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A study of the scribal hands of Knossos based on phylogenetic methods and find-place analysis*

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This paper presents a study of the scribal hands of Knossos that is based largely upon phylogenetic methods and find-place analysis. It will be divided into three parts. The first part describes the results of an analysis of the scribal hands using phylogenetic methods. The second part is an interpretation of the results of the phylogenetic analysis taking account of the find-places of the tablets. The third part introduces an extended phylogenetic analysis that considers the rate of evolution of the scribal hands and uses this to propose specific dates for scribal hands.

Part I: The Phylogenetic Analysis

1. Introduction

1.1. *Background*

In the early writings about the Knossos Linear B tablets, it was commonplace to refer to the "Unity of the Archives", implying that the overwhelming bulk of tablets were originally part of the same archive and thus written about the same time. However, it was already recognised in *Scribes*[1] that there are two distinct graphical units at Knossos that are largely separated from the remaining tablets. These are

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[1] pp. 128-129; *Scribes* = *Les Scribes de Cnossos.*

located in the Room of the Chariot Tablets *(RCT)*[2] and North Entrance Passage (*NEP*). Each of these two deposits of tablets is the work of numerous different scribes and each has a palaeographic unity that is largely distinct not only from the other but also from the remaining Knossos tablets.[3]

In a subsequent discussion of the tablets from the *RCT*, Chadwick (1968) wrote: "It is hard to resist the conclusion that this group is not closely related to the remainder of the archives, though it refers to towns in Crete and uses many well-known Mycenaean names. Such isolation might be explained chronologically, if this deposit belonged to a different date from the rest…". He then goes on to to elaborate on an alternative hypothesis that the *RCT* tablets are the practice inscriptions of a scribal school but this latter suggestion did not gain widespread support.

In his book, *Early Destruction,*[4] Driessen (p. 114) concluded that the *RCT* tablets could be attributed to LM II, pre-dating the bulk of the remaining Knossos tablets that date from the destruction of the Palace in early LM IIIA2 (p. 109). In this way, the distinctive palaeographic features of the *RCT* tablets were explained as being due to chronological separation.[5]

In the meantime, paleography was being developed as an increasingly sophisticated tool for understanding developmental and chronological relationships. Bennett (1966a) attempted to show the way in which the *VIR* ideogram, found at Knossos, Mycenae and Pylos, had developed typologically and possibly chronologically. In another paper, Bennett (1966b) used the systematic paleographical differences between the Pylos and Knossos tablets to disprove the suggestion that the Pylos tablets were taken as "loot" from Knossos. He concluded that these paleographical differences meant either that the sites had been isolated for several generations before they were both destroyed, or that one site was destroyed several generations before the other. In this way, Bennett was the first person to attribute chronological significance to systematic paleographical variations between sites. In a lengthy paper on the development of the Mycenaean writing system, Palaima (1988 p. 309) observes that "the trend is for sign forms in Linear A to develop from MM III through LM IB *in the direction of Linear B*". He also notes (p. 320) "one observes a tendency

[2] In this paper, it will be convenient to abbreviate some of the Knossos room names, as follows: *RCT* = Room of the Chariot Tablets; *NEP* = North Entrance Passage; *CoST* = Corridor of the Sword Tablets.

[3] Olivier draws particular attention to the absence of the simple form of the signs, *ni* and *sa* in the scribal hands of the *NEP*.

[4] *Early Destruction = An Early Destruction in the Mycenaean Palace at Knossos.*

[5] It should be noted that although this book received unfavourable reviews from some archaeologists (Popham, 1993 and Warren, 1992) its conclusion, that the *RCT* tablets pre-date the remaining Knossos tablets, has been widely (though not unanimously) accepted amongst Linear B scholars.

towards simplification of elaborate shapes when moving from the Knossos tablets (where some shapes are very close to LM IB Linear A) to the mainland tablets. I have always suspected these differences to have resulted from simplification through time, though this is beyond proof."

In a similar vein, in *RCTK*,[6] Driessen suggests that it is possible to divide the Knossos scribes into four groups ranging from the *RCT* hands to the *conservative*, *centrist* and *progressive* styles of the remaining scribes. He described his analysis of these latter groups of scribes as follows: "If we take the principles of progressive change towards simplification and the shift of relative frequencies as being indicative, a survey of the scribal tables from *Scribes* combined with the thematic tables given here [in *RCTK*] can result in the determination of more conservative 'scribes' on the one hand, more progressive ones on the other hand, and real hybrid ones whose graphic style shows as an amalgamation of features common to both groups".[7] He concludes, "the 'scribes' of the *North Entrance Passage* all come from the *Conservative* or *Centrist* scribal groups, while the most *Progressive* 'scribes' seem to have worked in the *West Magazines*, the *Arsenal* and the *East Wing*. Some exceptions do occur, however, which is why an intensive study of the Knossos corpus may succeed in a more detailed division and result in the attribution of other epigraphic, linguistic and administrative features along the lines of this classification."

1.2. *Introduction to the new analysis*

The present work can be regarded as a response to the call for the more intensive study that Driessen recommends. Its starting point is the general study of Linear B hands by Christina Skelton (2008) that demonstrated that it was possible to apply phylogenetic methods and derive a highly plausible structure of the chronological development of the writing styles across the whole range of Mycenaean sites represented. The aim here is based on Skelton's study and applies the same type of phylogenetic analysis to "all" of the major Knossos scribes (rather than the small number that were used in the initial survey).

In *RCTK* (p. 151), Driessen draws attention to only three sign variations that were used to distinguish the various styles (i.e. *ni* & *sa* with or without circle where

[6] *RCTK = The Scribes of the Room of the Chariot Tablets at Knossos.*

[7] *RCTK*, p. 151. Driessen's results are as follows:
Conservative style: 104, 106, 107, 109, 120, 123, 127, 137, 141, 203, 222.
Centrist style: 102, 110, 111, 112, 113, 114, 117, 118, 119, 122, 125, 126, 134, 136, 139, 201, 202, 204.
Progressive style: 101, 103, 105, 108, 115, 116, 121, 128, 129, 130, 133, 131, 132, 135, 138, 140.
In a footnote (p. 151), he also suggests that scribes 141 & 222 should be regarded as a subcategory intermediate between *RCT* and the *Conservative* group.

the Y branches; *ka* with a wavy or straight cross). The phylogenetic analysis developed by Skelton is based on 131 such characteristics. These are described in outline by Skelton (2008).

Skelton's phylogenetic analysis (2008) separates the main Knossos hands into three groups: *RCT*, *NEP* and "later Knossos". For the purposes of this paper it is useful to establish some new terminology and define three stylistic groups of handwriting at Knossos.

- Early Knossian Linear B Style (e.g. *RCT*)
- Middle Knossian Linear B Style (e.g. *NEP*)
- Late Knossian Linear B Style (e.g. scribes 103 & 117)

It is stressed that, at this stage, these divisions are made on the basis of handwriting styles and do not necessarily imply chronological differences. The possibility that there are chronological separations will be considered in Part II. Each of these stylistic groups will be further divided into "conservative" and "progressive". It is emphasised that the major differences are between the Early, Middle and Late Knossian styles, whereas the terms "conservative" and "progressive" will be used for more subtle differences in style that would probably have co-existed at the same time.[8]

The main objectives of Part I of this paper are as follows:

- To set out the forms of the key signs that distinguish the different stylistic groups.
- To allocate each of major Knossos scribal hands to one of these stylistic groups.
- To lists the hands for each of the find-places and separate these into the different stylistic groups.

Since the application of these methods to Linear B scripts is a new field of study, each of the findings derived using the statistically based phylogenetic methods will be interpreted in terms of conventional palaeography. Thus, it is not necessary for the reader to be familiar with the details of phylogenetic methods in order to understand the basis for the definition of the stylistic groups. Essentially, we will be using the statistically based methods of phylogenetics to draw our attention to details of Linear B writing that otherwise tend to be obscured by the mass of detail. In this way, phylogenetic methods are being used to support the conventional palaeographic methods that have been predominant to date.

Olivier's *Scribes* is the foundation of all work on the scribal hands of Knossos. The attribution of scribal hands from this study has been progressively updated during

[8] Cf. the differences in scribal style that co-existed at the time of the destruction of the palace at Pylos (Skelton 2008).

the 40 years since its original publication. The latest attribution of scribal hands based on *Scribes* is given in *CoMIK*. There has been a more recent study, *RCTK* by Driessen; however, the final publication of that work in 2000 post-dated the publication of *CoMIK* and its results were not included, although it is clearly an important contribution. Therefore, for the purpose of this paper, the attribution of the Knossos tablets to scribal hands are based on *CoMIK* except for the *RCT* hands that are based on *RCTK*, unless stated otherwise. However, the interpretation of the detailed shapes of the signs is based on the drawings in *CoMIK* for all hands, unless stated otherwise.

The approach to phylogenetic methods used in this paper will be to start from the phylogenetic *trees* developed by Skelton (2008a, see figures 4a & 4b of that paper) that show the development of scribal hands.[9] However, for simplicity of presentation we will exclude four of the *taxa* that were included in that *tree* as they represented isolated inscriptions (i.e. Kafkania pebble, Mycenae Ui 2, Khania Hand 115 and Knossos V 52). The reason for excluding these is because the sparseness of signs associated with these inscriptions tends to cause a large increase in the number of optimal *trees*. In Skelton's paper (2008), the data for each Knossos scribe was based only on the tables of signs given in *Scribes* and *RCTK*. However, in this paper, the data for each Knossos hand is based on the full set of signs on the tablets attributed to that scribe, unless stated otherwise. Figures 1a and 1b show the *weighted* and *unweighted trees* following these changes.[10] Although these show differences of detail, these *trees* are clearly analogous to those given in Skelton's original paper (2008). These *trees* will form the basis for the work that follows.[11]

In her original paper, Skelton (2008) generally selected hands with a relatively large number of signs.[12] In the present paper, we are extending the analysis to

[9] Although this paper has the deliberate aim of minimising the use of technical phylogenetic words, it is inevitable that a few words, such as *tree* and *branch* have to be included. These will be given in italics.

[10] In Skelton (2008), re-weighting was done on the basis of the *consistency indices*. In this paper we will re-weight using the *rescaled consistency indices*. The latter are preferred since these allow the possibility of zero-weighting for some characters (Kitching *et al.* 1998, pp. 111, 117).

[11] In general it is not sensible to include all of the hands from each find-place in each of the phylogenetic analyses. This is because many of the hands are associated with so few signs that the analysis cannot properly assess them and the net result is hundreds of *trees* with the same *tree length*. Therefore, for this paper, in each analysis the selection of hands has been made on the basis of the numbers of signs in their repertoires. Even with this limitation, the analysis often produces several equivalent *trees*. In such cases, we have chosen to present a "typical" *tree* (rather than fill the journal with dozens of *trees* that are barely distinguishable or present *consensus trees* that are quite difficult to interpret). (These *trees* are labelled "1st tree of xx".) The reader is warned that, as the *trees* presented here are representative, care should be taken not to over-interpret their contents.

[12] The exception to this were the four test *taxa* that have already been discussed above.

include more of the Knossos scribal hands, which necessarily involves considering hands with fewer signs in their repertoire. In terms of the phylogenetic analysis, this results in a reduced level of definition and confidence in the *trees* produced by the analysis. Ideally, we would naturally prefer to have well-defined *trees* in which we had a high level of confidence. However, for the purposes of the present analysis, we are aiming towards the less demanding objective of defining the Early, Middle and Late Knossian styles and their "conservative" and "progressive" variants and attributing the scribal hands to each of these categories. In the course of this paper, we will present phylogenetic *trees* because they are a useful part of the presentation but the reader should be careful not to endow these with interpretations and confidence levels that extend beyond the discussion given in this paper.

Phylogenetic methods were designed to analyse the evolution of biological entities. However, in the present work these methods are being applied to the evolution of writing styles. It is important to stress this difference because writing styles are essentially fashions that are adopted by particular scribes. Once a particular writing characteristic has been introduced it is possible for it to be adopted or rejected by successive scribes, in the same way that other fashions come and go. For this reason there is not a straightforward progression from older to newer forms of some signs. However, as there are many signs, it is possible to place hands in their relative chronological positions even though some of their signs may not be representative of the current style.

The approach used in this paper will be to consider each of the three stylistic groups in turn, beginning with the Early Knossian style as found in the Room of the Chariot Tablets. It is worthwhile repeating that this part of the paper is primarily concerned with the scientific analysis. The interpretation of the results of this analysis is given in Part II.

2. Early Knossian Linear B Style: The Scribes of the Room of the Chariot Tablets

2.1. *Attributing tablets and signs to the* RCT *scribes*

At first sight it seems straightforward to attribute tablets and signs to the different *RCT* scribes since we could simply use the lists of tablets for each scribe set out in *RCTK*, pp. 71-87. However, close reading of the text of *RCTK* shows that Driessen judged that sometimes two different scribes wrote the signs on a tablet. It is important for the present study that we try to avoid confusing the work of different scribes. Therefore, we will spend a little time specifying which signs we are not including on the tablets listed for each scribe in *RCTK*.

124-B. With reference to Ce 50, *RCTK* states (p. 73), "It is possible that the additions in smaller characters are by another hand, although there are no graphically aberrant features and a similar feature also occurs on V 60". With reference to V 60, *RCTK* states (p. 73), "The same hand [i.e. 124-B] was probably responsible for the smaller written entry between the signs of the first word".

Considering the small signs on Ce 50: the *ra* is different from that on Ce 61 and V 147 and the *pe* is different from that on the other 124-B tablets. Considering the small signs on V 60: *a* is distinctive and different from that on the other 124-B tablets and the "sceptre" on the *o* is atypical.

These differences in form would suggest that we cannot be confident that 124-B wrote the small signs on Ce 50 and V 60. Therefore, for the present study, the small signs on these two tablets were not included within the repertoire of signs by 124-B.

124-G. According to *RCTK* (p. 80), "The attribution of these tablets to 124-G are more or less secure, although some doubts still remain for the Xd-fragments". However, the fact that half of the signs used in the phylogenetic analysis are from the Xd fragments makes the basis for including 124-G very weak. Therefore, although Driessen lists 124-G as a major scribe, his scribe will not be included in the first instance (but see section 2.4 below).

124-I and 124-V. According to *RCTK* (p. 81), "The *verso* [of V 337] may be by a different hand, however: it is less carefully inscribed and a different stylus may have been used", "It is possible that the inscribed *verso's* of the Sc-tablets are by the same 'scribe' who has inscribed the *verso* of the set by 124-V" and (on p. 94), "the *verso* of 124-V's tablets and some of 124-I's tablets may have been inscribed by (the same?) third party". On this basis, the writing on the *verso's* of the tablets by 124-I and 124-V has not been included in the repertoire of these scribes.

124-X. According to *RCTK* (p. 87), "A medium-sized stylus was used for the usually tidy and deep traits; the same stylus was used for the normal and smaller entries, except perhaps on L 178". There is an implication here that the small signs on L 178 may have been written by a different scribe. This is supported by noting that the *u* sign differs from that on Xd 214. On this basis, the three small signs on L 178 are not included in the repertoire of signs by 124-X.

2.2. *Using phylogenetic methods to compare the writing styles of major* RCT *scribes*

The *RCT* scribes do not all write Linear B signs in the same style. The analysis will show that it is possible to determine which scribes tend to use "more conservative" forms of the signs and which use "more progressive" forms.

The phylogenetic analysis is based on the same data that was used to generate the trees in Figures 1a & 1b but extended to include all of the hands which were

designated as major *RCT* hands in *RCTK* (p. 71), i.e. 124-A, B, D, E, F, I, R, S (but excluding 124-G, see the discussion above).

The analysis gives the trees shown in Figures 2a & 2b. These retain the basic structure of the tree outside the *RCT*. However, within the *RCT* it shows a development of styles from "more conservative" to "more progressive", as follows,

124-A > 124-B > 124-R > 124-S > (124-D, 124-E, 124-F, 124-I)

It is not possible to determine with confidence any chronological ordering of the hands shown in parentheses.

Before we go further we should try to understand the basis for this chronological ordering. The key characteristics that show more conservative traits are set out in Table 1.[13]

Table 1

Characteristic	More conservative	Intermediate	More progressive
22: *do* dot in centre	B		I, S
25: *mo* crossbars on branches	F, R, S	D	I
32: *qi* lines forming stalk	B	R	E
38: *ne* shape of arms	A	R, S	F
69: *wo* top dot/line	A	R, S	E, F, I
95: *nu* central dot/line	B	R, S	
109: *ki* middle stroke	B, R	S	I
111: *ki* baseline	B, R, S		I
116: *pe* vertical stroke(s)	A, R	B, S	E
127: *ku* stroke on tail	B, F, R, S	D	E

It is evident from Table 1 that it is possible to find a set of characteristics which identify some hands as being "more conservative" because they appear more

[13] In Table 1, the numbers refer to the series of characteristics defined by Skelton (2008). For the purposes of this table, the "more conservative" features are defined to be: dot in centre of *do*; crossbars on the branches of *mo*; stalk of *qi* has three lines; *ne* has one C-shaped arm and one S-shaped arm with an additional stroke on the C-shaped arm; top "line" of *wo* drawn as a dot; *nu* has a central dot; *ki* has a middle horizontal stroke and a baseline; left-hand vertical of *pe* is made up of two strokes; tail of *ku* is a single stroke. For the purposes of this table the "more progressive" features are: absence of dot in centre of *do*; no crossbars on the branches of *mo*; stalk of *qi* is a single line; *ne* has one C-shaped arm and one S-shaped arm but without an additional stroke on the C-shaped arm; top "line" of *wo* drawn as a line; *ki* does not have a middle horizontal stroke or baseline; left-hand vertical of *pe* is made up of a single stroke; tail of *ku* has an additional stroke. For the purposes of this table the "intermediate" hands usually use a mixture of both "more conservative" and "more progressive" versions of a sign. There are some cases where "intermediate" needs further specification: stalk of *qi* has two lines; *nu* has a central stroke.

frequently in the left column than in the right column. This demonstration does not duplicate the phylogenetic analysis in all of its complexity, but it does give some indication of the features that are underlying its analysis.

Thus, we have shown that:

- It is possible to order the major *RCT* scribes on a scale of being "more conservative" or "more progressive".
- This division is essentially the same for the weighted and unweighted analyses.
- It is possible to understand the basis of this division (if not its precise detail) by considering a relatively small number of characteristics of the signs.

The next question is how we should begin to interpret this result.

This sequence of *RCT* scribes clearly does not represent successive generations (as might be expected from an analysis of biological organisms). It is highly likely that all of the scribes represented on the *RCT* tablets were working at the same time. Thus we are considering here subtle changes in handwriting styles that were present within a group of scribes that were working alongside each other.

Furthermore, it should be noted that the sparseness of the data for the *RCT* hands could mean that the relative positions of some hands in the sequence would be different if more tablets had been preserved. In addition, we have already seen (Figs. 2a & 2b) that one can change the ordering to some extent by giving different levels of weighting to handwriting characteristics. Therefore, when we try to draw conclusions, we should be considering groups of features rather than small individual changes.

For these reasons, it is proposed that we should divide the major *RCT* scribes into two groups.

- Scribes 124-A, 124-B, 124-R and 124-S are "more conservative".
- Scribes 124-D, 124-E, 124-F and 124-I are "more progressive".

The next step is to consider the minor scribes and we will begin this by examining the writing of 124-X.

2.3. *Considering 124-X*

Hand 124-X is not associated with many signs but whenever this hand is included in the phylogenetic analysis it invariably appears alongside hands from the *NEP*. This is for the simple reason that the forms of the signs used by 124-X are very similar to those used by, for example, hand 104 (with the sole exception of *ri*). This is interesting because it implies that the style of writing of hand 124-X would be more at home in the *NEP* than in the *RCT*. In other words, we could regard 124-X as being the "missing link" between the *RCT* and the *NEP*.

Thus, we can identify 124-X as having a "very progressive" style of writing within the *CT*. Table 2 gives a list of the sign characteristics that distinguish 124-X from the major hands in the *RCT*.[14]

Table 2

Characteristic	More conservative	More progressive	Very progressive
9: *a* number of horizontal lines	A, B, E, I, S	D, F, R	X
14: *u* upward turning hook	A, D, F, R, S	B	X
46: *ni* circle at branching	B, E, I, S	F	X
49: *ni* Y drawn with 2 or 3 strokes	B, E, I, S		F, X
65: *si* number of crossbars	F, S	B	X

It is interesting to note from this table that the "progressive" traits shown by 124-X tend to have been foreshadowed by 124-B or 124-F. The tentative implication from this could be that the style of writing of these two scribes influenced 124-X.

The *RCTK* (p. 93) Additional Tablet Grouping number (3) also shows very progressive traits analogous to those of 124-X. This grouping consists of only two tablets, Xd 149 and F 153. The *do* is "more progressive". However, the *ni* and *u* are "very progressive" and the arm shape on the *ne* is even more progressive than any found in the *RCT* hands that are considered in this paper.

2.4. *Extending the analysis of the* RCT *scribes*

We will now extend the analysis to cover the other groups of *RCT* scribes identified in *RCTK*. In these cases, the number of signs in each of the groups being tested is too small for the phylogenetic analysis to be regarded as reliable. Therefore, we will simply consider the characteristics listed in Tables 1 & 2 that are indicative of whether the hand is more or less conservative.[15]

[14] It is possible that, in some of these cases, we may be over-interpreting the data because of the small number of signs associated with 124-X. The numbers in Table 2 refer to the series of characteristics defined by Skelton (2008). For the purposes of this table, the "more conservative" features are defined to be: *a* has one horizontal stroke; the top of the hook on *u* continues at the same angle; no circle in the branching of *ni*; also for *ni* the Y is drawn using three strokes; only one crossbar on *si*. For the purposes of this table, the "very progressive" features are defined to be: *a* has two horizontal strokes; the top of the hook on *u* turns upwards; there is a circle in the branching of *ni* and therefore the Y of the *ni* is drawn using two strokes; two crossbars on *si*. For the purposes of this table, the "more progressive" hands use a mixture of both "more conservative" and "very progressive" versions of a sign.

[15] No discussion is given in cases where there are too few signs of interest.

124-C. This hand shows traits that are both "more conservative" and "more progressive". For example, *mo* is "more conservative" but *do*, *ku* and *wo* are "more progressive".

124-G. This hand is unusual because it shows traits that are "more conservative", "more progressive" and "very progressive". For example, *do* on Sc 235 is "more conservative", *wo* on Sc 130 & Vc 293 is "more progressive" and *ni* on Xd 7761 is "very progressive". For this reason, if 124-G is included within a phylogenetic analysis, it can appear in different places in the tree depending upon the relative weighting given to the characteristics. It is noted in *RCTK* (p. 80) that the attributions to this hand "are more or less secure, although some doubts still remain for the Xd-fragments". It is also noted that "the physical aspects of a collection of 124-G's tablets is … identical to those inscribed by 124-F". Further, we should note that 7761 is the only tablet with a type 1b format that has been attributed to 124-G. On the basis of the present findings, it is suggested that the attribution of Xd 7761 to 124-G should be questioned. Instead, it is tentatively suggested that Xd 7761 should be attributed to 124-F (compare *ni* with that on V 145; for the format, size and stylus characteristics of the tablet compare it with Sc 243). If this is accepted, then it would remove the "very progressive" sign from the repertoire of 124-G, and its repertoire becomes more consistent.

124-V. This hand also shows traits that are both "more conservative" and "more progressive". The *ki* is "more conservative", whereas the *wo* is more progressive".

124-1. There are three signs that indicate that this group of tablets were written by a "more progressive" hand, *wo*, *ku* (U 109) and *do* (U 7507). This is consistent with the statement in *RCTK* (p. 88) that it was possible that these tablets were written by 124-D, which is a "more progressive" hand.

124-3. There are few signs represented by this grouping and only one of the characteristics shown in Table 1 is present. The *ku* on Xd 110 indicates a "more progressive" hand. This is not inconsistent with the suggestion in *RCTK* (p. 89) that this tablet may have been inscribed by 124-D.

124-4. We will begin here by noting that the *wo* & *do* on V 7049 are not very well preserved and so we will use the shape of these signs given on Xd 282. There are three features that show evidence of a "more conservative" hand. These are the signs *do*, *wo* (Xd 282) and *mo* (Uf 120) (see Table 1 above). However, this is not in agreement with *RCTK* (p. 89), which suggests that these tablets may have been written by 124-D, a "more progressive" hand. Therefore, it is suggested that some caution ought to be shown before attributing the 124-4 group of tablets to 124-D.

124-9. This hand shows "more conservative" features in the signs *do* (Xd 167, 169) and *wo* (Xd 167, Sc 7480). It is suggested in *RCTK* (p. 92) that it is possible that 124-R was responsible for this group of tablets. The present analysis is not inconsistent with this suggestion.

We will now return to the subject of the discussion in Section 2.1 and consider whether it is possible to make any statement about the writer of the additional signs that appear on the tablets of 124-B, 124-I, 124-V and 124-X. The first point to make is that these additional signs include examples that are "more conservative", "more progressive" and "very progressive", so that it is most unlikely that they were written by the same hand.

We will begin by noting the examples that include progressive signs. These are the *versos* of V 337 (particularly the *ni*) and Sc 252 (which is inscribed with *a-mi-ni-si-jo*, with the *ni* and *si* showing very progressive traits). The *a-mi-ni-si-jo* on Sc 252 was probably written by the same hand that wrote the same word on the *versos* of Sc 7476 & 7782 because these show double horizontal lines on the *si* and a central circle in the *ni*. However, the *a-mi-ni-si-jo* on Sc 217 & 237 appears to have been written by a different hand(s). We can add to this by noting that the inscription on the *verso* of Sc 258 is "more conservative". This implies that a single person did not write the inscriptions on the *versos* of the Sc tablets.

3. Middle Knossian Linear B Style

3.1. *The Scribes of the North Entrance Passage*

3.1.1. Attribution of tablets to *NEP* hands

We will begin this section by highlighting a number of features in the attribution of tablets to hands that arose during the close examination of the signs on the *NEP* tablets.

- Hand 102: There are a relatively large number differences between the signs on tablets attributed to hand 102. In order to reduce this variability, we have divided hand 102 into 102a and 102b.[16]

[16] This division of hand 102 follows the suggestion of introducing 102b by Olivier in *Scribes* p. 43, "l'idéogramme *103 (entier seulement en B 1055) est assez peu semblable à celui de Ak 780.1, ce que la différence de format pourrait expliquer; As 1517r. B 807 et B 1055 devraient peut-être provoquer la création d'un classement '102b'". This suggestion is supported by Melena 1975, p. 33. The key differences are as follows: for 102 both arms of the *ne* are S-shaped curves (780, 781, 872) whereas for 102b the left arm is C-shaped (1055.3) (characteristic 38); for 102a the "Y" of the *sa* is drawn with 3 strokes (848, 872, 875) whereas for 102b it is drawn with two strokes (1055.2, 1517.3) (characteristic 53); for 102a the upper "horizontal" line of the *qo* is a continuous wavy line (843.3) whereas for 102b it is a continuous straight line (1517.1) (characteristic 55); for 102a the *ke* has a central vertical stroke (7000.1) whereas for 102b that stroke is omitted (1517.10) (characteristic 73); the form of the *ku* is very different between 102a (872.3a) and 102b (1517.6) (characteristics 125, 127); the form of the *VIR* is very different between 102a (780) and 102b (1055*r.*) [as noted in *Scribes* (p. 97) there is a chance that *VIR* on 1055*v.* could be the work of a different scribe].

- Hand 102a wrote the tablets: Ak 780-784, 828, 830, 7001, 7003?, 7005, 7007?, 9002, E 843, 848?, F 854, K 740?, 829, 872, 873?, 875.
- Hand 102b wrote the tablets: As 1517, B 807 and 1055.

· Hand 104: In *CoMIK*, B 806 is attributed to hand 104, however, the signs on the *verso* of appear to have been written by a different hand. For example, in the *ra* of hand 104 the line of the arc continues vertically down towards the horizontal line (see 799.2, 799.6, 779v.4, 802.1, 806.2, 5025, 5028, 8206) whereas this feature does not appear on the *verso* of 806. In addition, the *ne* of hand 104 has a baseline and no central embellishment (see 799.6, 799v.2) whereas the *ne* on the *verso* of 806 does not have a baseline but does have a central line. Therefore the signs on the *verso* of 806 have not been included in the repertoire of hand 104.

· Hand 122: In *CoMIK*, Uf(2) 7486 is attributed to hand 122?. However, the *me* and *na* signs are very similar to those in *ke-ke-me-na* on Uf(2) 983, which is attributed to hand 123. (Note also that *me* is dissimilar to the two *me* signs on 839 by hand 122, with only one line crossing on the right.) Furthermore, it seems possible that *]me-na* should be restored as *ke-ke-]me-na* and this word already appears on two tablets by hand 123 (Uf 835, 983) but none of the other tablets that have been attributed to hand 122. Therefore the signs on 7486 have not been included in the repertoire of hand 104.

3.1.2. Using phylogenetic methods to compare the writing styles of major *NEP* scribes

The phylogenetic *trees* including *NEP* hands are shown in Figure 3a & 3b. These *trees* are based on the hands included in Figures 1a & 1b but also include many of the major hands from the *RCT* and *NEP*.[17] The *tree* in Fig. 3a is a *consensus* of 17 *trees* which all had a minimum *tree length* equal to 874.

The structures in Figs. 3a & 3b are quite complex and different from each other. If hands are included or removed from the analysis the detailed structure within these results are often changed. Therefore, rather than relying on the detail within the *trees*, we will concentrate on the underlying patterns.

The features that identify *NEP* hands as being different from the "more conservative" *RCT* hands are the absence of the dot in the loop of *do* (characteristic 22), the circle at the branching of the *ni* (characteristic 46) and single vertical stroke of *pe* (characteristic 116).

[17] The following hands were excluded because they have a limited number of signs and this caused instability in the calculation of the phylogenetic *trees*: 124-A, 124-E; 109, 112, 120, 122, 134, 137.

We can use *trees* in Figures 3a & 3b to suggest the division of the *NEP* scribes into two groups:

- Conservative *NEP* hands: 104, 106, 107, 111, 114, 127.
- Progressive *NEP* hands: 102a, 110, 118, 123 and 125 (with 110 being the most progressive).

The feature that identifies hands 102a, 110, 112, 118, 123 and 125 as being "progressive" compared to the other *NEP* hands is the tendency to omit baselines on *qa*, *ne*, *ru*, *wo*, *ai*, *o*, *ki* and *ma* (characteristics 27, 37, 42, 68, 71, 104, 111 and 121). These baselines are generally present for *RCT* hands (although there are some exceptions, such as the absence of a baseline on *wo* for hand 124-A). The baselines are also present for the "conservative" hands of the *NEP* included in this analysis. Thus, they are a straightforward way of distinguishing between "conservative" and "progressive" hands in the *NEP*.

The feature that identifies 110 as being "more progressive" than the other major hands of the *NEP* is the absence of feet on the legs of *pu* (characteristic 82). Hand 110 also omits the top bar on *ne* (characteristic 40), however, although this is shared by hand 101, this feature does not persist amongst the Knossos hands.

Now that we have defined the characteristics that distinguish the "conservative" and "progressive" *NEP* hands, it is possible to extend the analysis to include all *NEP* hands. Thus we can divide the *NEP* hands into the following groups:[18]

- Conservative *NEP* hands: 102b, 104, 106, 107, 109, 111, 114, 120, 122, 127, 134, 137, 201, 203, 217 (with 120, 122 & 203 being the most conservative).
- Progressive *NEP* hands: 102a, 110, 112, 118, 123, 125, 204, 207, 219 (with 110 being the most progressive).

Hands 120 & 122 are identified as being "more conservative" than other *NEP* hands because of the crossing on the branches of *mo* (characteristic 25). Another "conservative" feature of hand 120 is the inclusion of a third line in the stalk of the *qi* (characteristic 32). These are both features that are representative of "more conservative" *RCT* hands. Hand 203 can be regarded as "more conservative" because it includes a dot in the *do* (characteristic 22), which is found in "more conservative" *RCT* hands and is not included by any of the major *NEP* hands.

NEP hands are characterised by the presence of a circle at the branching of the *ni* and *sa* (characteristics 46 & 50). It is worth noting that some of the "conservative" *NEP* hands are characterised by including a dot in *mi* (characteristic 117) and by having a wavy cross in *ka* (characteristic 120). We should also note the following

[18] The poor level of preservation on 8100 and 8149 makes it difficult to determine whether there is underlining on the *ru* & the form of the *o*, and so hand 206 has been excluded from the above list. The level of evidence for 225 is too little to include in the above list with confidence.

features which are characteristic of some of the *NEP* hands but which do not appear in Late Knossian style hands: internal loop in *mi* (characteristic 118); a wavy cross in *ka* (characteristic 120); seated man in *VIR* (characteristic 130).

A single tablet by hand 207 was found in the *NEP* (L 869) and there is also a tablet attributed to hand 101? (V 958). It will be demonstrated below that hands 101 and 207 clearly have a Late Knossian style. In addition, the tablet L 868 has Late Knossian features.[19]

Finally, it is important to note the separation between 102a ("progressive") and 102b ("conservative"). There are a significant number of differences between 102a & 102b; therefore, it is recommended that in future they should be treated as two separate hands.

3.2. *The Scribes of the Room of the Column Bases*

Hand 141 shows an absence of a dot in the loop of *do* and a circle at the branching of *ni* (characteristics 22 & 46). These are characteristics of the *NEP* hands but not the *RCT* hands. According to the phylogenetic modelling (Figure 3a), hand 141 ranks as conservative *NEP*. This hand sometimes includes a dot in *mi* (characteristic 117) and, as already noted, this is a characteristic of conservative *NEP* hands.

There are a few features that distinguish hand 141 from the *NEP* hands.

- *tu* has an internal detailed embellishment (characteristic 113).
- *tu* can have a stem which points to either left or right (characteristic 115; the left pointing stem is found on 364, which is attributed to hand 141?).
- The left hand vertical of the *pe* is sometimes two strokes (rather than a single stroke; characteristic 116; see Fh 341).

It is not possible to make a comparison here with the major *RCT* hands due to the absence of *tu* signs. In respect of the *pe* sign, the use of two strokes is found for the "more conservative" hands, 124-B, R, S.

Hand 222 is clearly of a similar style to hand 141; however, there are too few signs to be able to say with confidence whether it is more or less conservative.

3.3. *The Hands of the Arsenal and the Corridor of the Sword Tablets*

3.3.1. Attribution of the tablets

Hand 128: The *na* of *a-ja-me-na* on Sd 4409 is clearly different from all of the other examples of this sign written by hand 128, including the *na* in the previous word on Sd 4409. Therefore it will be assumed that this sign was written by another hand.

[19] It has already been noted in *Scribes* (p. 129) that the writing on tablet L 868 is not typical of other the *NEP* tablets.

Hand 131: The *wa* and *ra* on So 4443 are unlike those on So 4445 and So 4442, respectively. Therefore, for the purposes of this paper, the signs on So 4443 have not been included in the repertoire of hand 131.

Hand 132: 1508 and 5187 were found in the East-West Corridor and were attributed to 132? in *CoMIK*. However, this is doubted by Firth & Melena[20] because of the differences in the logograms. There are also differences between **22* on 1508 and on 4456. Therefore, the signs from 1508 and 5187 were not included in the repertoire of hand 132.

3.3.2. Phylogenetic analysis

The hands found in the Arsenal are 128, 129, 130, 131, 132 & 133. We will omit hand 129 from the present discussion because of the consistently high level of uncertainty associated with the attributions of tablets to this hand. The hands found in the Corridor of the Sword Tablets (*CoST*) are 101, 102b, 105, 126.[21]

Figures 4a & 4b show the phylogenetic *trees* that include many of the hands found in the Arsenal and *CoST*.[22] The hands 105, 126, 128, 131 can be found on the *tree* at a "chronological position" a little later than the *NEP* hand 102a but markedly earlier than the Late Knossian hands associated with the textile industry (hands 103, 115, 117, 119 etc.).

With the exception of hands 101 & 102b, the hands of the Arsenal and *CoST* essentially share the same features as the progressive *NEP* hands, i.e. there is a tendency to omit baselines on *qa*, *ne*, *ru*, *wo*, *ai*, *o*, *ki* and *ma* (characteristics 27, 37, 42, 68, 71, 104, 111 and 121). However, they do not omit feet on the legs of *pu* (characteristic 82) cf. hand 110. All the hands with *sa* include a circle at the branching.

There is one feature that is particular to the Arsenal hands, 128, 130, 133 & 202, and not seen amongst the other major hands at Knossos. For these hands, on *na* there is a small hook at the top of the main vertical stroke (characteristic 5). This is evidently a feature that was passed on to these Arsenal scribes when they were taught to write (but note that hands 129 & 131 do not show this characteristic). Similarly, hands 128 & 130 sometimes write the "sceptre" on the *o* as a continuation of the right vertical stroke (characteristic 103). Again, this characteristic is not seen amongst the other major scribal hands of Knossos.

[20] Firth & Melena 2000, p. 114 in the footnote to the table.

[21] See Firth, 2002, p. 249. We are omitting 221 as the possible scribe on Og 1527 here for the reasons set out by Firth 2002, p. 252. In addition, the above list includes 102b, rather than 102?; see the discussion on hand 102 above.

[22] These trees were used for the analysis of the Arsenal, *CoST* and the hands with the Late Knossian style. The following major hands were excluded because they have a limited number of signs which caused instability in the calculation of the phylogenetic *trees*: 108, 113, 121, 129, 130, 132, 133, 140.

It is interesting to note the markedly concave upper line on *jo* for hand 133. This characteristic is not included within the list used for the phylogenetic analysis. However, it is also a feature of hand 104, which is found at similar "chronological position" to hand 133 on Figures 4a & 4b.

As already noted, the tablets from *CoST* were written by hands 101, 102b, 105 & 126. Figure 4a & 4b would imply that the inclusion of hand 101 in this list is anomalous because it appears in a later "chronological position" in the *tree*. We will return to this in Part II, where there is a full discussion on the interpretation of the results of the phylogenetic analysis.

4. Late Knossian Linear B Style

Under this heading, we are including:

- Most of the tablets found in the West Wing (excluding those tablets found in the *RCT* and *RCB*), i.e. hands 103, 108, 113, 115, 119, 121, 135, 136, 138, 139, 140.
- Most of the tablets found in the East Wing (excluding those tablets found in *CoST*), i.e. hands 101, 117, 119, 221.[23]

4.1. *Phylogenetic Analysis*

The results of the phylogenetic analysis are given in Figures 4a & 4b.[24] The Late Knossian hands can be classified as being more progressive than the Middle Knossian because they have an increased absence of baselines on *qa*, *ne*, *ru*, *wo*, *ai*, *o*, *ki* and *ma* (characteristics 27, 37, 42, 68, 71, 104, 111 and 121) and an absence of feet on the legs of *pu* (characteristic 82) cf. hand 110. In addition, there is high proportion of hands that do not have circles at the branching of *ni* and *sa* (characteristics 46 and 50) and have no dots around the *do* (characteristic 21). The hands also have a more standardised *ra* sign with a C-shaped semi-circle facing away from the vertical.

Of these hands, the phylogenetic analysis suggests that hands 101 & 139 (and, by extension, hand 140) are more "conservative" than the others because the "sceptre" on the *o* is a loop. By contrast, for the other major hands in this group, the "sceptre"

[23] V 958 has been excluded from the list of tablets by hand 101 because it is judged to include too many sign variations compared to the other tablets by this scribe. For example, there are only two short vertical strokes on the *se* (characteristic 12), there are small dots around the *do* (characteristic 21), there is only a single horizontal mid-stroke on the *no* (characteristic 86) and the opening of the semi-circle faces down on the *ra* (characteristic 99).

[24] The phylogenetic analysis excludes hands 108, 121, 140 and 221 because they have a limited number of signs which caused instability in the calculation of the phylogenetic *trees*.

is a single vertical line (characteristic 103). In addition, hands 101 & 139 frequently include circles at the branching of *sa* (characteristic 50), whereas the other major hands do not include circles. According to the phylogenetic analysis, these two features are sufficient to place hands 101 & 139 (and, by extension, hand 140) on a separate *branch* from the other hands in this group.

If we define 101, 139 & 140 to be the more "conservative" Late Knossian hands, then it follows that the other major hands are more "progressive". One feature of some of the "progressive" hands (103, 108, 113, 115) is *me* without a vertical stroke on left (not defined as characteristic) and without short strokes on the right (characteristic 20). This combination of features does not occur on "earlier" hands.

Using the above guidance, we can also examine the minor hands and summarise the findings as follows:

- The "conservative" Late Knossian hands are 101, 139, 140, 221, 223.
- The "progressive" Late Knossian hands are 103, 108, 113, 115, 116, 117, 119, 121, 135, 136, 138, 207, 209, 214, 215, 218, 220.

4.2. *The Relationship between Knossos hands and Mainland hands*

It is worthwhile considering briefly why the phylogenetic analysis consistently places the Late Knossian Linear B hands on a separate *branch* to the hands from the Mainland. In order to give a relatively short response to this question, we will concentrate on the relationship between the Knossos hands and the most conservative Mainland hands according to the phylogenetic analysis (i.e. hands 41 & 43 from Pylos and hand 304 from Thebes).

Pylos hands 41 & 43 show several traits that could be regarded as Middle Knossian. There are baselines on the *qa*, *ru*, *wo, o*, *ma* (characteristics 27, 42, 68, 104, 121) and sometimes on the *ne* and *ai* (characteristics 37, 71). However, neither includes a circle in the branching of *ni* or *sa* (characteristics 46 & 50), which are typical of Middle Knossian hands. Furthermore, neither Pylos 41 nor 43 represents the "sceptre" on the *o* as a single stroke (characteristic 103), as would be typical of "progressive" Late Knossian hands. In addition, Pylos hands 41 & 43 both represent the "wings" of *ku* with an arc, whereas most hands at Knossos use a wavy line (characteristic 125).[25] In this way, we can understand why Pylos hands 41 & 43 have a position in the phylogenetic tree that corresponds chronologically to something later than Middle Knossian, but on a separate *branch* from "progressive" Late Knossian hands.

The tree separates after the Arsenal and *CoST* hands from Knossos. The particular feature which is characteristic of some of those hands (128 & 130) and which is

[25] The only exceptions amongst the major hands at Knossos are the Middle Knossian hands 102b & 137.

carried forward by Pylos hand 41 is writing the "sceptre" on the *o* as a continuation of the right vertical stroke (characteristic 103).

Hand 304 from Thebes also has baselines on *qa*, *ru, o* and *ma* (characteristics 27, 42, 104, 121) and it also represents the "wings" of *ku* with an arc. Thus, these are a set of features that are common to hand 304 from Thebes and hands 41 & 43 from Pylos, although this set of features is not shared with any of the Late Knossian hands. Again, this goes some way towards explaining why the phylogenetic *tree* separates Late Knossian hands from Pylos hands and from Thebes hands in the way that it does.

5. Concluding Remarks

It only remains in Part I to provide a series of tables given as an appendix to summarise all the above detail together in a coherent form.

- Table 3 lists the scribal hands corresponding to each of the stylistic groups.[26]
- Table 4 lists the hands (or individual tablets where they have not been attributed to a scribe) for each of the find-places and separates these into the different stylistic groups.
- Table 5 presents the key signs that have been highlighted and the form of the signs for each of the different stylistic groups.

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[26] The numbers of tablets corresponding to each of the stylistic groups depends on the cut-off used to define tablets that are too fragmentary to consider, but in broad terms, roughly 20% of the tablets are Early Knossian, 30% are Middle Knossian and 50% are Late Knossian.

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Table 3

EARLY KNOSSIAN		MIDDLE KNOSSIAN		LATE KNOSSIAN	
Conservative	Progressive	Conservative	Progressive	Conservative	Progressive
124-A	124-D	102b	102a	101	103
124-B	124-E	104	105	139	108
124-R	124-F	106	110	140	113
124-S	124-I	107	112	221	115
124-9	124-X	109	118	223	116
	124-1	111	123		117
	Xd 149, F 153	114	125		119
		120	126		121
		122	128		135
		127	130		136
		134	131		138
		137	132		207
		141	133		209
		201	202		214
		203			215
		217			218
					220

TABLE 4

Find-place	Early Knossian	Middle Knossian		Late Knossian	
		conservative	progressive	conservative	progressive
A				139	138
B1					X 35, 39
B2				101	
B4		217			
B5		K 700			
C	124 hands				
D					
E1		141, 222?			
E2		Uf 432			
E3					
E4					
E5					115, 136
E6		X 435			
F1		217			121
F2		X 410			121
F3		F 452, X 459; 118?		223	115, 138?, 207
F4		X 7559, 7633			
F5					
F6					113, 115
F7a					119
F7					108, 113, 115, 209, 220

TABLE 4 (CONT.)

Find-place	Early Knossian	Middle Knossian		Late Knossian	
		conservative	progressive	conservative	progressive
F8					103, 108, 135
F9					103
F10					103
F11					103
F12					
F13					103, 115
F14		Ak 640, Ap 5547, 8154			103, 115, 116, L 588
F15		120			121, 136
F16					115
F17					135
F18		106		140	103, 135
F19					103, 116?
G1				140	103
G2					103, 117?, 136
H1					Oa 732
H2					214
H3					
H4					
H5					
H7					102a?, 207?
I1		B 755			136, 227*

Table 4 (cont.)

Find-place	Early Knossian	Middle Knossian		Late Knossian	
		conservative	progressive	conservative	progressive
I2 & I3		102b, 104, 106, 107, 109, 111, 114, 120, 122, 127, 134, 137, 201, 203, 217	102a, 110, 112, 118, 123, 125, 204, 219	101?	136?, 207 L 868
I4		Ap 769, B 772			
I6					
J1					117, 119
J2				101	
J2bis					
J3		102b	105, 126	101	
J4				221	
K					
K1		102b			117?, 135?, 215
Arsenal			128, 130, 131, 132, 133		
Arsenal vicinity		U 8210, X 8213; 118?			
Little Palace					
Unexplored Mansion					

Notes:
1. There was insufficient data to give guidance for the find-places omitted from the above table.
2. Hand 227 is defined to be the inscriber of tablets Ai(2) 762, Od 765, 7312, 7326, 7779, 8628 (Firth & Melena, this volume).
3. It has been assumed here that V 756 (hand 125) was found in the NEP (and not the Room of the Bügelkannes). See Firth 2002, p. 97, Driessen 2000, p. 37 FN.
4. NEP scribes [1] are defined here to be 102b, 104, 106, 107, 109, 111, 114, 120, 122, 127, 134, 137, 201, 203, 217 and NEP scribes [2] are defined here to be 102a, 110, 112, 118, 123, 125, 204, 219, 101?

TABLE 5

Characteristic	Early Knossian		Middle Knossian		Late Knossian	
	conservative	progressive	conservative	progressive	conservative	progressive
5 NA						
19 ME						
21, 22 DO						
25 MO						
27 QA						
32 QI						
37, 38, 40 NE						
42 RU						
46, 49 NI						
50 SA						
59 JO						

TABLE 5 (CONT.)

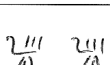
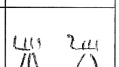
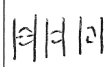
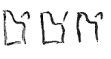
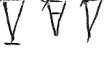
Characteristic	Early Knossian		Middle Knossian		Late Knossian	
	conservative	progressive	conservative	progressive	conservative	progressive
68, 69 WO						
71 AI						
82 PU						
95 NU						
103, 104 O						
109, 111 KI						
113, 115 TU						
116 PE						
117, 118 MI						
120 KA						
121 MA						

TABLE 5 (CONT.)

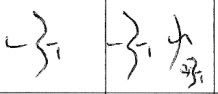
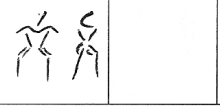
Characteristic	Early Knossian		Middle Knossian		Late Knossian	
	conservative	progressive	conservative	progressive	conservative	progressive
127 KU						
130 VIR						

Fig. 1a UNWEIGHTED TREE (1st tree of 2)
Tree length = 789
Consistency index (CI) = 0.3676
Homoplasy index (HI) = 0.6324
Rescaled consistency index (RC) = 0.2096

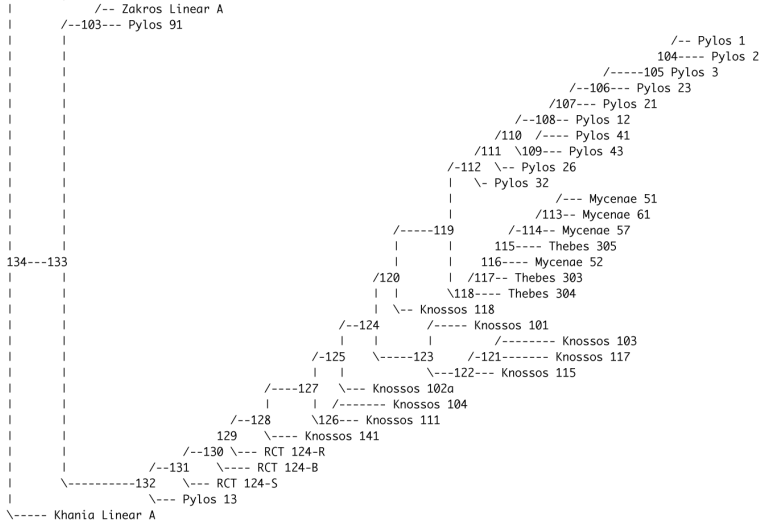


Fig. 1b WEIGHTED TREE
Tree length = 167.85438
Consistency index (CI) = 0.5719
Homoplasy index (HI) = 0.4281
Rescaled consistency index (RC) = 0.4209

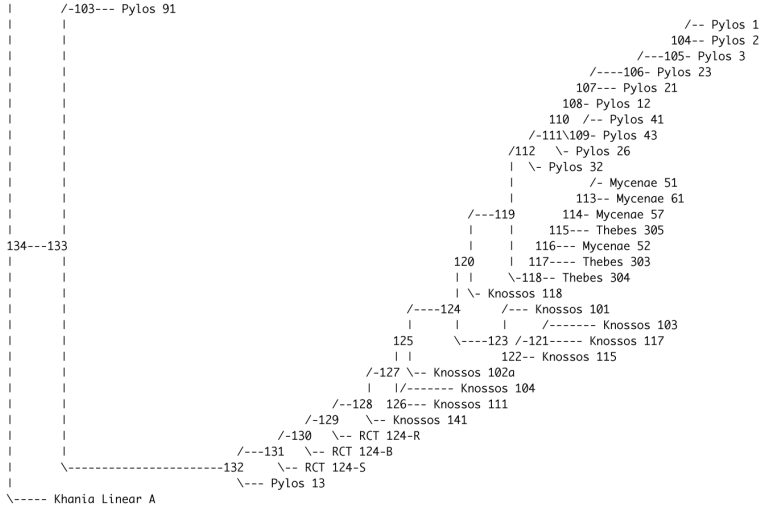


FIG. 2a UNWEIGHTED TREE (1st tree of 3)
Tree length = 830
Consistency index (CI) = 0.3518
Homoplasy index (HI) = 0.6482
Rescaled consistency index (RC) = 0.2015

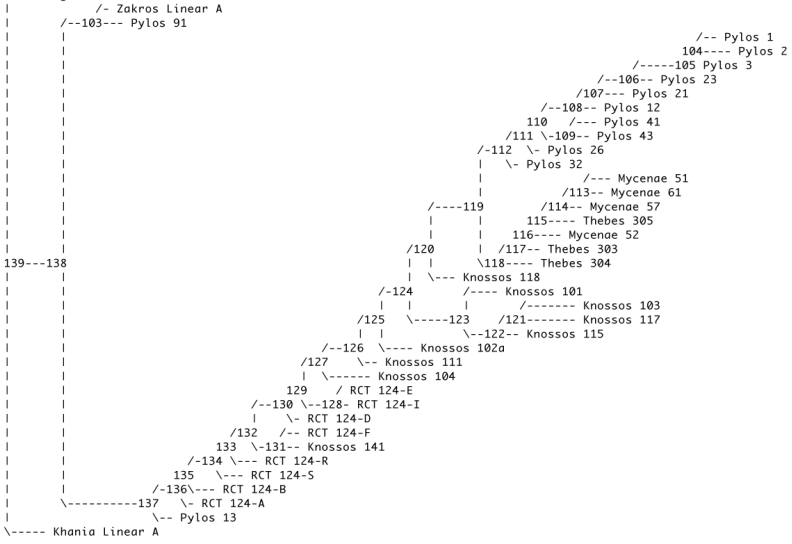


FIG. 2b WEIGHTED TREE
Tree length = 173.51703
Consistency index (CI) = 0.5471
Homoplasy index (HI) = 0.4529
Rescaled consistency index (RC) = 0.3948

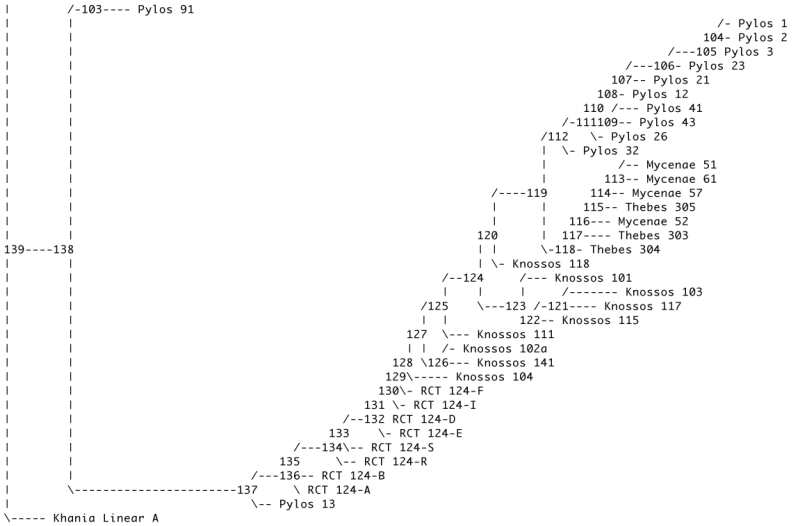


FIG. 3a UNWEIGHTED TREE (1st tree of 17)
Tree length = 874

FIG 3b WEIGHTED TREE
Tree length = 170.36281

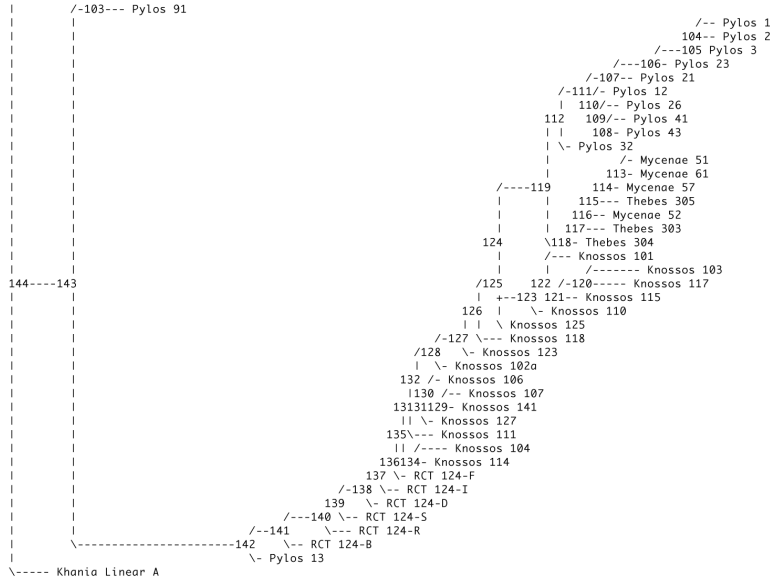


FIG 4a UNWEIGHTED TREE (1st tree of 6)

FIG. 4b WEIGHTED TREE (1st tree of 3)