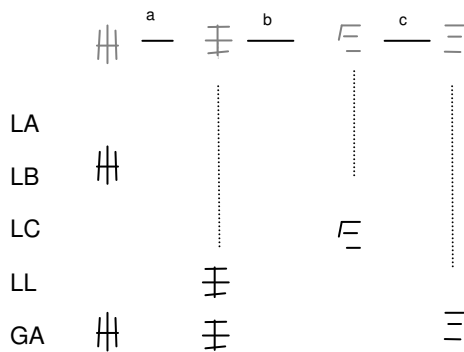


Figure S15.2.2 A D'AT trope describing transformations of the basic morphology underlying ksi_2 and related symbols. (a) 90° rotation (b) middle line moved to the side, (c) elimination of middle line. Dotted lines connect forms found in the archaeological record within a particular taxon (in black) with the corresponding D'AT transformation states (in gray).

3.16 Omikron

The Greek name for this letter is *ou* or *o micron* (οὺ and ὀ μικρόν). The Phoenician name has been reconstructed as *ʿain* and corresponds to a guttural sound (Levantine scripts did not note vowels). The related Linear B symbol has a Ventris value [O] (Linear A and Linear B symbols belong to the AB61 group). It is tempting to suggest a possible derivation of the name omicron from it seems to have been a simplification by writing only the small (*micron*) part of the Linear B symbol (“write the little part from the O”, “*to o micron*”). The letter was written as disproportionately small compared to the other letters even before the introduction of *omega* (which happened later) and hence it is tempting to suggest that *omega* got its name in juxtaposition to *omicron*, rather than vice versa, as currently thought (12).

The connection with the semitic meaning of the symbol (“eye”) and its link with the respective Proto-Sinaitic based on this observation is undermined by the fact that the dot is often noted in other symbols not related to the meaning of “eye” like the *qoppa* (see below). The presence of the dot seems to depend on the method and tools used for creating the symbol. Examples of omicron and related symbols are shown in fig. 16.1












Vinča signary		Win 186		
Egyptian				
Linear A		HT 93a.6		
Protosinaitic				
Linear B		Kn 127		Py An 657
Levantine Protolinear		Beth Shemesh		El-Khader
Linear C				
Phoenician abjad		Ahiram		
Archaic alphabets		Dipylon jug		Thera, Pl. 61

Figure S16.1. Morphological variants of symbols that have been proposed as related or homologues of the *omicron* forms. The Linear B symbol has the value [O] while the Egyptian and Phoenician correspond to a guttural sound /ʕ/, not existing in Greek. The presence of a dot in the middle of the symbol has been suggested as palaeographically important but seems more related to the way the symbol was cut. The LC symbol is too derived and not represented

The D'AT tropes describing topologies of transformations linking the various forms of *omicron* are given in figure S16.2

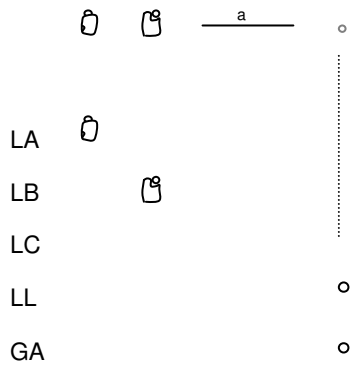


Figure S16.2.2 A D'AT trope describing transformations of the basic morphology underlying *omicron* and related symbols. (a) notation of only the small circular part Dotted lines connect forms found in the archaeological record within a particular taxon (in black) with the corresponding D'AT transformation states (in gray).

3.17 Pei

3.17.1 Pei₁

The Greek name of the letter was *pei* (πεῖ, later πῖ), while the Phoenician name for the letter has been reconstructed as *pe*. The basic morphology is a straight line with a line meeting it on top and a third line parallel to the first. In some cases, these two latter lines merge to a curve. A fourth line existed in the related Linear A and Linear B symbols. In fact, on closed examination, it seems that two different *pei* symbols co-existed in archaic alphabets related to two different Linear B symbols *pei*₁ related to Linear B [Po] (Linear A and Linear B symbols belong to the AB11 group) and Linear C [Pe] and *pei*₂ related to Linear B [Pe]. Examples of *pei*₁ forms are shown in Fig. S.17.1.1











Vinča signary		Win 14	
Egyptian			
Linear A		Kn 22b	 Kh 9.1
Protosinaitic			
Linear B		Kn 503	
Levantine Protolinear			
Linear C		92, Aristagoras	 153, Onasitima
Phoenician abjad			
Archaic alphabets		Dipylon jug	

Figure S17.1.1 Morphological variants of symbols that have been proposed as related or homologues of the *pei*₁ forms. The Linear B symbol has the value [Po] and the Linear C [Pe] while the Egyptian and Phoenician correspond to /p/.

The D'AT tropes describing topologies of transformations linking the various forms of *pei*₁ are given in figure S17.1.2

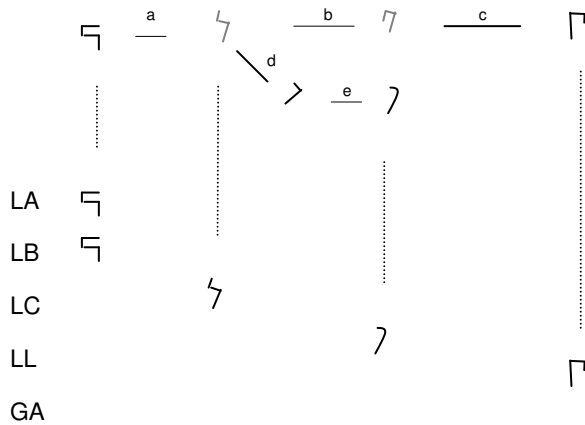


Figure S16.2.2 A D'AT trope describing transformations of the basic morphology underlying *pei*₁ and related symbols. (a) loss of top line and slight rotation (b) shift of line to the bottom of middle line (c) catoptrical image and slight rotation to not the central line as vertical or nearly vertical (d) loss of side line (e) top and central line merged to curved line. Dotted lines connect forms found in the archaeological record within a particular taxon (in black) with the corresponding D'AT transformation states (in gray).

3.17.2 pei_2

The second form, pei_2 is often taken to derive from pei_1 with merger of the top and side lines to form a curve that developed to a closed curve. It seems plausible, however that the Linear B related symbol [Pe] (group B72) influenced directly the development of this morphology, at least in some local alphabets, hence the classical name *pei* (alternatively, of course, the name could be related to Linear C [Pe]).

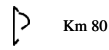
Vinča signary

Egyptian

Linear A

Protosinaitic

Linear B



Levantine Protolinear

Linear C

Phoenician abjad

Archaic alphabets

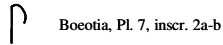


Figure S17.2.1 Morphological variants of symbols that have been proposed as related or homologues of the pei_2 forms. The Linear B symbol has the value [Pe].

The D'AT tropes describing topologies of transformations linking the various forms of pei_2 are given in figure S17.2.2

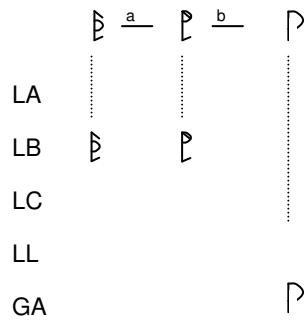


Figure S17.2.2 A D'AT trope describing transformations of the basic morphology underlying pei_2 and related Linear B symbols. (a) curved line written towards the top of the symbol (b) loss of top sna bottom straight lines. Dotted lines connect forms found in the archaeological record within a particular taxon (in black) with the corresponding D'AT transformation states (in gray).

3.18 San

The Greek name for this letter was *san*, (*σάν*, at least in the Doric alphabets (31)), while the name of the Phoenician equivalent has been reconstructed as *šin*. The basic plan consisted of four zig-zag lines, much like our M. The Linear B related symbol [Sa] was also made of four lines, although their relative size could differ widely, with a central stem sometimes protruding. An alphabetic *san* of very similar shape (protruding middle line), representing a -ss combination, is recorded from Ephesus and other Asian Minor cities (31). The Linear C [Sa] consisted of only two lines, sometimes with a prominent stem, like the symbol on the Izbet Sartah ostrakon, which is also similar to the Linear A symbol that has been suggested to present this syllabic value (Linear A and Linear B symbols belong to the AB31 group). The alphabetic Greek symbol has been used with the value of double s (e.g. it is used in an Ephesian inscription in the word *τεσσαράκοντα*, replacing the two *sigma*), which in dialect also be replaced by tt. This seems consistent with the use of the symbol in Semitic dialects for both /t/ and /š/ sounds (for example in Standard Old Aramaic, (20)). The exact pronunciation in antiquity is, as with most letters, a matter for conjecture. Although the -σσ- is sometimes pronounced like *sh* in the contemporary Pontic and Cypriot dialects, which is similar to the *san* value in Semitic scripts, the sound *sh* is absent from most other Greek dialects and modern Greek, so any value is conjectural. Note the inversion in the placement of *sigma* and *san* in the alphabetic order between the Levantine abjads and the alphabet.















Vinča signary		Win 3						
Egyptian								
Linear A		HT95a.3						
Protosinaitic								
Linear B		Kn 941		Kn 618		Kn 2111		Kn 455
Levantine Protolinear		Izbet Sartah						
Linear C		16 Timocharis		92, Aristagoras				
Phoenician abjad		Ahiram						
Archaic alphabets		Thera, Pl. 61, inscr. 1				Kolophon, plate 66, inscr. 53		

Figure S18.1. Morphological variants of symbols that have been proposed as related or homologues of the *san* forms. The Linear B and Linear C symbols have the value [Sa] while the Egyptian and Phoenician correspond to /š/.

The D'AT tropes describing topologies of transformations linking the various forms of *san* are given in figure S18.2

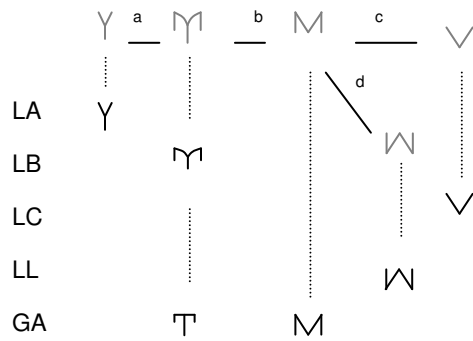


Figure S18.2 A D'AT trope describing transformations of the basic morphology underlying *san* and related symbols. (a) two side lines noted (b) middle line not noted (c) loss of side lines (d) inversion. Dotted lines connect forms found in the archaeological record within a particular taxon (in black) with the corresponding D'AT transformation states (in gray).

3.19 Qoppa

The Greek name for the letter was *qoppa*, (ϙόππα) one of the two letters to have this ending. The Phoenician name has been reconstructed as *qof*. The basic morphology of the symbol consists of a circle and a straight line that may or may not cross into the circle. Sometimes a dot is found within the circle, just like the *omicron*, depending on the cutting of the symbol, locality and scribe. The related Linear B symbol has the syllabic value [Ko] (Linear A and Linear B symbols belong to the AB70 group), but is written with two lines, like a birds beak. The simplified *qoppa*, also resembles Linear B [Qa], which could explain the name (presumably from **ko-k^wa*, “the Ko that looks like the Qa”, becoming ϙόππα in classical script; see also *kappa*). Only two letter names end in *-ppa* and it is remarkable that those two symbols bear close similarity or relation to the Linear B labiovelar [Qa]. This further reinforces the notion of continuity of the scripts since it is all but impossible that someone could have come up with such names in a random way, without understanding of those similarities. In classical Greek alphabets *qoppa* is used interchangeably with *kappa*, but also as a replacement for *chi*, especially before *-o* and *-u* (34), which agrees with its correspondence to the Linear B [Ko] (the K- series developed to k, g^h, k^h ; κ, γ, χ). This is also how it was used by semitic speakers (see theta above).












Vinča signary		Win 138		
Egyptian				
Linear A		Pk Za11b		
Protosinaitic				
Linear B		Kn 249		
Levantine Protolinear		Izbet Sartah		
Linear C	-			
Phoenician abjad		Shiftiba'al		Yehimilk
Archaic alphabets				
			Thera, Pl. 62, inscr. 18	Thera, Pl. 61, inscr. 6
				
				Argos, Pl. 27, inscr. 17 & Pl 29, inscr. 30

Figure S19.1. Morphological variants of symbols that have been proposed as related or homologues of the *qoppa* forms. The Linear B symbol has the syllabic value [Ko] while Egyptian symbols correspond to *k*.

The D'AT tropes describing topologies of transformations linking the various forms of *qoppa* are given in figure S19.2

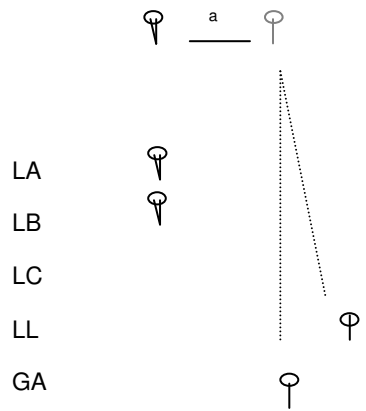


Figure S19.2 A D'AT trope describing transformations of the basic morphology underlying *qoppa* and related symbols. (a) loss of one of the two lines Dotted lines connect forms found in the archaeological record within a particular taxon (in black) with the corresponding D'AT transformation states (in gray).

3.20 Rho

The Greek name of the symbol was *rho* (ῥῶ) with a reconstructed Phoenician name *ros*. The Phoenician name has been linked with the name for “head” hence the Proto-Sinaitic symbol is given the value /r/. The related Linear B symbol has the value [Ri/Li] (Linear A and Linear B symbols belong to the AB53 group), although the corresponding Cypriotic symbol and already acquired the value [Ro], as notation of r- and l- lines separated (6). The symbol has retained that value as a name to this day. The basic morphology of the symbol is made up of a closed curve with one or two lines protruding, giving rise to two variants of the symbol (both related to AB53), represented by the Greek (Ρ) and Latin (R) letters corresponding to the sound /r/.

















Vinča signary		Win 180						
Egyptian								
Linear A		Ph 7a.2						
Protosinaitic								
Linear B		Kn 423		Kn 995		Kn 462		Kn 468
Levantine Protolinar		Izbet Sartah						
Linear C		Minocretes		180, Pausandros				
Phoenician abjad		Ahram						
Archaic alphabets		Mycenae, Pl. 31, inscr. 6		Argos, Pl. 29, inscr.30			Pithekoussai: Nestor's cup	

Figure S20.1. Morphological variants of symbols that have been proposed as related or homologues of the *rho* forms. The Linear B symbol has the syllabic value [Ri/Li], while the Linear C is [Ro], the Egyptian to /l/ and /r/ and the Phoenician to /r/.

The D'AT tropes describing topologies of transformations linking the various forms of *rho* are given in figure S18.2

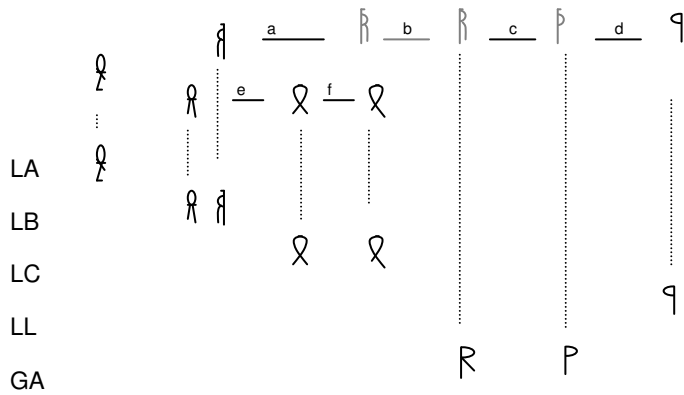


Figure S20.2A D'AT trope describing transformations of the basic morphology underlying *rho* and related symbols. (a) catoptrical image (b) loss of top lines (c) loss of side line (d) catoptrical image (e) symbol written with one continuous line (f) left line shorter than right or disappearing. Once more, note that the Linear C with “atrophic” left line, Levantine and archaic (and classical) Greek are morphologically equivalent and that the trope is *not* representing historical sequence but morphological topology. Dotted lines connect forms found in the archaeological record within a particular taxon (in black) with the corresponding D'AT transformation states (in gray).

3.21 Sigma

The last of the three sibilants of archaic alphabets had the Greek name sigma (σίγμα) while the reconstructed Phoenician name of the related symbol is *sāde* (note the inversion in the order of sigma and san between the Levantine abjads and the alphabet). In the Ionic alphabet this was the eighteenth letter, replacing the *san* of the Doric, although it was written in local alphabets like the Doric *san* (that is, looking like our M); the horizontal form prevailed, fusing with/displacing *san* and allowing the generalised use of mu_1 (that was morphologically closely related with *san*; the four line form that has become our M). The basic morphology consisted of three or four zig-zag lines with one side sometimes longer, as in the Levantine scripts. The syllabic scripts have the basic morphology of one long vertical line and two shorter, connected by a horizontal line. This becomes zig-zag in the letter form; for a similar transformation see mu_2 . The related Linear B (Linear A and Linear B symbols belong to the AB9 group) and Linear C symbols have the syllabic value [Se]. The Greek name is related to the word *σιγμός* (from onomatopoeic *sigmos* “hissing”), with the standard adoption of –a suffix found in other letters. A four-stroke variant written vertically, closer to the Linear B [Se] was present in Laconia.














Vinča signary		Gimbutas: 1973:13		
Egyptian				
Linear A		HT 27b.5		
Protosinaitic	?			
Linear B		Kn 63		
Levantine Protolinear		Qubur el Walaydah		Izbet Sartah
Linear C				
Phoenician abjad		Yehimilk		Beqa' arrowheads
				Karatepe
Archaic alphabets		Lakonia, Pl. 35, ins. 7		Boeotia, Pl. 7, inscr. 1
				Dipylon oinochoe

Figure S21.1. Morphological variants of symbols that have been proposed as related or homologues of the *sigma* forms. The Linear B and Linear C symbol have the syllabic value [Se] while the Egyptian and Phoenician symbols correspond to /s/.

The D'AT tropes describing topologies of transformations linking the various forms of *sigma* are given in figure S21.2

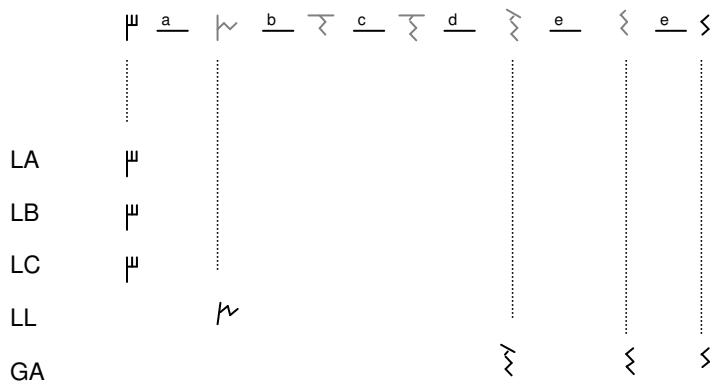


Figure S21.2 A D'AT trope describing transformations of the basic morphology underlying *sigma* and related symbols. (a) vertical lines merging into a zig-zag pattern (b) 90° rotation (c) extra line written in cursive (d) long line written smaller and in angle to other lines; every pair written in parallel (e) loss of one of the lines. Dotted lines connect forms found in the archaeological record within a particular taxon (in black) with the corresponding D'AT transformation states (in gray).

3.22 Tau

The Greek letter has the name tau, (ταῦ) which is also the reconstructed name of the Phoenician symbol. The basic morphology is one of two lines meeting in a t-shape. The related Linear B symbol has the syllabic value [Da] (Linear A and Linear B symbols belong to the AB1 group), which became [Ta] in Linear C. The other letter to retain its ancestral syllabic value with the addition of –u suffix was *wau*.










Vinča signary		Win 2
Egyptian		
Linear A		HT 95a.1
Protosinaitic		
Linear B		Kn 1
Levantine Protolinear		Lachish
Linear C		142, Kypromedon
Phoenician abjad		Ahiram
Archaic alphabets		Pithekoussai: Nestor's cup

Figure S22.1. Morphological variants of symbols that have been proposed as related or homologues of the *tau* forms. The Linear B symbol has the syllabic value [Da] while the Linear C symbol denotes [Ta], while Egyptian and Phoenician correspond to /t/.

The D'AT tropes describing topologies of transformations linking the various forms of *tau* are given in figure S22.2

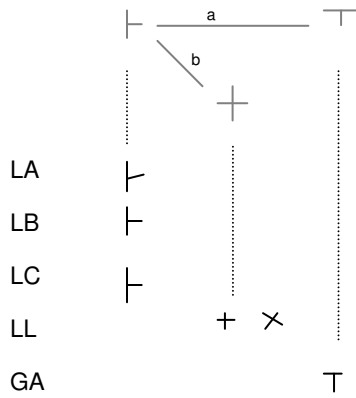


Figure S22.2 A D'AT trope describing transformations of the basic morphology underlying *tau* and related symbols. (a) 90° rotation (b) shift of top line to centre. Dotted lines connect forms found in the archaeological record within a particular taxon (in black) with the corresponding D'AT transformation states (in gray).

3.23 Ypsilon

The last letter of the archaic alphabet had the Greek name *u* or later *ypsilon* (ὤ, υ ψιλόν). There is no Semitic equivalent, both because the abjads do not note vowels but also because they stop at letter 22 (*tau*) and do not write the symbol corresponding to the fifth vowel. The basic morphology is a line, with a secondary line meeting in angle, which later became the more familiar to us Y shape. The related Linear B (Linear A and Linear B symbols belong to the AB10 group) and Linear C symbols have both the value [U] which became the name of the alphabetic symbol. Note the different shape of Linear C variants (with secondary lines or written upside down) to separate it from the Linear C [Sa] that is morphologically similar.










Vinča signary		Win 48	
Egyptian			
Linear A		Kn Zb 40.2	 HT 122a
Protosinaitic	-		
Linear B		Kn 749	 Kn 1
Levantine Protolinear	-		
Linear C		85, Hylates	 2-3 Apollo Hylates
Phoenician abjad	-		
Archaic alphabets		Pithekoussai: Nestor's cup	

Figure S23.1. Morphological variants of symbols that have been proposed as related or homologues of the *u* (*ypsilon*) forms. The Linear B and Linear C symbols have the syllabic value [U] which is close to the sound represented by the Egyptian symbol combination.

The D'AT tropes describing topologies of transformations linking the various forms of *ypsilon* are given in figure S23.2

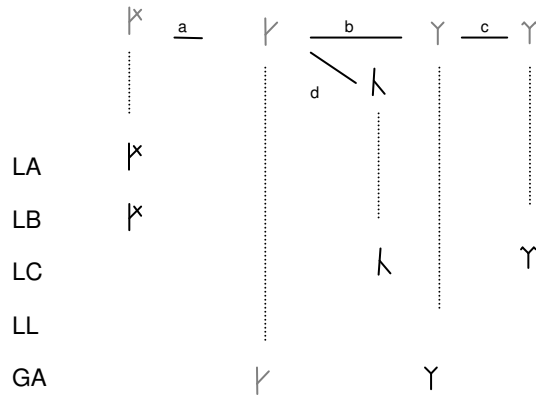


Figure S23.2 A D'AT trope describing transformations of the basic morphology underlying *ypsilon* and related symbols. (a) loss of secondary line (b) split of upper part in two lines (c) secondary lines noted (d) inversion. Dotted lines connect forms found in the archaeological record within a particular taxon (in black) with the corresponding D'AT transformation states (in gray).

4. Matrix

Matrix generated following the analysis of symbol morphology and used for the study of systematic relationships of different scripts. The matrix was generated by analysis of individual semaphores/symbols (see also materials and methods, SOM 1)

```
[taxa      000000000111111111222222222233333333334444444444555555555566666666667
          1234567890123456789012345678901234567890123456789012345678901234567890]
linearA   1111110111111111111101110111111111111111111111111111100101111101100111
linearB   11111101111111111111011101111111111111111111111111111110111101100111
cypriot   111---01----1111000---101010011111110--11111--11101100110111101100111
phoenic   11111001100010111100101---010001110---11001111011001111110111011101---
occiden   1111110110001011011110110001000111010011001111011101111110111011111110
```

```
01: [Alpha1: First line present]
02: [Alpha2: Second line drawn in angle to the first]
03: [Alpha3: Third line crossing the other two]
04: [Beta1: axial line present]
05: [Beta2: upper semicircle present]
06: [Beta3: full lower semicircle fully present]
07: [Gamma1: two straight lines with vertical or near vertical, gamma-like extensions,
combined at the middle]
08: [Gamma2: single straight line with vertical or near vertical, gamma-like extension]
09: [Delta 1: central triangle present]
10: [Delta 2: left mark ('peak') present]
11: [Delta 3: right mark ('peak') present]
12: [Delta 4: crossed lines at lower part present]
13: [Epsilon1: axial line present]
14: [Epsilon2: twin, leg-like extensions present]
15: [Epsilon3: three to four lines meeting the axial line]
16: [Wau1: Left line present]
17: [Wau2: Right line present]
18: [Wau3: middle line present]
19: [Wau4: top line present]
20: [Wau5: side lines protruding when present]
21: [theta1: circle present]
22: [theta2: 2-4 horizontal lines or dots present]
23: [theta3: single dot or crossed line present]
24: [Iota2.1: vertical line present]
25: [Iota2.2: horizontal line present]
```


26: [Iota2.3: sidelines present]
27: [Kappa 1: Major closed curve present on the upper half of the symbol]
28: [Kappa 2: semicircle or angular shape present]
29: [Kappa 3: presence of left semicircle line directed to the left - "left handle"]
30: [Kappa 4: presence of right semicircle directed to the right - "right handle"]
31: [Kappa 5: horizontal line present]
32: [Kappa 6: vertical line present]
33: [Labda 1: vertical line present]
34: [Labda 2: horizontal line present]
35: [Labda 3: other shapes present]
36: [Ma 1: Upper part consisting of four lines]
37: [Ma 2: lower part present]
38: [Ma 3: lower part circle-like]
39: [Mu 1: vertical line present]
40: [Mu 2: secondary lines present, curved or straight]
41: [Nu 1: left line present]
42: [Nu 2: right line present]
43: [Nu 3: central part made of two lines, fusing to S or N like shape]
44: [Ksil: 3 lines present]
45: [Ksi2: other line(s) present]
46: [Omikron1: circular shape present]
47: [Omikron2: other shapes present]
48: [Peil: line 1 present]
49: [Peil.2: line 2 present]
50: [Peil.3: line 3 present]
51: [Peil.4: line 4 present]
52: [San1: left line in V-forming angle present]
53: [San2: right line in V-forming angle present]
54: [San3: second left line present]
55: [San4: second right line present]
56: [Qoppa1: circular line on top]
57: [Qoppa2: closed curve line present]
58: [Qoppa3: second line from the circle present]
59: [Ro 1: upper part enclosed curve]
60: [Ro 2: lower part one or two lines attached to the bottom of the curve]
61: [Sigma1: Axial line present]
62: [Sigma2: line vertical to axial, with secondary parallel lines present]
63: [Sigma3: 2-3 zig-zag lines present]
64: [Ta 1: vertical line]
65: [Ta 2: horizontal line]
66: [Ta 3: crossing line on top of vertical line]
67: [Ta 4: crossing line present both sides of the vertical line]
68: [Ypsilon1: vertical present]
69: [Ypsilon2: side line in angle present]
70: [Ypsilon3: other lines present]

5. Abbreviations

CM: Cyprominoan

D'AT trope: D'Arcy Thompson trope

DMG: *Documents in Mycenaean Greek* (2)

GORILA: *Recueil des inscriptions en Lineaire A.* (4)

GA: Greek alphabet(s)

LA: Linear A

LB: Linear B

LC: Linear C

LL: Levantine Linear (Levantine Proto-linear, before 1050 B.C and Phoenician after that date) (8, 20)

PIE: Proto-Indo-European

SOM: supporting on-line material

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