

# How the Voynich Manuscript was created

Torsten Timm  
torsten.timm@kereti.de

**Abstract:** The Voynich manuscript is a medieval book written in an unknown script. This paper studies the relation between similar spelled words in the Voynich manuscript. As main result, the text generation method used will be disclosed.

**Keywords:** Voynich manuscript, word grid, text generation method

## 1 Introduction

The Voynich manuscript, rediscovered by Wilfrid Voynich in 1912, contains a text in an unknown script (see figure 1) as well as exotic illustrations of unidentifiable plants, cosmological charts, astronomical symbols and bathing women. The author, the purpose and the origin of the manuscript are still unknown. The manuscript consists of 240 parchment pages. The parchment was carbon-dated to the early 15<sup>th</sup> century [see Stolte]. The style of the illustrations is that of medieval Europe. The script uses 20-30 different glyphs. The exact number is uncertain since it is unclear whether some of the glyphs are distinct characters or a ligature of two other characters. The text is written from left to right and apparently divided by spaces into words. For a more detailed introduction see the paper "What We Know About The Voynich Manuscript" by Reddy and Knight [see Reddy].

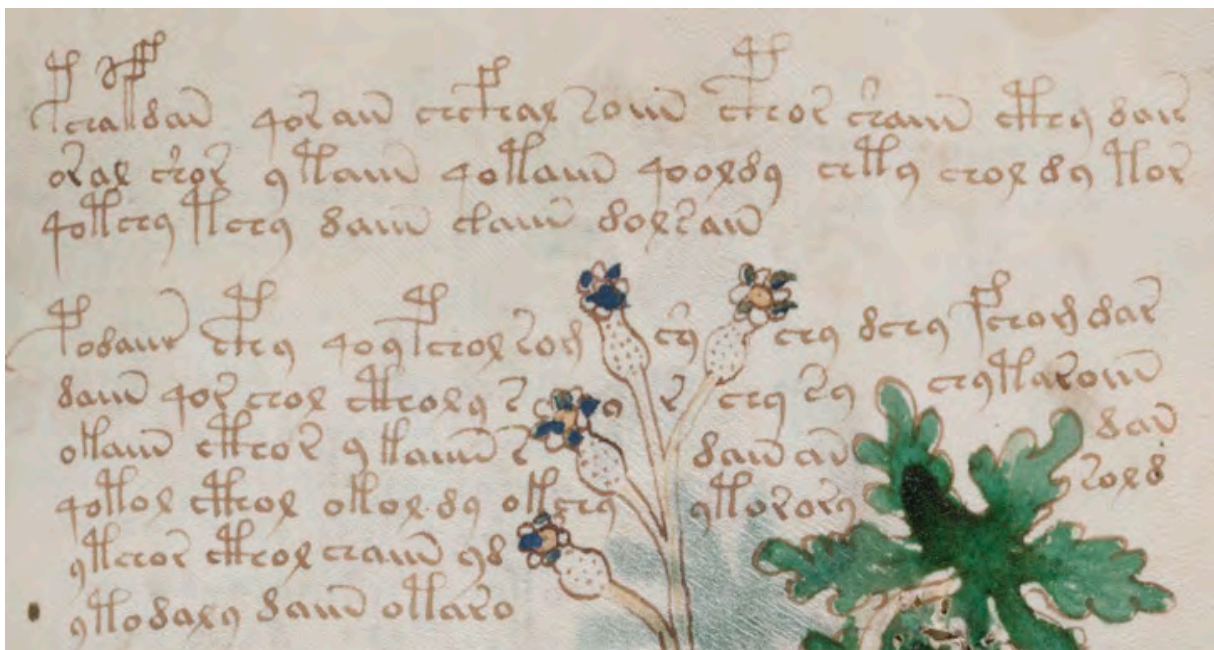


Figure 1: part of page <f36r><sup>1</sup>

<sup>1</sup> High-resolution scans are available at <http://www.jasondavies.com/voynich/>

The Voynich manuscript, also referred to as the VM, raises several unanswered questions. The main question is whether the text within the manuscript contains a message in an unknown or constructed language, an encoded message using an unknown cipher system or whether it is a pseudo text containing no message at all. Some statistical features of the text correspond to a natural language whereas others do not. For instance, the number of different glyphs and their frequency distribution indicate an alphabetical script. The word frequency distribution also behaves as expected according to Zipf's law. This law was proposed by Georg Zipf in 1935 and makes predictions about the word frequencies for a text using natural language. For instance, it predicts that the second most frequent word will occur approximately half as frequently as the most frequent word. The word length distribution in the manuscript follows a binomial distribution with an underrepresentation of short and long words, an unusual characteristic in a natural language.<sup>2</sup> One possible explanation for this is, indeed, that the manuscript contains text in a constructed language.<sup>3</sup> It could, however, feasibly be argued that the manuscript does contain a natural language but that short words were not always given their own boundaries and long words are rare because vowels were omitted.

Although the text reveals numerous semantic patterns, no one has been able to read it or to decipher the script in the last hundred years. One hypothesis, therefore, is that the VM is a medieval hoax containing a meaningless text. However, there are some good reasons for refuting such a hypothesis. It seems unlikely that anybody in the 15<sup>th</sup> century would have had the knowledge to simulate numerous language-like patterns. Furthermore, there would have been no need for a medieval forger to simulate statistical patterns of which nobody at the time was aware.

## 2 Repeated word sequences

An important initial task when deciphering an unknown script is to describe the most characteristic properties and to determine interesting patterns. Gunther Ipsen described this task in 1954 as: "Deciphering always begins with a determination of the object. This is initially a simple description of what is. If this description is conducted with

---

<sup>2</sup> The length of the words is equally distributed around the arithmetical mean [see Stolfi]. The average word length is 5.5. Such a distribution is unusual because natural languages tend to make frequent use of short words. Typical for a natural language is therefore an asymmetric distribution.

<sup>3</sup> The cryptographer William F. Friedman (1891-1969) suggested: "The Voynich MSS was an early attempt to construct an artificial or universal language of the a priori type."

care and attention and observes not only that which is close and obvious but also the small and delicate features of the object, then this description becomes a determination which recognizes the individual element as something distinctive; it penetrates." [Ipsen: p. 421, own translation].<sup>4</sup>

The text of the VM seems to be unique because repetitive phrases are missing. On the one hand, it is possible to describe adjacency rules on the letter level. There are, for instance, typical letter combinations but also letter combinations that never occur. On the other hand, there are no similar rules on the word level. Only a few repetitive phrases can be found. There are only 35 word sequences, which use at least three words and appear at least three times.<sup>5</sup> Only for five of these sequences is the word order unchanged for the whole manuscript, whereas for 30 out of 35 phrases the word order does change.<sup>6</sup> Does this mean, that it is simply coincidence that these five sequences did not appear in a different order? An additional observation is that in 24 out of 35 cases these repeated sequences use at least two words which are either spelled the same or very similarly. Does that mean that they are only repeated because they use similar words? For instance, the words  $\epsilon\omicron\gamma$  ("chol")<sup>7</sup>,  $\acute{\epsilon}\omicron\gamma$  ("shol") and  $\mathcal{H}\omicron\gamma$  ("cthol") occur together three times.<sup>8</sup> Each time, the word order is different:

<f1v.P.6>      $\epsilon\omicron\gamma \mathcal{H}\omicron\gamma \acute{\epsilon}\omicron\gamma$  ("chol cthol shol")  
<f4r.P.2>      $\epsilon\omicron\gamma \acute{\epsilon}\omicron\gamma \mathcal{H}\omicron\gamma$  ("chol shol cthol")  
<f42r.P2.10>  $\mathcal{H}\omicron\gamma \epsilon\omicron\gamma \acute{\epsilon}\omicron\gamma$  ("cthol chol shol")

In a text using human language grammatical relations should exist between words, and these relations should result in words used together multiple times. Therefore, the lack of repetitive phrases is surprising for a whole book containing more than 37,000 words. Is it possible to find an explanation for the observed weak word order in the VM?

---

<sup>4</sup>Original: "Jede Entzifferung hebt mit der Bestimmung ihres Gegenstandes an. Das ist zunächst schlichte Beschreibung dessen, was ist. Wenn dies Beschreiben sorgfältig und aufmerksam erfolgt, daß es nicht nur das Nächste bemerkt, das offen liegt, sondern auch die feinen und kleinen Züge am Sosein des Gegenstandes, dann geht die Beschreibung in Bestimmung über, die das Einzelne als Besonderes erkennt; sie wird eindringlich." [Ipsen: p. 421].

<sup>5</sup>Transcription by Takeshi Takahashi [Takahashi].

<sup>6</sup>See addendum: I. Repeated sequences using the same words (p. 30).

<sup>7</sup>By using the EVA alphabet it is possible to write the VM-word  $\epsilon\omicron\gamma$  as "chol". The EVA alphabet, created by René Zandbergen and Gabriel Landini, can be used to analyse the text and to name the VM-words [see Zandbergen]. The letters do not give any information about the meaning of the corresponding VM glyph.

<sup>8</sup>Two more similar phrases exist:  $\epsilon\omicron\gamma \acute{\epsilon}\omicron\gamma \mathcal{H}\omicron\gamma$  ("chor shor cphor") in line <f17r.P.5> and  $\epsilon\omicron\gamma \mathcal{H}\omicron\gamma \acute{\epsilon}\omicron\gamma$  ("chol cphol shol") in line <f100r.P2.6>. This observation fits the hypothesis that phrases are repeated because they contain words similar to each other.

### 3 A word grid

A closer look at the VM gives the impression that similarly spelled words occur frequently above each other.<sup>9</sup> Does this mean that there is a relation between words spelled similarly? The starting point for the following considerations is the examination of the connection between words spelled similarly. The most frequently used words are  $\delta a u \omega$  ("daiin" occurring 863 times),  $o \gamma$  ("ol" occurring 537 times) and  $\tau c \delta \eta$  ("chedy" occurring 501 times). Hence, it is possible to group the words according to their similarity and frequency:

#### $\delta a u \omega$ -series

daiin (863 times) | aiin (469 times) | dain (211 times) ...  
qokain (279) | qokaiin (262) | okaiin (212) | otaiin (154) ...

#### $o \gamma$ -series

ol (537) | or (363) | dol (117) ...  
ar (350) | dar (318) | al (260) | dal (253) ...  
chol (396) | cheol (172) ...

#### $\tau c \delta \eta$ -series

chedy (501) | chey (344) | cheey (174) ...  
shedy (426) | shey (283) | sheey (144) ...  
qokeedy (305) | qokedy (272) | otedy (155) ...  
qokeey (308) | okeey (177) | qoky (147) ...

At first glance, it seems possible to describe at least two different groups of glyphs. The first group contains glyphs handled like vowels, while the second group of glyphs is handled like consonants:

I)  $o \ a \ e \ i \ y$  (o, a, e, i, y)

II)  $\tau \ z \ \nu \ \rho \ \sigma \ \xi \ \delta \ \eta \ \theta \ \kappa \ \lambda \ \mu \ \nu \ \omega$  (ch, sh, n, r, s, l, d, m, q, k, t, p, f)

An interesting observation is that glyphs from group II are rarely consecutive. There is at least one exception to this rule. Before and after  $\gamma$  ("l") glyphs from group II are also allowed.

In most cases similar spelled variants of a glyph group exists. Sometimes the only difference between two glyph groups is an additional quill stroke. This is the case, for instance, for  $\delta a u \omega$  ("daiin") and  $\delta a \omega$  ("dain"). In other cases, similarly shaped glyphs replace each other.<sup>10</sup> One example of such a case is  $\omega \tau a i i n$  ("okaiin") and  $\omega \tau a i i n$  ("otaiin"). It is interesting that for  $\kappa$  ("k") and  $\tau$  ("t") two other similarly shaped glyphs occur

<sup>9</sup> Example: See  $\tau \omega \omega$ ,  $\tau \omega \gamma$  and  $\tau \omega \delta$  above each other in figure 1 lower left half.

<sup>10</sup> See also the glyph relation chart by Sean B. Palmer [Palmer].

within the VM. These glyphs are ꝥ ("f") and ꝧ ("p").<sup>11</sup> Surprisingly, similarly spelled words such as ꝧꝧꝧ ("opaiin") and ꝧꝧꝧ ("ofaiin") also occur within the VM. This raises the question as to whether there is a connection between similarly spelled words?

Based on the observation that it is possible to generate other words, which exist in the VM, by replacing similar shaped glyphs, it is possible to list the following rules:

- "i", "ii" and "iii" can replace each other (i - ii - iii)
- "e", "ee" and "eee" can replace each other (e - ee - eee)
- "ee" and "ch" can replace each other (ee - ch)
- "ch" and "sh" can replace each other (ch - sh)
- "o" and "a" can replace each other (o - a)
- "o" and "y" can replace each other (o - y)
- "d", "l", "m" and "r" can replace each other (d - l - m - r)
- "n", "r" and "s" can replace each other (n - r - s)
- "k", "t", "p" and "f" can replace each other (k - t - p - f)
- "chk", "eke" and "ckh" can replace each other (chk - eke - ckh)

These rules for similar glyphs only apply with some restrictions. For instance o and y can replace each other only as the first or as the last sign. Another example is that it seems that o ("o") is not interchangeable with a ("a") after ꝥ ("q") or before ꝧ ("k"). Additionally, prefixes such as ꝧo ("qo"), l ("l") or ch ("ch") are common for the VM-words. After such a prefix, the following glyph ch ("ch") or d ("d") commonly changes into ꝧ ("k"). Furthermore, it is possible to delete a glyph, if this leads to a valid VM-word. But although it is possible to describe such rules, in most cases it is also possible to find at least one exception for them. For instance it is possible to find strange words like daisn ("daisn"), oꝧꝧꝧ ("oꝧaiin"), ꝧꝧꝧꝧꝧꝧꝧꝧ ("okeokeokeody") and ꝧꝧꝧꝧꝧꝧꝧꝧ ("otkchedy").<sup>12</sup> Such words usually occur only once.

With this set of rules, it is possible to build a "grid" for the VM-words. For a grid containing all words occurring at least four times and covering 80% of the VMS-text see addendum: V. Grid (p. 52). It is surprising that in most cases all conceivable spelling permutations of a glyph group exist. If there is a gap, such as the missing word doir ("doir") for the

---

<sup>11</sup> Regarding ꝧ and ꝧ an interesting observation was published by D'Imperio in 1980. A sequence of glyphs is repeated four times on folio <f57r>. "In two instances ꝧ with only one loop occurs ... while in the other two, we see ꝧ with two clear loops in the corresponding position. Since all the other symbols appear identical, the conclusion seems inescapable that the single- and double-looped forms are functionally the same" [D'Imperio: p. 24f].

<sup>12</sup> daisn occurs in line <f102v1.P1.2>, oꝧꝧꝧ in line <f103v.P.18>, ꝧꝧꝧꝧꝧꝧꝧꝧꝧ in line <f71r.R1.1> and ꝧꝧꝧꝧꝧꝧꝧꝧꝧ can be found in line <f104.P.17>.

$\delta_{\text{a}\text{v}}\text{v}$ -series, this can be explained by the fact that words similarly spelled to  $\delta_{\text{a}\text{v}}\text{v}$  also occur only a limited number of times. Moreover, it is possible to describe relations for words using similar glyphs. For instance, in most cases, words with  $\text{c}^2$  ("sh") are less frequent than the corresponding variant using  $\text{c}$  ("ch"). Also words using  $\text{p}^{\text{f}}$  ("p") or  $\text{f}^{\text{p}}$  ("f") instead of  $\text{k}^{\text{p}}$  ("k") and  $\text{t}^{\text{p}}$  ("t") are generally less frequent. Similar relations can be described for words using  $\text{a}$  ("a") instead of  $\text{o}$  ("o"),  $\text{ee}$  ("ee") instead of  $\text{e}$  ("e") etc. Furthermore, it seems that if a word is spelled similarly to  $\delta_{\text{a}\text{v}}\text{v}$  ("daiin"),  $\text{o}\text{v}$  ("ol") or  $\text{cc}\delta\text{g}$  ("chedy"), it is more frequent than a word, which is spelled less similar. To quantify this effect, the edit distance (ED), defined as the number of steps required to transform two words into each other, can be used.<sup>13</sup> For instance, it is possible to transform  $\delta_{\text{a}\text{v}}\text{v}$  ("daiin") into  $\delta_{\text{a}\text{v}}\text{v}$  ("dain") by deleting one  $\text{v}$  glyph and into  $\delta_{\text{a}\text{v}}\text{v}^2$  ("dais") by deleting an  $\text{v}$  and by replacing  $\text{v}$  with  $\text{v}^2$ . Therefore, the edit distance between  $\delta_{\text{a}\text{v}}\text{v}$  ("daiin") and  $\delta_{\text{a}\text{v}}\text{v}$  ("dain") is one, whereas the edit distance between  $\delta_{\text{a}\text{v}}\text{v}$  ("daiin") and  $\delta_{\text{a}\text{v}}\text{v}^2$  ("dais") is two.

### $\delta_{\text{a}\text{v}}\text{v}$ - or $\text{v}$ -series

daiin (863)	aiin (469)	dain (211)	ain (89)	ED=0/1/1/2
daiir ( 23)	aiir ( 23)	dair (106)	air (74)	ED=1/2/2/3
daiim ( 5)	aiim ( 3)	daim ( 11)	aim ( 7)	ED=1/2/2/3
daiis ( 5)	aiis ( 3)	dais ( 4)	ais ( 1)	ED=1/2/2/3
daiil ( 1)	aiil ( 1)	dail ( 2)	ail ( 5)	ED=1/2/2/3

Obviously the relationship between edit distance and frequency of a word is not without exceptions. For instance,  $\delta_{\text{a}\text{v}}\text{v}^2$  ("dair" ED=2) is more frequent than  $\delta_{\text{a}\text{v}}\text{v}^2$  ("dair" ED=1). However, this exception also applies to  $\delta_{\text{a}\text{v}}\text{v}^{\text{f}}$  ("daim" ED=2), since  $\delta_{\text{a}\text{v}}\text{v}^{\text{f}}$  is also more frequent than  $\delta_{\text{a}\text{v}}\text{v}^{\text{f}}$  ("daiim"). A similar behavior can be observed for the  $\text{o}\text{v}$ -series, where it is also not possible to explain that  $\text{a}\text{v}^2$  ("ar") is more frequent than  $\text{a}\text{v}$  ("al") based on the edit instance alone. And this pattern is also repeated for similarly spelled glyph groups. For instance,  $\delta_{\text{a}\text{v}}\text{v}^2$  ("dar") is also more frequent than  $\delta_{\text{a}\text{v}}\text{v}^2$  ("dal"), and  $\text{v}\text{a}\text{v}^2$  ("sar") is more frequent than  $\text{v}\text{a}\text{v}$  ("sal").

These observations make it possible to predict the occurrence and the frequency of similarly spelled words. For instance, if it is known that  $\text{cc}\delta\text{g}$  ("chedy") is frequent, it is possible to predict that  $\text{c}^2\text{c}\delta\text{g}$  ("shedy") is also frequently used although less frequently than  $\text{cc}\delta\text{g}$ . And if we know that  $\text{g}\text{c}\text{c}\text{g}$  ("ychy") only occurs four times it is possible to predict that a glyph group

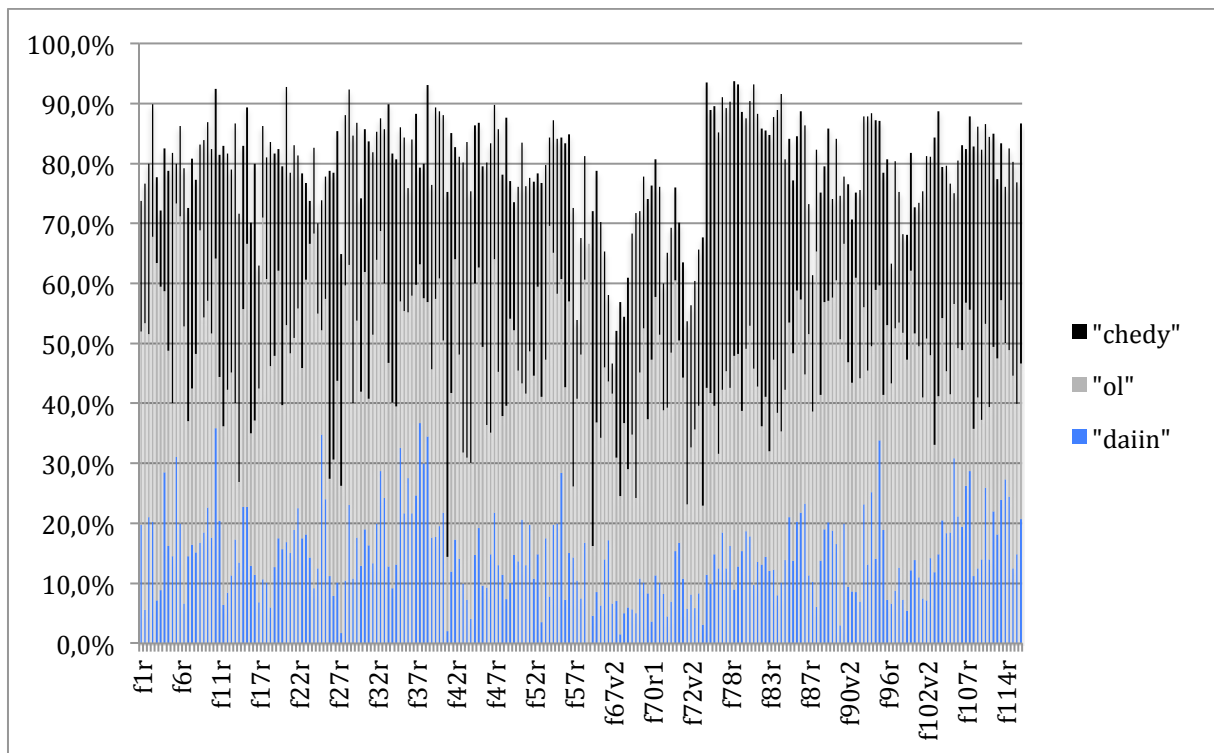
<sup>13</sup>To consider the peculiarities of the VM script, the edit distance is defined as follows: If a glyph is deleted, added or replaced by a similar glyph, this is counted as one change. Also, the change from  $\text{ee}$  into  $\text{c}$  or from  $\text{c}^2$  or  $\text{c}^{\text{f}}$  into  $\text{c}$  is counted as one change. If a glyph is replaced by a non-similar glyph, this is treated as deleting one glyph and adding another glyph. This is counted as two changes.



օւշ ( "ochy" ) should also exist and that the groups զւծ ( "ychdy" ), զշ ( "yshy" ) and օւշշ ( "osheedy" ) probably occur less than four times.

The grid reveals that the words of the VM are connected to each other. It is possible to generate another word from the word pool by replacing a glyph by a similar one, or by adding or deleting a glyph. How was it possible to construct a language with "generated" words and to write a text containing over 37,000 words with determinable word frequencies? Was the scribe counting the words he was writing? This seems very unlikely. A better explanation would be the assumption that it is an unintended side effect of the manufacturing or encoding process that similarly spelled words occur with predictable frequencies.

#### 4 Labels



Graph 1: proportion of words of the ծաւ ( "daiin" ), օլ ( "ol" ) and լւծ ( "chedy" ) series in %

Graph 1 shows the proportion of words related to ծաւ ( "daiin" ), օլ ( "ol" ) and լւծ ( "chedy" ) for all pages of the manuscript.<sup>14</sup>

<sup>14</sup>The fact that a word is not part of the grid only means that this word occurs less than four times. For words occurring three times or less, transcription problems get more important. The number of samples that could be checked for related words close by is limited for them. Since it is very

The proportion of words related to  $\delta\alpha\omega\omega$  is around 15%. The mean value for words related to  $\omicron\zeta$  ("ol") and  $\tau\epsilon\epsilon\delta\eta$  ("chedy") is 33% and 31%, respectively. This means that words of the  $\omicron\zeta$ - and  $\tau\epsilon\epsilon\delta\eta$ -series are used twice as frequently as words of the  $\delta\alpha\omega\omega$ -series. A possible explanation for this distribution is that there are also twice as many spelling variations for the  $\omicron\zeta$ - and  $\tau\epsilon\epsilon\delta\eta$ -series.<sup>15</sup>

There are pages where words of a particular series are frequently used and pages where they are rare.<sup>16</sup> Graph 1 also shows that the number of words which are part of the grid decreases for the pages from <f67r1> to <f73v>. These pages belong to the Cosmological section and to the section with Zodiac illustrations. Since the grid contains all words used at least four times, this means that more unique and rare words occur on these pages.

The figures used in the Cosmological and Zodiac section are named by using labels. It is interesting that on some pages it seems that some labels are "generated" by replacing glyphs with similarly shaped ones. Page <f70v2> provides an example of this:

<f70v2.S1.1>	$\omicron\tau\alpha\tau\alpha\zeta$	("otara1")
<f70v2.S1.2>	$\omicron\tau\alpha\tau\alpha\tau$	("otalar")
<f70v2.S1.3>	$\omicron\tau\alpha\tau\alpha\eta$	("otalam")
<f70v2.S1.4>	$\delta\omicron\zeta\alpha\tau\alpha\eta$	("dolaram")
<f70v2.S1.5>	$\omicron\tau\alpha\tau\alpha\eta$	("okaram")
<f70v2.S1.8>	$\omicron\tau\alpha\zeta\delta\alpha\zeta$	("okaldal")

There is another interesting observation for page <f70v2>. In line <f70v2.R3.1> a word  $\omicron\tau\epsilon\omicron\tau\epsilon\eta$  ("oteotey") and a word  $\omicron\tau\epsilon\omicron\tau\epsilon\omicron\tau\epsilon\omicron\tau\epsilon\omicron$  ("oteoteotsho") did occur. The repetition of  $\omicron\tau\epsilon$  within both words is probably not a coincidence since the first word occurs only four times and the second word is unique.

<f70v2.R3.1>	$\omicron\tau\epsilon\eta$ ... $\omicron\tau\epsilon\omicron\tau\epsilon\eta$ ... $\omicron\tau\epsilon\omicron\tau\epsilon\omicron\tau\epsilon\omicron$
<f71r.R1.1>	$\omicron\tau\epsilon\eta$ ... $\omicron\tau\epsilon\omicron\tau\epsilon\eta$ ... $\omicron\tau\epsilon\omicron\tau\epsilon\omicron\tau\epsilon\omicron\delta\eta$

---

time-consuming to add rare words to the grid, the author has limited his research to words that occur four times and more.

<sup>15</sup> For the  $\delta\alpha\omega\omega$ -series, 384 spelling variants (4,7%) were found. For the  $\omicron\zeta$ -series, 997 spelling variants (12,3%) and for the  $\tau\epsilon\epsilon\delta\eta$ -series, 958 variants (11,8%) were found.

<sup>16</sup> For instance the maximum proportion for words of the  $\delta\alpha\omega\omega$ -series is 37% on page <f37v>. The minimum is on page <f27v>. On this page and for this series only the glyph group  $\delta\alpha\omega\delta\eta$  ("daidy") occurs in line <f27v.P.2>. The maximum use of words of the  $\omicron\zeta$ -series is on page <f54r> and is 62%, and for the  $\tau\epsilon\epsilon\delta\eta$ -series on page <f41r> it is 61%.



Furthermore, on page <f71r> a similar duplication pattern using  $\sigma\kappa$  did occur. In this case, the unique words  $\sigma\kappa\sigma\eta$  ("okeoky") and  $\sigma\kappa\sigma\kappa\sigma\kappa\sigma\eta$  ("okeokeokeody") did occur.<sup>17</sup> These observations raise the question as to whether the generating mechanism for labels is less complex and therefore easier to reveal. Maybe the scribe was focused on arranging the text in circular form.

An indication that labels were generated during writing is the use of some identical labels in the astronomical and in the herbal section. These labels are  $\sigma\kappa\alpha\eta$  ("okary"),  $\sigma\kappa\eta$  ("oky"),  $\sigma\kappa\alpha\gamma\alpha\eta$  ("otalam"),  $\sigma\kappa\epsilon\sigma\eta$  ("okeoly"),  $\sigma\kappa\alpha\gamma\eta$  ("otaly"),  $\sigma\kappa\sigma\eta$  ("otoky"),  $\sigma\kappa\alpha\gamma\sigma\eta$  ("otaldy"),  $\sigma\kappa\alpha\eta$  ("otal"),  $\sigma\kappa\sigma\eta$  ("otal"),  $\gamma\kappa\epsilon\sigma\eta$  ("ykeody"),  $\sigma\kappa\epsilon\sigma\eta$  ("okeody"),  $\sigma\kappa\epsilon\sigma$  ("okeos"),  $\sigma\kappa\sigma\eta$  ("otory"),  $\sigma\kappa\sigma\eta$  ("okody") and  $\sigma\kappa\alpha\omega$  ("oran").<sup>18</sup> One would at least not expect several stars or star constellations to be named after plants or parts of plants. Moreover, some similarly spelled labels occur together in both sections.<sup>19</sup> A possible explanation for this observation is that these labels depend on each other.

## 5 Context dependency

In the VM it is noteworthy that many words look similar to a word written one or two lines above. To quantify this effect it is possible to calculate the number of times a word occurs twice within the same line and within previous lines.<sup>20</sup> Graph 2

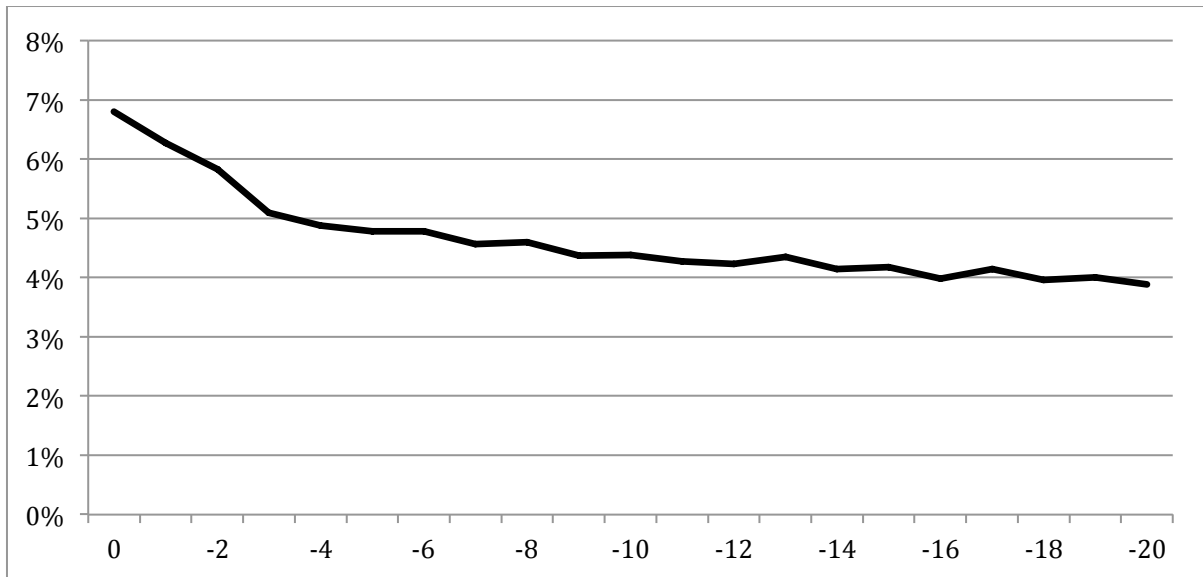
<sup>17</sup>The repetition pattern for  $\sigma\kappa$  and  $\sigma\kappa$  occurs on four pages within the Astronomical and Zodiac section. In line <f68v1.C.2>  $\sigma\kappa\eta$  ...  $\sigma\kappa\sigma\kappa\eta$ , in line <f70v2.R3.1>  $\sigma\kappa\eta$  ...  $\sigma\kappa\sigma\kappa\eta$  ...  $\sigma\kappa\sigma\kappa\sigma\kappa\eta$ , on page <f71r> in line <f71r.R1.1>  $\sigma\kappa\eta$  ...  $\sigma\kappa\sigma\kappa\eta$   $\sigma\kappa\epsilon\sigma\eta$  ...  $\sigma\kappa\sigma\kappa\sigma\kappa\sigma\eta$  ...  $\sigma\kappa\epsilon\sigma\eta$  together with  $\sigma\kappa\sigma\kappa\eta$  in line <f71r.S1.9> and in line <f72v2.R2.1>  $\sigma\kappa\eta$  ...  $\sigma\kappa\sigma\kappa\eta$   $\sigma\kappa\epsilon\sigma\eta$ . The two glyph groups  $\sigma\kappa\sigma\kappa\sigma\kappa\eta$  and  $\sigma\kappa\sigma\kappa\sigma\kappa\sigma\eta$  are the only groups which contain three instances of the same gallow glyph.

<sup>18</sup>See addendum: II. Labels (p. 34).

<sup>19</sup>For instance the labels  $\gamma\kappa\epsilon\sigma\eta$  ("ykeody") and  $\sigma\kappa\epsilon\sigma\eta$  ("okeody") are used together on page <f69v>, <f73v> and <f102v>.  $\gamma\kappa\epsilon\sigma\eta$  is used in line <f69v.L.16>, <f73v.S1.7> and <f102v1.L1.1> and  $\sigma\kappa\epsilon\sigma\eta$  occurs on <f69v.L.23>, <f73v.S1.8> and <f102v1.L1.2>. Also  $\sigma\kappa\alpha\eta$  ("okary") - occurring in line <f72v3.S2.8>, <f73r.S2.2> and <f99r.L1.1> - and  $\sigma\kappa\eta$  ("oky") - occurring in line <f72v3.S2.3>, <f73r.S2.5> and <f99r.L1.3> - are used together on three pages.

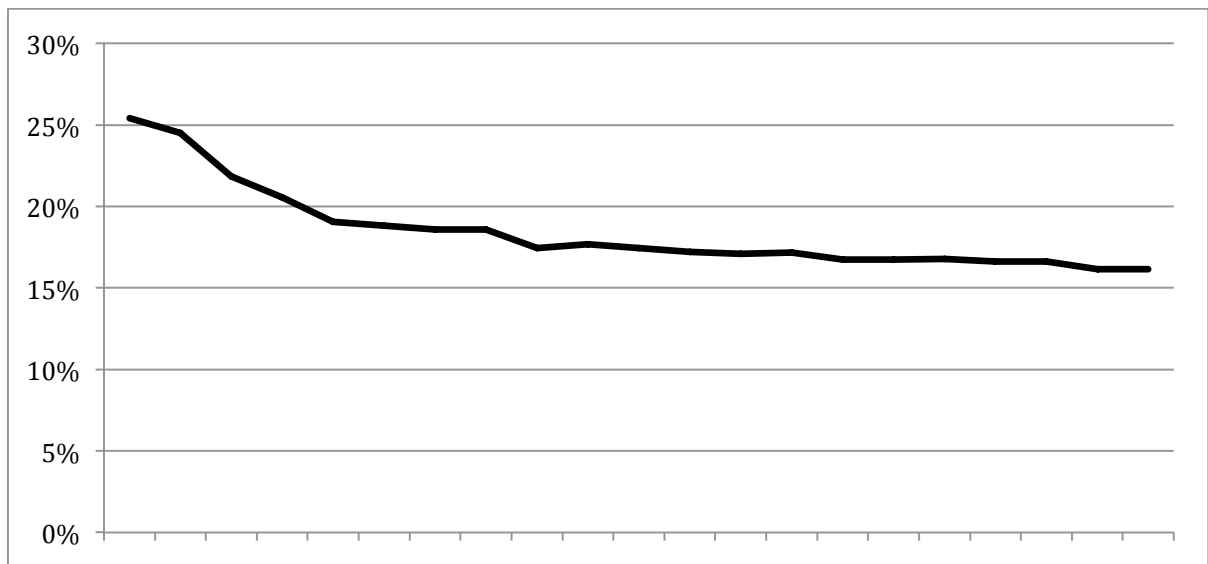
<sup>20</sup>See addendum: VI. Statistics for graph 2 (p. 69). Single letter words are eliminated from this calculation. Additionally, the whole book is treated as a unit. Therefore, the first line of a page is compared with the last line of the previous page and so on. Even if a word occurs multiple times within the start-line it is only compared once with previous lines. For the first line, on average only 50 % of that line remains to search for a word pair. To obtain a comparable result the number of occurrences for repeated words is counted. Example: If, in consecutive lines, a word occurs multiple times within each line, the repeated word count is two for every line in which a word occurs twice, three for every line in which a word occurs three times and so on.

shows that there is a peak of repeated words for three consecutive lines. In other words, if a word appears in one line there is an increased chance that this word will also appear within one of the next three lines.



Graph 2: repeated words within the previous 20 lines for each line of the VM

This effect increases if similar words are compared (see graph 3). For the following calculation, glyph groups with an edit distance of one are regarded as similar.<sup>21</sup>

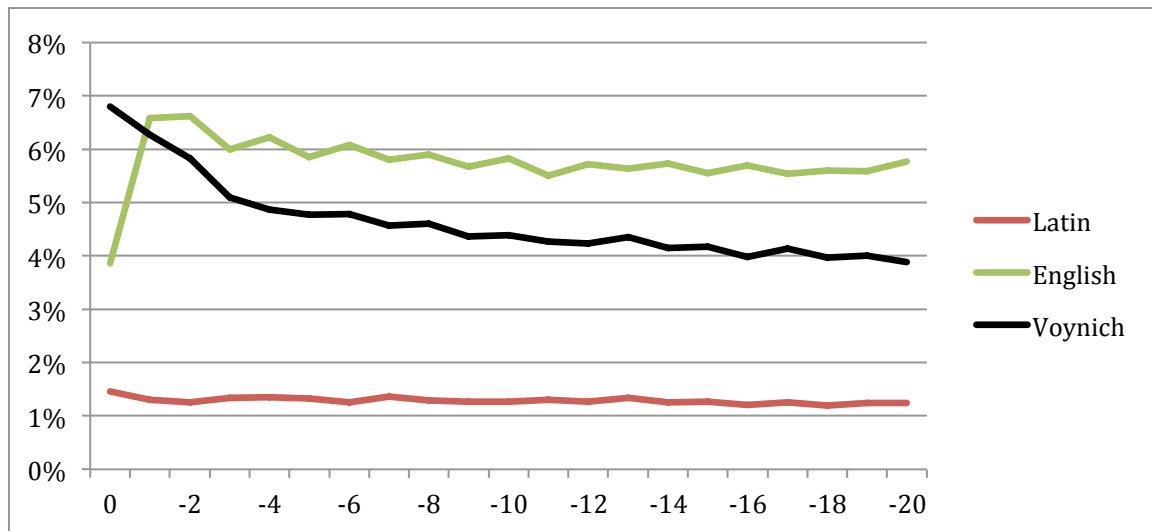


Graph 3: similar words within the previous 20 lines for each line of the VM

As shown in graph 4, the level of repeated words for a Latin text<sup>22</sup> is lower than it is for the VM.

<sup>21</sup>See addendum: VII. Statistics for graph 3 (p. 69). To use an elementary algorithm to calculate the edit distance it is accepted that the edit distance between  $\epsilon$  ("ee") and  $\sigma$  ("ch") is calculated as two.

<sup>22</sup>The Aeneid by Virgil 80-19 BC



Graph 4: repeated words within the 20 lines for the VM an Latin and an English text

Latin as an inflecting language uses markers like suffixes to express different grammatical functions. Therefore, the number of repeated words is very small for Latin. The level of repeated words in an English text<sup>23</sup> is comparable to the VM. The increase in repeated words for consecutive lines is a feature, which cannot be found in a Latin or an English text.<sup>24</sup> The examined English text shows only a small increase in repeated words for consecutive lines. After this small peak, the number of repeated words remains the same, whereas for the VM the number of repeats permanently decreases. It seems that the high level of context-dependency is specific for the VM and therefore needs explaining.

Schinner found a similar result in 2007 when using the random walk method to analyze long-distance relations within the VM. He demonstrated that the probability of the occurrence of a similar word decreases with distance:

"Interpreting normal texts as bit sequences yields deviations of little significance from a true (uncorrelated) random walk. For the VMS, this only holds on a small scale of approximately the average line length; beyond positive correlation build up: the presence/absence of a symbol appears to increase/decrease the tendency towards another occurrence." [Schinner: p. 105]

The calculation reveals a pattern for the usage of similar words. They are not randomly distributed within the VM. They are used on the same pages next to each other.

<sup>23</sup>The Aeneid by Virgil translated by Dryden in 1697

<sup>24</sup>For the English text the number of repeated words within a line decreases. This effect is probably a result of the rhyme scheme used in poem "The Aeneid". This rhyme scheme leads to words which always occur in the same position within a line and which therefore can only occur once in a line.

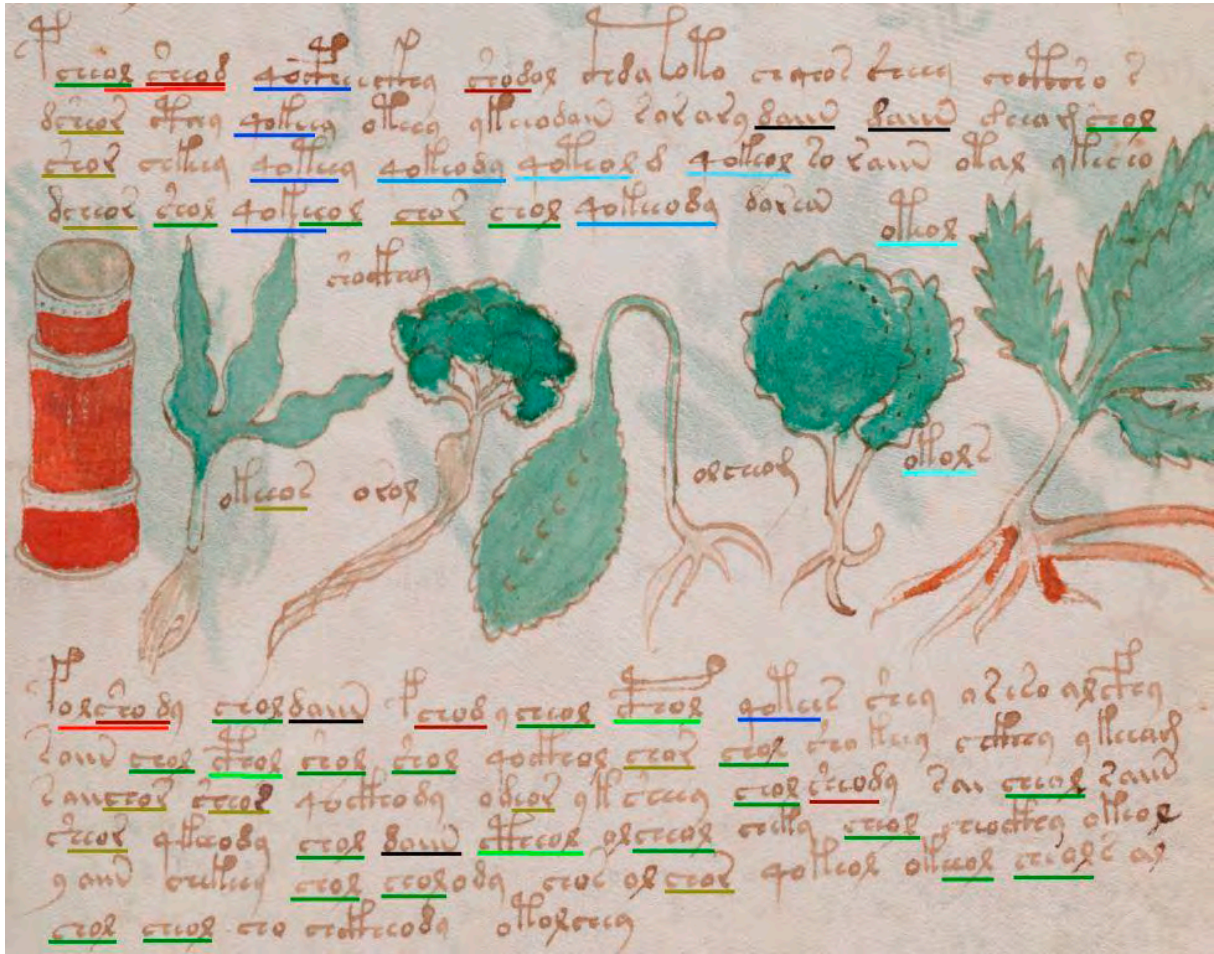


Figure 2: part of page <f100r>

As example see figure 2. Similarly spelled glyph groups are marked in this figure with different colored lines. For instance, the initial glyph group for the second paragraph in line <f100r.P2.5> is  $\text{folshody}$  ("folshody"). The first paragraph on this page has a similar sequence of  $\text{ol sheod}$  ("ol sheod") in line <f100r.P1.1> (both sequences are marked red).<sup>25</sup>

## 6 Evidence

On page <f100r> similarly spelled glyph groups occur near to each other. Is this page an exception or do similar groups typically appear together on the same pages? This hypothesis can be confirmed by checking a control sample using all glyph groups appearing a certain number of times within the VM.

In this paper all words occurring seven times and all words occurring eight times are used as two separate control

<sup>25</sup> A good way to verify the described pattern is by checking rare words. For instance,  $\text{dolcheedy}$  ("dolcheedy") and  $\text{rolchedy}$  ("rolchedy") occur only once. But both words can be found next to each other in line <f77v.P.33>.

samples. To limit the samples, all words also appearing as subgroups of other words are excluded. The result for the remaining 20 words occurring only seven times is that in 115 out of 140 cases (82%) similar words can be found near to each other.<sup>26</sup> For the group of words used eight times, the result is that in 64 out of 72 cases (89%) at least one similar word was found within a maximum distance of three lines and a maximum edit distance of three.<sup>27</sup> Furthermore, if near is defined as both glyph groups must be used one after another or in two consecutive lines one above the other, the result is still interesting. In 60 out of 140 cases (43%) and in 25 out of 72 cases (35%) a similar glyph group can be found for both samples. In other words, similar glyph groups can be found above each other twice as often as they can be found side by side.<sup>28</sup>

A feature of the VM is that similarly spelled glyph groups are used together on the same pages near to each other. This means, the reason that similarly written words have similar frequencies is that they appear together on the same pages. In other words, the scribe was writing similar spelled glyph groups near to each other because they depend in some way on each other. This result also explains the observation that repeated phrases typically consist of equally or similarly spelled glyph groups. Such phrases occur multiple times because of the connection between similarly spelled groups.

## 7 The way the scribe was generating the text

Taking the glyph groups used seven and eight times as an example it is possible to describe the changes for similar glyph groups occurring near to each other:

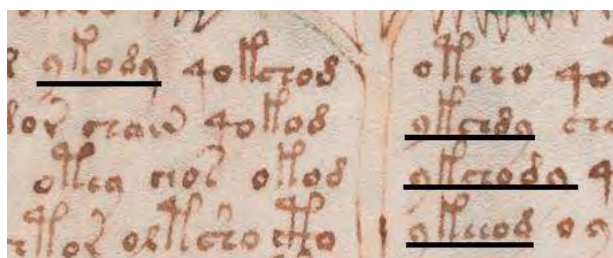


Figure 3: part of page <f53r> with glyph groups similar to offloda underlined

<sup>26</sup>Near to each other means within a range of three lines before and after a word, and similar means that it is possible to transform them into each other by changing three or fewer glyphs (edit distance  $\leq 3$ ).

<sup>27</sup>See addendum: III. Glyph groups occurring seven times (p. 35) and IV. Glyph groups occurring eight times (p. 45)

<sup>28</sup>The ratio is 39:22 for the words occurring seven times and 16:11 for the words occurring eight times.



- <f53r.P.5>      9lløδ9
- <f53r.P.6>      9llεδ9 (ø removed and ε added)
- <f53r.P.7>      9llεοδ9 (the previously removed ø was added)
- <f53r.P.8>      9llccoδ (ε replaced with cc and the final 9 removed)

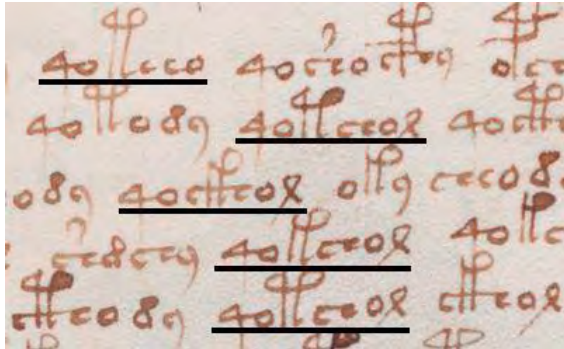


Figure 4: part of page <f93v> with glyph groups similar to 9ollccox underlined

- <f93v.P.1>      9ollcco
- <f93v.P.2>      9ollccox (cc replaced with ε and a final x added)
- <f93v.P.3>      9ollccox (llε replaced with llε)
- <f93v.P.4>      9ollccox (llε replaced with llε)
- <f93v.P.5>      9ollccox (ll replaced with ll)

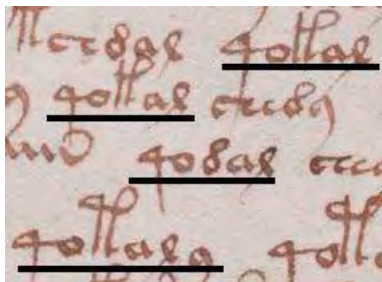


Figure 5: part of page <104r> with glyph groups similar to 9ollax underlined

- <f104r.P.33>      9ollax
- <f104r.P.34>      9ollax (nothing changed)
- <f104r.P.35>      9ollax (ll removed and δ added)
- <f104r.P.36>      9ollax9 (δ removed and ll and the final 9 added)

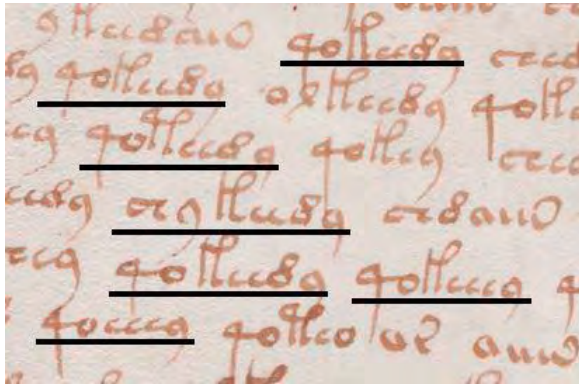


Figure 6: part of page <112v> with glyph groups similar to *foccc* underlined

- <f112v.P.14>    *fofccd*
- <f112v.P.15>    *fofccd* (nothing changed)
- <f112v.P.16>    *foffcd* (ff replaced with ff)
- <f112v.P.17>    *coffcd* (ff replaced with ff and fo with co)
- <f112v.P.18>    *fofccd* (co replaced with fo)
- <f112v.P.18>    *fofcc* (cc replaced with ccc and d removed)
- <f112v.P.19>    *foccc* (ff removed)

Now the following rules can be used to describe the way the scribe was generating the text:

- I) Copy a already written glyph group and replace one or more glyphs with similarly shaped glyphs. An example is *daid daid daid* ("dain dail dair") in line <f45v.P.4>.<sup>29</sup>
- II) Copy a glyph group and delete one or more glyphs. See, for instance, line <f27v.P.1> *fochof chof cho* ("fochof chof cho") or *lkeedy* ("lkeedy"), *lkeedy* ("lkeedy") and *lkeedy* ("lkeedy") in line <f111r.P.37>.
- III) Copy a glyph group and add one or more glyphs. An example is *okedy gokedy gokeedy* ("okedy gokedy gokeedy") in line <f31r.P.10>.
- IV) Create a new glyph group by merging two groups. Example: *ol chedy* ("ol chedy") and *olchedy* ("olchedy") in line <f75v.P2.18> and line <f75v.P2.19>.
- V) Create two words by splitting a glyph group created by rule IV). Example: *olchedy* ("olchedy") and *ol chedy* ("ol chedy") in line <f80r.P.5> and <f80r.P.6>.
- VI) From time to time copy a glyph group without changing anything. See for instance *qokain* ("qokain") in line <f116r.P.7>, <f116r.P.8> and <f116r.P.9>.
- VII) For the first word of a paragraph a gallow glyph like *f* ("p") or *f* ("f") was commonly added. Furthermore, both

<sup>29</sup>Glyph groups like *daid* ("daid") are rare. It seems that a glyph was normally not replaced by a glyph, which was already part of the group.



gallow glyphs were preferred within the first line of a paragraph.

VIII) Use a combination of the rules I-V and VII.

In order to use the described rules for an empty page, it was probably useful to use a second page as a source. There are indications that the scribe preferred the last completed sheet for this purpose. One peculiarity for the words used seven or eight times is that they often appear on subsequent pages. For instance 𐌒𐌔𐌐𐌔 ( "qodal" ) appears on four consecutive sheets: <f51v>, <f52r>, <f53v> and <f54v>. For the glyph groups, which occur seven or eight times, this happens more often on subsequent sheets (37 times) than on the front- and back of a page (5 times).<sup>30</sup>

The connection between consecutive lines and between similar glyph groups exists because the text is a copy of itself. The statistical features of the text can be explained by the hypothesis that the author of the VM was using the described self-referencing system to generate the text. This text generation mechanism also explains the observation that for common glyph groups almost all spelling variations occur. The use of different spelling variations is no coincidence, because the scribe was generating new words by varying glyph groups already used.

Many rare or unique words were used as labels for the pages <f67r1> to <f73v> (see graph 1 on p. 7). A possible explanation for this observation is that text written in circular form was harder to copy.

One result of the text generation mechanism is that similar elements can be found in the same position within the lines. It is practical to copy a glyph group from the same position some lines above. One observation for the VM is therefore that some elements are typical for a specific position within a line. For instance the 𐌒 glyph typically occurs at the end of a line.

By copying and manipulating the glyph groups again and again, the character of the text would change over time. One way to avoid this effect would be to invert the modification rules from time to time. And indeed this type of repetition did occur. For instance, on page <f77v> two similar word sequences occur in lines 5 and 15 (see figure 7: both sequences are marked with black rectangles).

<f77v.P5> 𐌒𐌔𐌐 𐌔𐌔𐌔𐌒 𐌒𐌔𐌐𐌔 𐌔𐌔𐌔𐌒 𐌒𐌔𐌐𐌔𐌒 ( "sal shedy qokal chedy qokedy" )  
<f77v.P15> 𐌒𐌔𐌐 𐌔𐌔𐌔𐌒 𐌒𐌔𐌐𐌔𐌒 𐌒𐌔𐌐𐌔 𐌔𐌔𐌔 ( "sal chedy qokedy qokal shed" )

---

<sup>30</sup> Further examples can be found by checking rare or unique glyph groups. For instance, the unique word 𐌔𐌔𐌐𐌔 ( "osaro" ) appears on page <f100r>. A possible source for this word is the unique glyph group 𐌔𐌔𐌐𐌔 ( "osary" ) on page <f99v>. In a similar way, a possible source for the first word on page <f79v> 𐌒𐌔𐌐𐌔𐌔𐌔𐌒 ( "poldshedy" ) is the rare word 𐌒𐌔𐌐𐌔𐌔𐌒 ( "olshedy" ) on the previous sheet in line <f78v.P.2>.

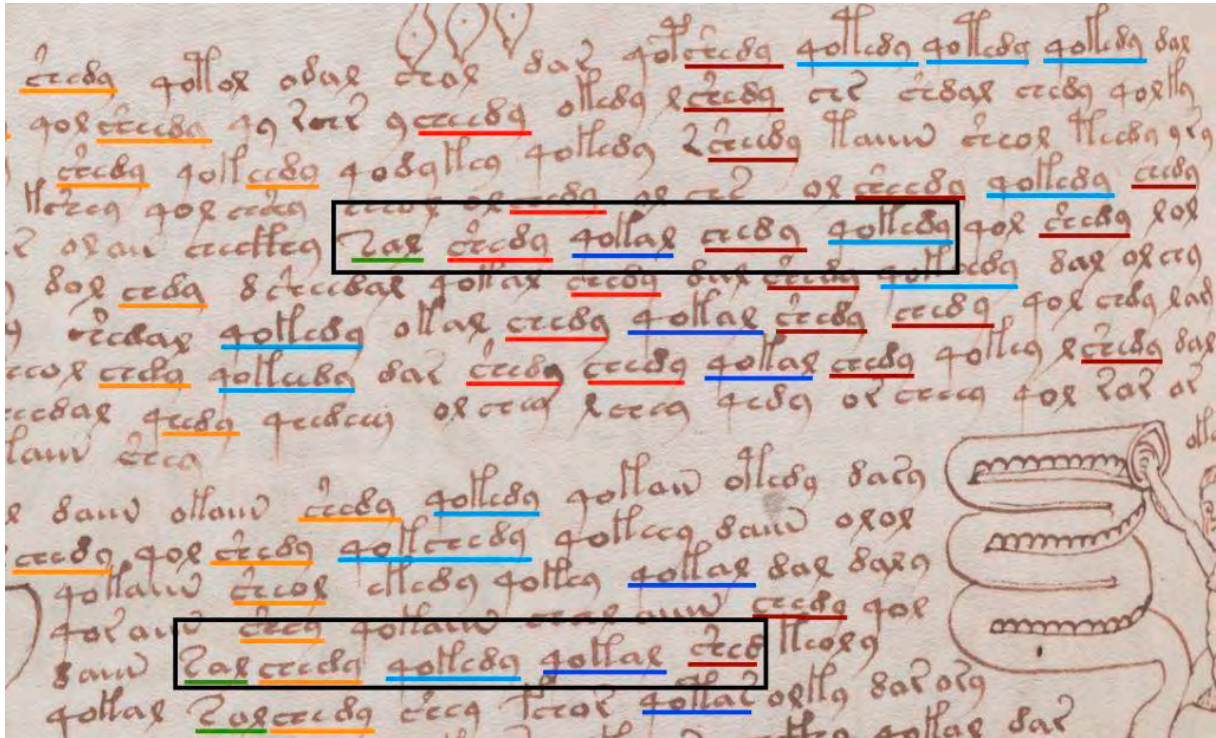


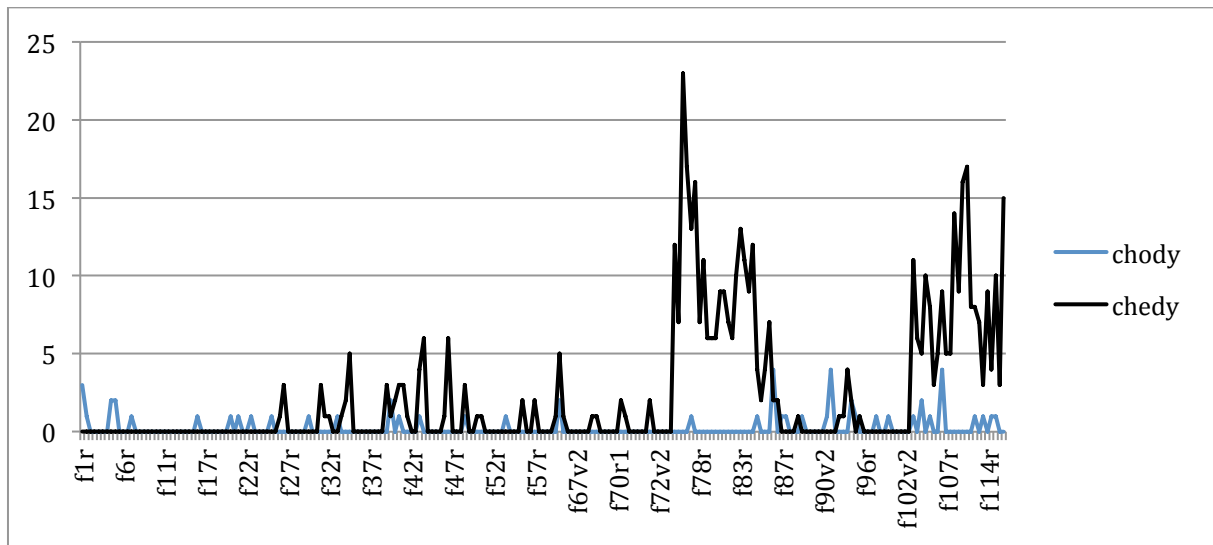
Figure 7: part of page <f77v>

There are two explanations for the similarity of these two sequences. On this page, many glyph groups are copied by inverting a formerly used modification rule. Additionally, there are three chains of glyph groups connected to  $\text{cedy}$  ("chedy") on this page (they are marked with orange, red and dark red). An observation for this page is that in most cases similar glyph groups are arranged one above the other, whereas the glyph group below is shifted a step to the right, in the direction of writing. A possible explanation for this observation is that the scribe was copying glyph groups he was able to see.

## 8 Relations between similar glyph groups

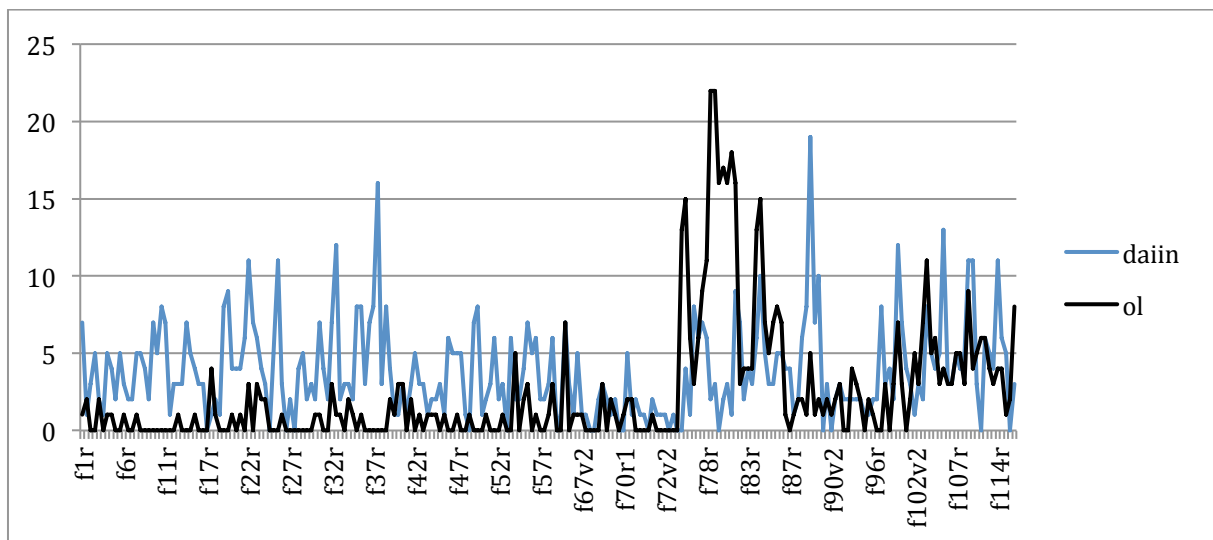
In 1976 Currier described at least two different hands and two different languages within the manuscript [see Currier]. According to Currier two or more scribes created the manuscript, and each scribe only wrote a part of the manuscript. A good way to distinguish between these two languages is the usage of  $\text{cedy}$  ("chedy").  $\text{cedy}$  is the third most frequent word. This word is missing for the pages using the language Currier named A and frequent on pages using language B. Instead of  $\text{cedy}$  ("chedy"), the words  $\text{chody}$  ("chody") and  $\text{shody}$  ("shody") occur for pages using language A (see graph 5). And also the interim word  $\text{cheody}$  ("cheody") appears on pages using language A, whereas  $\text{chody}$  ("chody") is also used on pages using

language B. The method for creating the text is the same for the whole manuscript. The difference between both "languages" may only be that the scribe changed his preferences while writing the manuscript.



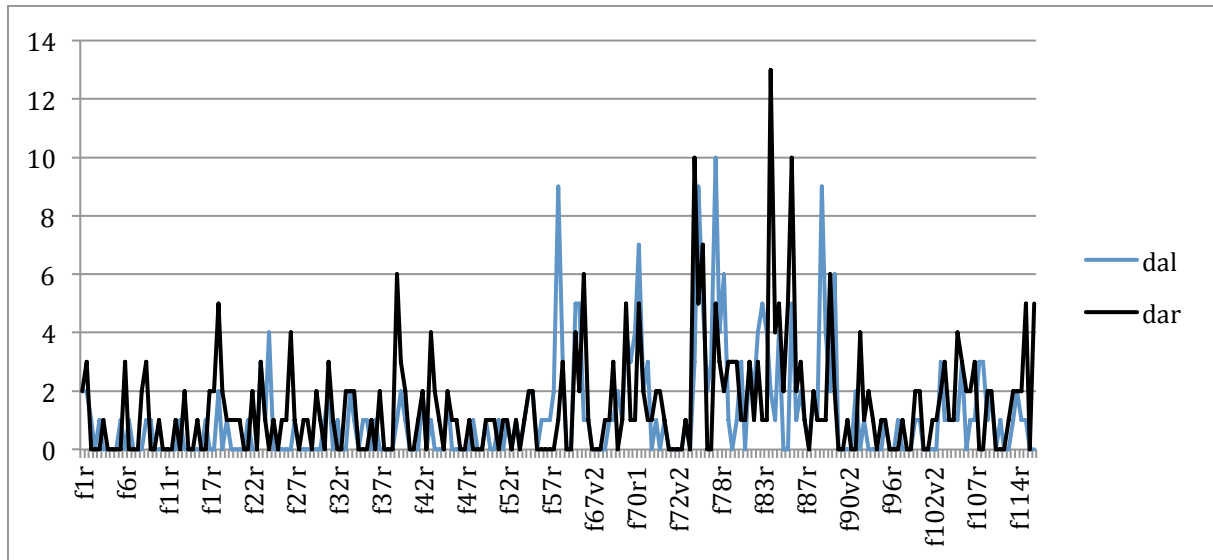
Graph 5: appearance of  $\tau\omicron\delta\gamma$  ("chody") and  $\tau\epsilon\delta\gamma$  ("chedy")

Not only  $\tau\epsilon\delta\gamma$  ("chedy") but also  $\omicron\gamma$  ("ol") is unequally distributed across the pages of the VM (see graph 6). The most frequent word  $\delta\alpha\omega\omega$  ("daiin") occurs with similar frequencies throughout the manuscript. It is interesting that the frequency of  $\delta\alpha\omega\omega$  does not increase in the sections with pages containing more text.<sup>31</sup> This means that even the distribution of frequently used words is inhomogeneous for the VM.



Graph 6: appearance of  $\delta\alpha\omega\omega$  ("daiin") and  $\omicron\gamma$  ("ol")

<sup>31</sup>Such parts are the biological section (pages <f75r> – <f84v>) and the recipes section (pages <f103r> – <f116r>).



Graph 7: occurrence of  $\text{ḍal}$  ("dal") and  $\text{ḍar}$  ("dar")

The examination of the relation between similarly spelled glyph groups for the whole manuscript only showed a weak correlation. For instance, in the case of  $\text{ḍal}$  ("dal") and  $\text{ḍar}$  ("dar") it is hard to detect a relation between both frequency graphs (see graph 7). The correlation coefficient between the frequency of occurrence for  $\text{ḍal}$  ("dal") and the frequency of occurrence for  $\text{ḍar}$  ("dar") is only 0.2.<sup>32</sup> The text length of a page better explains the frequency of occurrence for both words, since the correlation coefficient between text length and frequency is 0.4 in both cases. This means that one word is not related to a specific similarly spelled word. In fact, each word is related to all other similarly spelled words. In the case of  $\text{ḍal}$  ("dal") and  $\text{ḍar}$  ("dar") this means that they are also related to words like  $\text{ar}$  ("ar"),  $\text{dor}$  ("dor") and  $\text{sar}$  ("sar") etc. This explains why similarly spelled glyph groups have similar frequencies. The more often a glyph group appears, the more often it was used as a source for generating other glyph groups.

## 9 Lack of corrections

One important observation for the VM is the lack of corrections [see Reddy: p. 79]. Did the scribe not make any mistakes? If the intention was to avoid repetitions, it is a mistake to repeat something. The easiest way to remove something repeated is to change it. One feature of the script used for the VM is that in many cases one additional quill stroke is enough to change a glyph into another one. For

<sup>32</sup>For calculating the correlation coefficient the frequencies were normalized with respect to the text length of each page.

instance, it would be easily possible to change  $\epsilon$  into  $\zeta$  or  $\circ$  into  $\alpha$ .

At least two variants of the  $\zeta$  glyph exist. The first variant consists of two quill strokes. In this case, it seems as if  $\epsilon$  was changed into  $\zeta$ . In the second variant, the  $\zeta$  was written with one quill stroke. Did this mean that the  $\zeta$  is a ligature of  $\epsilon$  and  $\gamma$  or did this mean that the scribe was frequently changing  $\epsilon$  into  $\zeta$ ?<sup>33</sup>

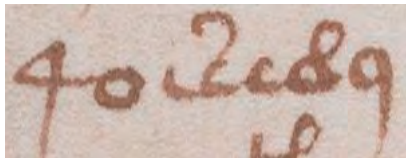


Figure 8:  $4\circ\zeta cdg$  in line <f82r.P2.24>

One example for the variant using two quill strokes is the unique glyph group  $4\circ\zeta cdg$  ("goesedy") in line <f82r.P2.24> (see figure 8). The fact that the corresponding spelling variation  $4\circ c c c d g$ , ("goeeedy") using  $\epsilon$  instead of  $\zeta$ , appears three times in the VM is an argument in favor of the hypothesis that the scribe was only changing  $\epsilon$  into  $\zeta$ .<sup>34</sup>

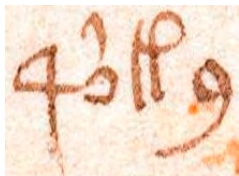


Figure 9:  $4\beta llg$  in line <f2r.P10>



Figure 10:  $\zeta\alpha w$  in line <f2r.P10>

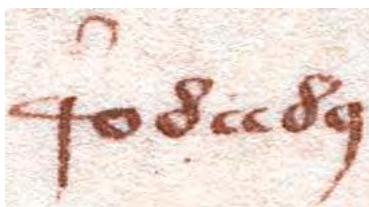


Figure 11:  $4\delta ccdg$  in line <f105r.P2.25>

Normally, an additional quill stroke was used to change  $\epsilon$  into  $\zeta$  or  $\alpha$  into  $\zeta$ . In some cases, such a plume was also added to

<sup>33</sup>One hypothesis could be that the glyph  $\zeta$  is also a ligature of  $\epsilon$  and  $\gamma$ . A similar hypothesis is that of Currier: "We have the fact that you can make up almost any of the other letters out of these two symbols  $\epsilon$  and  $\gamma$ ; it doesn't mean anything, but it's interesting." [Currier]

<sup>34</sup> $4\circ c c c d g$  ("goesedy") occurs in lines <f76.P.6>, <f76v.P.17> and <f105r.P2.13>.



other glyphs. This is at least the case for 4o1f9 ("qoky") and 2aw ("saiin") in line <f2r.P.10>, for 4o ("go") in line <f49r.P.14>, for 4oero ("gocho") in line <f49r.P.16>, for o9 ("ol") in line <f84r.P.1.4> and for 4o8cc89 ("qodeedy") in line <f105r.P.2.25> (for examples see figures 9, 10 and 11). Since these exceptions exist, the question arises as to whether ɔ and ɔ̂ are indeed two different glyphs or whether the additional ʹ-stroke has its own meaning? The second hypothesis is also supported by the occurrence of the glyph group ɔ̂ in line <f4r.P.2>.

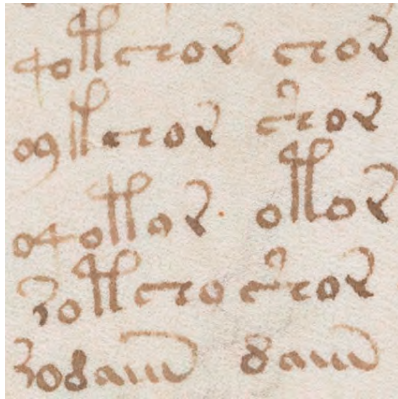


Figure 12: line <f10r.P.8> - <f10r.P.12>

Furthermore, on page <f10r> a glyph ʒ occurs twice (see figure 12). For this glyph the question is whether it is a variant of ɔ̂ or a ligature of two ɔ̂ glyphs?

The lines <f10r.P.8 - 12> are starting with 4o, o9, o4, ʒo and ʒo (see figure 12). This is interesting since only 20 words starting with o4 can be found in the VM. It seems as if the scribe was developing new spelling variants here. First, glyph groups starting with o4 and, second, a new glyph ʒ.



Figure 13: ɔ̂ʒ in line <f115v.P.32>

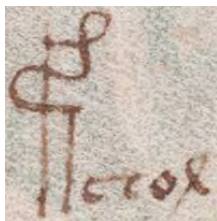


Figure 14: ʒɔ̂ in line <f14r.P.8>

For gallow glyphs some irregular variants exist.<sup>35</sup> For instance ɔ̂ʒcc89 ("chctheddy") is written six times as expected. But on page

<sup>35</sup> Irregular gallow glyphs can be found in lines <f8r.P.3.14>, <f9r.P.6>, <f14r.P.8>, <f24v.P.1>, <f25v.P.3>, <f36r.P.1>, <f42.P.2>, <f76v.P.25>.

<f115v> the group is written with an additional quill stroke connecting  $\approx$  with  $\mathfrak{H}$  (see figure 13). Another example of an ambiguous glyph is the  $\mathfrak{F}$  in line <f14r.P.8> (see figure 14). It is uncertain if this glyph is used as  $\mathfrak{F}$  or as  $\mathfrak{H}$  or as a new character. It seems as if the scribe was sometimes testing different design variants for the glyphs used.

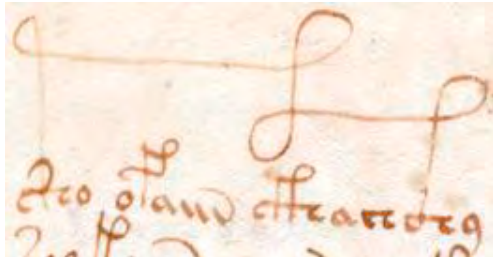


Figure 15: the first word on page <f42r>

Other examples are curlicue gallow glyphs used as initial markers for some pages. One example is on page <f42r> (see figure 15). In this case, the question arises as to whether this glyph is only used as decoration or has some meaning.<sup>36</sup>

Another example of ambiguousness in the VM can be found on page <f105r> in lines 9a and 10. When writing line 10, the scribe left a larger gap (see figure 16). It seems that the scribe was not satisfied with the resulting layout. To make the gap less obvious, he used larger gallow glyphs and filled the gaps between them with additional glyph groups.<sup>37</sup> This raises the question whether the additional glyph groups in line 9a constitute a separate line or whether they belong to line 10.

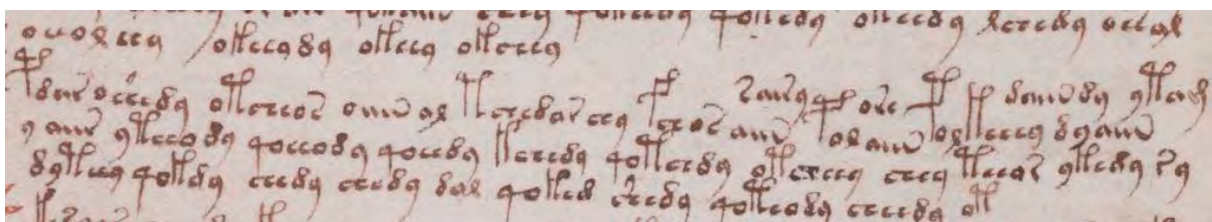


Figure 16: part of page <f105r>

It is to be expected that the scribe would run out of space at the end of a line. In addition, on many pages the text is placed around illustrations (see for instance figure 1). In

---

<f79r.P.1>, <f84r.P.15>, <f86v6.P.1>, <f87v.P.1>, <f90v2.P.1>, <f95v1.P.1>, <f114r.P1.1> and <f115v.P.32>.

<sup>36</sup> In the case of page <f42r> different transcriptions are conceivable. Carrier leaves the additional glyph unaccounted for. He reads  $\approx$  of  $\mathfrak{H}$   $\mathfrak{H}$   $\mathfrak{H}$   $\mathfrak{H}$  ("sho ofaiin cthachchy"). The transcription of the first study group is  $\mathfrak{H}$   $\mathfrak{H}$  of  $\mathfrak{H}$   $\mathfrak{H}$  ("tsho ofaiin cthachchy"). And Takahasi reads  $\approx$  of  $\mathfrak{H}$   $\mathfrak{H}$   $\mathfrak{H}$  ("sho ofaiin cthachcthy").

<sup>37</sup> These words fit into the gaps between the gallow glyphs or the gallow glyphs fit into the gaps between the words. The second case is less likely because in this case it would be necessary to predict the gallow glyphs while writing line <f105r.T1.9a>.



such cases, the available space was also limited. Therefore it would be no surprise if sometimes the last glyphs in a line were squeezed into the available space. However, there are no such crowded places in the VM. This behavior was described by Currier in 1976 as follows:

"The ends of the lines contain what seem to be, in many cases, meaningless symbols: little groups of letters which don't occur anywhere else, and just look as if they were added to fill out the line to the margin. Although this isn't always true, it frequently happens." [Currier]

One possible explanation for this feature is that it was possible for the scribe to select glyph groups which fitted into the available space.

## 10 Discussion

What conclusions can be drawn from the observations made for the text of the VM? First, it is possible to describe a text generation method for the VM. The text was generated by copying and modifying already written text. This method explains the fact that similarly spelled glyph groups are usually near to each other. This method also explains why the set of used words is constantly changing and why longer repeated word sequences are missing in the VM. The hypothesis that the text was generated by copying already written text leads to the conclusion that the glyph groups only behave like words, but have a different meaning.

Writing the text of the VM was clearly a monotonous and laborious process and required considerable time and motivation. However, only knowledge available in the 15<sup>th</sup> century was needed to use the described text generation mechanism. Therefore there is no indication that the text belongs to a later period than the parchment, which was carbon-dated to the 15<sup>th</sup> century.

The script used to write the VM uses similarly shaped glyphs. The design of these glyphs is based on some simple forms starting with  $\backslash$  and  $c$ . By combining this simple form with some additional ink strokes complex forms like  $\mathcal{J}$  or  $\alpha$  were also generated. In the same way as the scribe combined some ink strokes to design similarly shaped glyphs he also combined these glyphs to build similarly spelled glyph groups and these groups to create a text.

If everything is possible, nothing can be excluded. It is not possible to detect a falsely identified glyph from its context, because so many spelling variations occurred in the

VM. For "reading" the VM this means that it is necessary to identify every single glyph. But since similar glyphs can replace each other, the identification of glyphs is even more difficult than necessary. This means that it is far from being easy to transcribe the VM. For this reason it is no surprise that all published transcriptions of the VM frequently differ.

There are three possible explanations for the ambiguousness of the text of the VM. The first explanation is that it is not necessary to identify each glyph in order to read the VM because similar glyphs share the same meaning. The second explanation is that only some glyphs have meaning, and the third explanation is that it is not necessary to read the glyphs because they have no meaning.

The assumption that similar glyphs share the same meaning would result in a monotonous text repeating the same words again and again. Even without such an assumption the VM contains monotonous sequences such as the following two:

<f75r.P.38>    ʒllccδg ʒllccδg ʒllccδg ʒllccδg ʒllccδg ʒδg  
<f108v.P.39> ʒllccδg ʒllccδg ʒllccδg ʒllccg ʒllccg ʒllccg ʒllccδg

If similar glyphs share the same meaning such sequences would only repeat the same information multiple times. The text generation method found confirms the conclusion that the glyph groups in the VM are not used as words. All features of the VM, especially the weak word order, the existence of the *δawδ-*, *og-* and *ccδg-* series, the use of a limited number of prefixes and the connections between similarly spelled glyph groups, speak against such a hypothesis. For a natural language or for a constructed language the words should be used because of their meaning, and relations between words should be expressed by grammatical rules. Since the only relation found for the words within the VM is that similarly spelled words are used near to each other, an unknown natural language or a constructed language can be ruled out.

More interesting is the hypothesis that the VM is an encoded book of secrets. One hypothesis is that only a subset of glyphs has a meaning and the gaps between them are filled up with meaningless content. However, for common glyph groups in the VM each glyph can be replaced or deleted. Furthermore, longer repeated word sequences are missing for the VM. Therefore it is impossible that the VM was encoded using a simple cipher such as: only the first glyph of a glyph group should be read. But if the cipher is more complex, this raises the question why it was necessary to construct a new script and to simulate words using letters for vowels and consonants. Would it not be easier to use a normal text to hide a message? Nobody would assume a hidden message behind a text that can be read. Therefore it is unlikely that only a small group of glyphs for each page have a meaning. Furthermore, the

assumption that it is possible to distinguish between meaningful and meaningless glyphs would give a decipherer a degree of freedom, which means anything could be read into the VM. Therefore, it would not be possible to prove or disprove such a hypothesis.

Another conceivable hypothesis is, that one glyph group of the text stands for a letter or a syllable. In this case, the large number of different glyph groups could be explained if multiple groups stand for one and the same letter or syllable. One argument in favor of such an assumption is that the scribe was generating the same glyph groups numerous times on different pages. In most cases it is possible to distinguish the glyph groups of the three series by their end characters, which are in most cases  $\mathfrak{D}$  ("n"),  $\mathfrak{I}$  ("l") or  $\mathfrak{Y}$  ("y"). In combination with the use of common prefixes such as  $\mathfrak{qo}$  ("qo"),  $\mathfrak{l}$  ("l") and  $\mathfrak{ch}$  ("ch") it seems possible to build an encoding system for an alphabet using at least 24 letters.<sup>38</sup>

A method of encoding a text in a similar way has been known at least since the 16<sup>th</sup> century. Johannes Trithemius described such a method in his book *Polygraphiae* in 1508 [see *Hermes*: p. 139–152]. Trithemius' method uses a code table to assign multiple words to each letter.<sup>39</sup> The use of such a method would explain the occurrence of similarly spelled glyph groups, the word length distribution and the occurrence of three different word series. On the other hand, 8133 is a very large number of different glyph groups. Even if hapax legomena<sup>40</sup> are excluded, 2486 glyph groups and therefore approximate 100 different encoding variants for each letter of the plaintext alphabet will remain. The use of an encoding table containing such a number of glyph groups would make the encoding process unreasonably laborious. An explanation for these observations could be that the scribe was using synonymous glyphs or was adding meaningless glyphs. In such a case the problem would be to distinguish between meaningful and meaningless spelling variations. To use the encoding method described by Trithemius is by no means an easy procedure. As corrections are missing in the VM, a method to mark deleted glyph groups or glyphs would be needed. One hypothesis could be that glyphs were marked as deleted by an additional stroke, such as the stroke changing  $\mathfrak{c}$  into  $\mathfrak{c}^2$  or  $\mathfrak{e}$  into  $\mathfrak{e}^2$ .

Longer repeated word sequences are missing in the VM. This would lead to the conclusion that a plaintext word occurring multiple times was encoded differently each time. How is this possible? One explanation could be that a local element was used for encoding. One observation for the VM was that

---

<sup>38</sup> Since all three word series are used frequently and in similar proportion (1:2:2) for the pages of the VM one hypothesis could be that in such a case the  $\mathfrak{D}$ -series was used to encode fewer letters than the  $\mathfrak{I}$ - and the  $\mathfrak{Y}$ -series.

<sup>39</sup> See addendum: VIII. Code table as described by Trithemius (p. 70).

<sup>40</sup> Hapax legomena (lat.): words which occur only once

similarly spelled glyph groups are used near to each other. An explanation found for this feature is that the scribe was using glyph groups in his sight field for generating new words. In this way it would be possible to use a local element for the encoding process. On the other hand, the process of searching for an encoded glyph group and changing this group would make the encoding process more complicated than necessary. It would seem to be easier to select the next code word from a code tablet than to search for a suitable glyph group within the text already written.

To use a glyph group already written as a source is only easier if it is possible to select any group. But this is only possible under the assumption that the glyph groups have no meaning. In this case it would not matter which source word the scribe chose. By changing meaningless glyph groups it would be possible to generate the text during writing. The scribe only needed to choose a source word, a rule and between similar-looking glyphs. And he could be sure that someone not familiar with his idea would only see different words. The reason for this is that we are used to reading similar glyphs like *o* and *α* or *4* and *9*, differently. Such a method would also explain that similarly spelled glyph groups occur frequently one above the other and have a comparable frequency. The last hypothesis is therefore that it is not possible to read the VM because the glyph groups are meaningless. With this hypothesis it is possible to explain the features of the VM described in this paper. Particularly the fact that similarly spelled glyph groups occur with similar frequencies could be explained. If the scribe preferred words he was familiar with, he would unconsciously generate such words more times. Since a glyph group occurring more often would be used more frequently as a source for other glyph groups, spelling variations of this group would also occur more frequently.

By using similar glyphs and similarly spelled glyph groups it would be possible to write the same glyph groups again and again in different ways. Using this procedure, it would be possible to generate a meaningless text efficiently. Also the use of ambiguous glyphs does not do any harm if these glyphs have no meaning. Last but not least, it makes sense to illustrate a manuscript nobody can read. The illustrations would attract attention and everyone would assume that maybe the text is explaining the secret he can see within the strange illustrations. Or in other words, if the text cannot be read or decoded then a background story or some fanciful illustrations are needed to make a manuscript interesting.

One observation for the VM was that the set of words used within the manuscript changes over time. Since the same text generation method is used for the whole manuscript and since the set of words used permanently changes, it can be assumed that the whole text belongs together. Therefore, if the glyph groups do encode letters or syllables, it should be assumed

that in different parts of the VM the same letter or syllable was encoded differently. Another interesting observation is that similarly spelled glyph groups are used near to each other. Many times, similarly spelled glyph groups occur side by side or one above the other. This occurs more often than expected for letters or syllables for a hypothetical plaintext.<sup>41</sup> This observation would lead to the conclusion that similarly spelled glyph groups usually stand for different letters or syllables. But in most cases the difference between similar spelled glyph groups used near to each other is that similarly shaped glyphs replace each other. If there were an encoded message behind the VM this observation would lead to the conclusion that it would be necessary to distinguish between similarly shaped glyphs. This would mean that even if one knew the encoding mechanism it would be hard to decode the manuscript. Not only it would be necessary to distinguish between similarly shaped glyphs, but it would also be necessary to decode 8000 differently spelled glyph groups where different groups can have the same meaning and similar groups have usually different meanings.

One method of generating distinguishable glyph groups while writing could be to use only some basic geometrical elements such as linear strokes, curved strokes or circles to carry meaning. It is for instance thinkable that it was only necessary to count the number of *c* or *\* strokes for encoding a glyph group. But even for such a method numerous repetitive phrases, standing for repeated plain text words, could be expected. Thus, the fact that longer repetitive phrases are missing speaks therefore against such a simple method.

Sometimes it is possible to expand repetitive phrases under the assumption that similarly spelled glyph groups are related to each other. For the hypothesis of an encoded text using the method described by Trithemius such phrases would be a good starting point for searching for glyph groups standing for the same letter or syllable. From the following two examples on pages <f84r> and <f83v> – <f84v> it would be possible to conclude that for *ʒllcδg*, it is possible to replace *c* with *cc* and for *ʒoʒ* that it is possible to delete the leading *ʒ* and to replace *o* with *a*.

<f84r.P.3>      ʒccδg ʒllcδg ʒllccδg ʒllcδg ʒccδg ʒllawδ ʒccg  
 <f84r.P.10>    ʒccδg ʒllcδg ʒllccδg ʒllccδg ʒccδg ʒllawδ ʒccg

---

<sup>41</sup>Many places can be found where similar glyph groups occur side by side or one above the other. If we assume that similar glyph groups carry the same meaning this would lead to the conclusion that only the same plain text letters or syllables are repeated there.

<f83v.P1.2>     δοx 2cδ9 4ollcδ9 2cδ9  
 <f84r.P.6>        οx 2cδ9 4ollcδ9 2cδ9  
 <f84v.P.26>     δax 2cδ9 4ollcδ9 2cδ9

Both phrases occur on the same or on repetitive pages. Therefore it is possible to explain them by the assumption that the scribe generated similar phrases several times by copying from the same source or by copying them from one another. It is therefore possible to explain all features of the VM by the hypothesis that only permutations of the same glyph groups are repeated over and over again within the VM. In other words, it is not necessary to assume that the text of the VM contains a message. Moreover, the observed weak word order is a strong argument against the assumption that the sequence of glyph groups is influenced in some way by a message behind the text. The hypothesis of a meaningless pseudo text also explains the absence of corrections in the VM, since there would be no need to correct something meaningless.

On the other hand, it would be possible to explain even the weak word order, if we assume that a number of words, e.g. every second word, are meaningless fill words. Therefore it is not possible to disprove the hypothesis that there is a message behind the VM. In this context D'Imperio argued, "The trouble is, how can you prove that something is meaningless, or that its meaning is irrecoverable? That is just what is left after you've disproven all the specific positive decipherment theories you or anyone else has thought of so far. But another good one might still always come along." [Currier].

In the end, two hypotheses remain to explain the Voynich manuscript. The most plausible hypothesis is that the text generation method described in this paper was used to build a meaningless text. The second hypothesis is that the text generation method is part of a yet undiscovered encoding method used for encoding the manuscript.

### **Acknowledgements**

The author wishes to thank Jürgen Hermes and Nick Pelling for stimulating discussions and helpful suggestions.

## **Bibliography**

Prescott H. Currier, 1976: New Research on the Voynich Manuscript: Proceedings of a Seminar. Unpublished communication, retrieved July 19, 2014 from [http://www.voynich.nu/extra/curr\\_main.html](http://www.voynich.nu/extra/curr_main.html)

Jürgen Hermes, 2012: Textprozessierung - Design und Applikation. Dissertation, Universität zu Köln.

Gunther Ipsen, 1954: Zur Theorie der Entzifferung. Studium Generale, Jhg. 7, Heft 7, p. 416-423.

M.E. D'Imperio, 1980: The Voynich Manuscript: An Elegant Enigma, Aegean Park Press.

John Dryden, 1697: The Aeneid of Virgil  
Retrieved July 19, 2014 from <http://www.sacred-texts.com/cla/virgil/aen/index.htm>

Sean B. Palmer, 2014: Which Voynich MS glyphs are related?  
Retrieved July 19, 2014 from <http://inamidst.com/voynich/related>

Sravana Reddy / Kevin Knight, 2011: What We Know About The Voynich Manuscript, Proc. ACL Workshop on Language Technology for Cultural Heritage, Social Sciences, and Humanities, p. 78-86.

Andreas Schinner, 2007: The Voynich Manuscript: Evidence of the Hoax Hypothesis, Cryptologia, Vol. 31, Iss. 2, p. 97-107.

Jorge Stolfi, 2000: On the VM Word Length Distribution  
Retrieved July 19, 2014 from <http://www.ic.unicamp.br/~stolfi/voynich/00-12-21-word-length-distr/>

Daniel Stolte, 2011: UA Experts Determine Age of Book 'Nobody Can Read', Retrieved July 19, 2014 from <http://uanews.org/story/ua-experts-determine-age-book-nobody-can-read>

Takeshi Takahashi  
Retrieved July 19, 2014 from <http://voynich.freie-literatur.de/index.php?show=extractor>

Virgil (P. Vergilius Maro 70-19 BC), The Aeneid  
Retrieved July 19, 2014 from <http://www.sacred-texts.com/cla/virgil/aen/index.htm>

René Zandbergen / Gabriel Landini: 2000, EVA Alphabet,  
Retrieved July 19, 2014 from <http://www.voynich.nu/extra/eva.html>



## Addendum

### I. Repeated sequences using the same words

There are 35 repeated sequences using the same three words which occur at least three times within the VM (transcription after Takahashi). In five cases, the order is uniform. In all other 30 cases, the word order is changed.<sup>42</sup>

It is notable that in most cases the repeated sequences consist of words with similar or the same spelling, as in  $\text{chol.shol.cthol}$  ("chol.shol.cthol") or  $\text{gokeey.gokeedy.gokeey}$  ("**gokeey.gokeedy.gokeey**"). 10 sequences contain the same word **twice**. 14 sequences contain at least two similar spelled words. Two words are treated as similar if they can be transformed into each other by adding removing or replacing one glyph (edit distance=1).

#### a) Uniform word order

5 | 5  $\text{ol.shedy.qokedy}$  ("ol.shedy.qokedy") <f75v.P2.21> <f81v.P.18> <f84r.P.6> <f84r.P.10> <f84v.P.14>

4 | 4  $\text{chey.qol.chedy}$  ("chey.qol.chedy") <f81v.P.25> <f82r.P2.20> <f104v.P.4> <f111v.P.32>

4 | 4  $\text{ol.s.aiin}$  ("ol.s.aiin") <f55v.P.10> <f78r.P.35> <f85r1.P.13> <f94v.P.9>

3 | 3  $\text{r.ol.dain}$  ("r.ol.dain") <f32r.P.13> <f80r.P.14> <f111v.P.18>

3 | 3  $\text{shedy.qokedy.shedy}$  ("**shedy.qokedy.shedy**") <f83v.P1.2> <f84r.P.6> <f84v.P.26>

Note: In four out of five cases there are sequences such as  $\text{s.aiin}$  ("s.aiin"),  $\text{ol.shedy}$  ("ol.shedy"),  $\text{r.ol}$  ("r.ol") and  $\text{qol.chedy}$  ("qol.chedy"). For this sequences similar words like  $\text{saiin}$  ("saiin") (144 times),  $\text{olshedy}$  ("olshedy") (23 times),  $\text{rol}$  ("rol") (20 times) and  $\text{qolchedy}$  ("qolchedy") (10 times) exist. This raises the question whether there is a transcription problem for sequences such as  $\text{s.aiin}$  ("s.aiin"),  $\text{ol.shedy}$  ("ol.shedy"),  $\text{r.ol}$  ("r.ol") and  $\text{qol.chedy}$  ("qol.chedy")? A check reveals that this may only be the case for  $\text{r.ol}$  ("r.ol") in line <f32r.P.13> and for  $\text{ol.shedy}$  ("ol.shedy") in line <f84r.P.6>. For  $\text{otcho.rol.dain}$  in line <f32r.P.13> transcriptions like "otcho.rol.dain" (First study group), "otchor.ol.dain" or "otchorol.dain" are also conceivable. For  $\text{ol.shedy.qokedy}$  in <f84r.P.6> a transcription "olshedy.qokedy" (Currier, First study group) was also proposed.

---

<sup>42</sup> When two-word sequences are included there are 270 repeated sequences using the same words. In 92 out of 270 cases the word order is uniform.

## b) Changed word order

- 7 | 3 ጅሮጅ ሞሽሮጅ ሞሽሮጅ ("shedy.qokedy.qokeedy") <f75v.P.21> <f84r.P.3> <f84r.P.10>  
2 ጅሮጅ ሞሽሮጅ ሞሽሮጅ ("shedy.qokeedy.qokedy") <f77r.P.13> <f78v.P.7>  
1 ሞሽሮጅ ሞሽሮጅ ጅሮጅ ("qokeedy.qokedy.shedy") <f78r.P.2>  
1 ሞሽሮጅ ጅሮጅ ሞሽሮጅ ("qokedy.shedy.qokeedy") <f84v.P.18>
- 6 | 3 ዐጻ ሮሮጅ ሞሽሎ ("ol.chedy.qokain") <f78r.P.16> <f80r.P.6> <f80v.P.31>  
2 ሞሽሎ ዐጻ ሮሮጅ ("qokain.ol.chedy") <f75v.P.2.18> <f84v.P.32>  
1 ሮሮጅ ሞሽሎ ዐጻ ("chedy.qokain.ol") <f77v.P.22>
- 5 | 2 ዐጻ ሞሽሎ ጅሮጅ ("ol.qokar.shedy") <f78v.P.21> <f84v.P.24>  
1 ጅሮጅ ሞሽሎ ዐጻ ("shedy.qokar.ol") <f75r.P.35>  
1 ሞሽሎ ዐጻ ጅሮጅ ("qokar.ol.shedy") <f80r.P.31>  
1 ዐጻ ጅሮጅ ሞሽሎ ("ol.shedy.qokar") <f81v.P.19>
- 5 | 3 ዐጻ ሎ ዐጻ ("or.aain.ol") <f79r.P.13> <f86v4.P.3> <f86v6.P.7>  
1 ሎ ዐጻ ዐጻ ("aain.or.ol") <f54r.P.9>  
1 ዐጻ ዐጻ ሎ ("or.ol.aain") <f101v2.P.3>
- 4 | 3 ጅሮጅ ሞሽሮጅ ሮሮጅ ("sheedy.qokedy.chedy") <f76r.R.17> <f77v.P.4> <f84r.P.27>  
1 ሞሽሮጅ ጅሮጅ ሮሮጅ ("qokedy.sheedy.chedy") <f81r.P.19>
- 4 | 3 ዐጻ ዐጻ ሎ ("or.or.aain") <f55v.P.9> <f79v.P.39> <f85r2.P.6>  
1 ዐጻ ሎ ዐጻ ("or.aain.or") <f101v2.P.1a>
- 4 | 2 ሮሮጅ ሞሽሮጅ ሞሽሮጅ ("chedy.qokeey.qokeey") <f108v.P.45> <f112v.P.16>  
1 ሞሽሮጅ ሞሽሮጅ ሮሮጅ ("qokeey.qokeey.chedy") <f76r.R.14>  
1 ሞሽሮጅ ሮሮጅ ሞሽሮጅ ("qokeey.chedy.qokeey") <f103r.P.53>
- 4 | 2 ጅሮጅ ሞሽሎ ሮሮጅ ("shedy.qokaiin.chedy") <f103v.P.6> <f107v.P.35>  
1 ሮሮጅ ሞሽሎ ጅሮጅ ("chedy.qokaiin.shedy") <f77r.P.8>  
1 ሞሽሎ ጅሮጅ ሮሮጅ ("qokaiin.shedy.chedy") <f77r.P.26>

- 3 | 2 **ϷοϷ δαιν ϷϷϷ** ("chol.daiin.cthy") <f3r.P.3> <f15v.P.11>  
 1 **δαιν ϷοϷ ϷϷϷ** ("daiin.chol.cthy") <f15r.P.3>
- 3 | 2 **ϷοϷ ϷοϷ δαιν** ("**chol.chol**.daiin") <f56v.P.15> <f56v.P.16>  
 1 **ϷοϷ δαιν ϷοϷ** ("**chol**.daiin.**chol**") <f24r.P.18>
- 3 | 2 **ϷϷοϷ ϷοϷ ϷοϷ** ("**cthor.chol.chor**") <f9v.P.2> <f15v.P.12>  
 1 **ϷοϷ ϷοϷ ϷϷοϷ** ("**chol.chor.cthor**") <f16v.P.9>
- 3 | 2 **δαιν δαιν δαϷ** ("**daiin.daiin**.dal") <f35v.P.12> <f66r.R.19>  
 1 **δαιν δαϷ δαιν** ("**daiin**.dal.**daiin**") <f108r.P.16>
- 3 | 2 **ϷοϷαϷ ϷϷδϷ ϷϷδϷ** ("qokar.**shedy.shedy**") <f76r.R.14> <f76r.R.22>  
 1 **ϷϷδϷ ϷοϷαϷ ϷϷδϷ** ("**shedy**.qokar.**shedy**") <f75r.P.32>
- 3 | 1 **ϷοϷϷδϷ ϷοϷϷϷϷ ϷϷδϷ** ("**qokedy.qokeey**.chedy") <f77r.P.13>  
 1 **ϷοϷϷϷϷ ϷοϷϷδϷ ϷϷδϷ** ("**qokeey.qokedy**.chedy") <f83r.P.25>  
 1 **ϷοϷϷδϷ ϷϷδϷ ϷοϷϷϷϷ** ("**qokedy.chedy.qokeey**") <f111v.P.5>
- 3 | 2 **ϷοϷϷδϷ ϷοϷϷϷϷ ϷοϷϷδϷ** ("**qokedy.qokeedy.qokedy**") <f76r.R.43> <f84r.P.3>  
 1 **ϷοϷϷϷϷ ϷοϷϷδϷ ϷοϷϷδϷ** ("**qokeedy.qokedy.qokedy**") <f75r.P.38>
- 3 | 2 **ϷοϷϷδϷ ϷοϷϷϷϷ ϷοϷϷϷϷ** ("**qokedy.qokeedy.qokeedy**") <f84r.P.10> <f108r.P.48>  
 1 **ϷοϷϷϷϷ ϷοϷϷϷϷ ϷοϷϷδϷ** ("**qokeedy.qokeedy.qokedy**") <f75r.P.38>
- 3 | 2 **ϷοϷϷϷϷ ϷοϷϷϷϷ ϷοϷϷϷϷ** ("**qokeey.qokeedy.qokeey**") <f108r.P.42> <f108v.P.13>  
 1 **ϷοϷϷϷϷ ϷοϷϷϷϷ ϷοϷϷϷϷ** ("**qokeey.qokeey.qokeedy**") <f108r.P.6>
- 3 | 2 **ϷοϷαϷ ϷϷδϷ ϷοϷϷδϷ** ("qokal.shedy.qokedy") <f77v.P.31> <f83r.P.23>  
 1 **ϷϷδϷ ϷοϷϷδϷ ϷοϷαϷ** ("shedy.qokedy.qokal") <f103r.P.32>
- 3 | 2 **ϷοϷαϷ ϷϷδϷ ϷοϷαϷ** ("qokal.chedy.qokaiin") <f77v.P.27> <f104r.P.34>  
 1 **ϷοϷαϷ ϷϷδϷ ϷοϷαϷ** ("qokaiin.chedy.qokal") <f83v.P.28>
- 3 | 2 **ϷοϷ ϷϷϷϷ ϷϷϷ** ("qol.cheey.chey") <f79r.P.14> <f103r.P.50>  
 1 **ϷϷϷϷ ϷοϷ ϷϷϷ** ("**cheey**.qol.**chey**") <f79r.P.6>

- 3 | 2 Շւծց օք Շւծց ("shedy.ol.shedy") <f81r.P.18> <f84v.P.33>  
 1 Շւծց Շւծց օք ("shedy.shedy.ol") <f34r.P.5>
- 3 | 2 Շւծց գոկան Շւց ("shedy.qokain.shey") <f75v.P2.15> <f115r.P.27>  
 1 Շւց գոկան Շւծց ("shey.qokain.shedy") <f103r.P.20>
- 3 | 2 Շւց գոկար Շւծց ("shey.qokar.shedy") <f79r.P.25> <f83v.P2.24>  
 1 գոկար Շւծց Շւց ("qokar.shedy.shey") <f106v.P.22>
- 3 | 2 օք շւծց գօք ("ol.chedy.qol") <f75v.P2.18> <f84v.P.14>  
 1 շւծց գօք օք ("chedy.qol.ol") <f81r.P.22>
- 3 | 2 օր ան օրար ("or.aain.otar") <f85r1.P.32> <f86v5.P.12>  
 1 օրար օր ան ("otar.or.aain") <f39v.P.5>
- 3 | 2 ճար ար ար ("dar.ar.al") <f39r.P.7> <f115r.P.8>  
 1 ար ճար ար ("al.dar.ar") <f105v.P.6>
- 3 | 2 շւց շւց գոկեց ("cheey.chey.qokeey") <f103r.P.50> <f108r.P.15>  
 1 շւց գոկեց շւց ("cheey.qokeey.chey") <f111v.P.47>
- 3 | 1 Շւծց գոկալ շւծց ("shedy.qokal.chedy") <f77v.P.5>  
 1 շւծց գոկալ Շւծց ("chedy.qokal.shedy") <f77v.P.7>  
 1 Շւծց շւծց գոկալ ("shedy.chedy.qokal") <f77v.P.8>
- 3 | 1 շոք շոք շոլ ("chol.cthol.shol") <f1v.P.6>  
 1 շոք շոլ շոք ("chol.shol.cthol") <f4r.P.2>  
 1 շոք շոք շոլ ("cthol.chol.shol") <f42r.P2.10>
- 3 | 1 շոք շ շոք ("chol.s.cheol") <f3r.P.16>  
 1 շոք շոք շ ("cheol.chol.s") <f49v.P.18>  
 1 շ շոք շոք ("s.cheol.chol") <f90v1.P.8>

## II. Labels

The following "labels" occur in the Astronomical section, in the Zodiac section and in the Pharmaceutical section. The list contains the findings sorted according to their occurrence on pages <f99>, <f101> and <f102>. Some similarly spelled labels, they are highlighted by underlining, occur together in different sections.

	Astronomical section <f67r1 - f70r2>	Zodiac section <f70v2 - f73v>	Pharmaceutical section <f88r - f89v> and <f99r - f102v1>
oḥaḥ ("okary")		<u>f72v3.S2.8</u>   <u>f73r.S2.2</u>	<u>f99r.L1.1</u>   f99r.L1.9
oḥ ("oky")		<u>f72v3.S2.3</u>   <u>f73r.S2.5</u> f73v.S2.2	<u>f99r.L1.3</u>   f99r.L2.5
oḥaḥaḥ ("otalam")		f70v2.S1.3	f99r.L1.12
oḥeoḥ ("okeoly")		f70v2.S2.14   f72v1.S1.4	f99r.L2.5a
oḥaḥ ("otaly")		f70v2.S2.11   f72v3.S2.12 f73r.S1.2   f84r.Y.13	f88r.t.6   f99v.L1.5
oḥoḥ ("otoky")	<u>f67r1.S.2</u>		<u>f88r.t.5</u>   f99v.L1.8
oḥaḥaḥ ("otaldy")	<u>f67r1.S.1</u>		<u>f88r.m.1</u>   f101v2.R1.2
oḥaḥ ("otal")		f72r2.S2.1   f73r.S2.7	f99v.L3.1   f101v2.R1.3
oḥoḥ ("okol")		f73v.S0.1   f82v.L3.13	f88r.m.4   f101v2.R2.1
oḥeoḥ ("ykeody")	<u>f69v.L.16</u>	<u>f73v.S1.7</u>	<u>f102v1.L1.1</u>
oḥeoḥ ("okeody")	<u>f69v.L.23</u> f70r1.X.1	f72v2.S1.14   f73r.S1.3 f73v.S1.1   <u>f73v.S1.8</u>	<u>f102v1.L1.2</u>
oḥeoḥ ("okeos")		f73r.S2.1   f73r.S1.16 f73v.S1.14	f102v2.L1.4
oḥoḥ ("otol")	f68r1.S.21	f77r.X.4	f102v2.L1.5
oḥoḥ ("otory")	f68r3.X.4		f88v.m.2   f102v2.L1.6
oḥeoḥ ("okody")	f69v.L.5	f70v2.S2.8	f102v2.L2.1
oḥaḥ ("oran")	f67r2.Z.8		f102v2.L3.1

### III. Glyph groups occurring seven times

As a control sample glyph groups occurring seven times were used. To obtain a limited sample, glyph groups, which also appear as subgroups of other groups, are excluded. For example,  $\alpha\lambda\lambda\omega$  ("chekain") occurs seven times. But also the following similar words exist:  $\kappa\alpha\lambda\lambda\omega$  ("kchekain"),  $\alpha\lambda\lambda\alpha\omega$  ("chekaiin") and  $\alpha\lambda\lambda\alpha\alpha\omega$  ("chekaiiin"). In order to obtain a valid definition and to limit the number of words to be analyzed, this type of words is excluded from the sample.

The following 20 words remain:  $\sigma\lambda\lambda\omega\delta\alpha\lambda$ ,  $\sigma\lambda\lambda\omega\delta\theta$ ,  $\tau\omega\alpha\omega$ ,  $\tau\omega\delta\alpha\lambda$ ,  $\tau\omega\alpha\alpha\theta$ ,  $\tau\omega\alpha\lambda\lambda\theta$ ,  $\tau\omega\alpha\lambda\lambda\omega$ ,  $\tau\omega\lambda\theta$ ,  $\lambda\lambda\omega\delta\theta$ ,  $\lambda\lambda\omega\delta\theta$ ,  $\lambda\lambda\alpha\lambda$ ,  $\lambda\lambda\alpha\lambda\theta$ ,  $\alpha\sigma\lambda\lambda\theta$ ,  $\alpha\lambda\lambda\theta$ ,  $\alpha\lambda\lambda\theta\theta$ ,  $\alpha\lambda\lambda\theta\delta\theta$ ,  $\alpha\lambda\lambda\omega$ ,  $\delta\alpha\omega\delta\theta$ ,  $\delta\alpha\lambda\alpha\lambda$ .

The result is that there are 35 consecutive pages ( $35/((7-1)*20)=29.2\%$ ) and 118 similar words ( $115/(7*20)=82.1\%$ ) with a maximum distance of three lines. With other words it is a 80 % rule for the VMS that similar words are used together on the same pages in lines near to each other. With respect to labels, all labels occurring near to each other are treated as in one line. In 60 cases ( $60/(7*20)=42.9\%$ ) the similar words appear together in the same line or in two consecutive lines one above the other.

---

The first word is **oṭeodar** ("oteodar"). **oṭeodar** occurs seven times: <f41v.P.4> <f70r2.C.2> <f71v.R1.1> <f72r1.R2.1> <f72r3.R2.1> <f72v2.S1.10> <f105r.P2.35>. One additional observation is that **oṭeodar** occurs on subsequent sheets (>). On page <f71v> and <f105r> two similar sequences occur **oṭar oṭam oteodar** and **qoṭar oṭeodar oṭam**.

Consecutive pages: f70r2.C.2 > f71v.R1.1 > f72r1.R2.1 > f72r3.R2.1 > f72v2.S1.10

Similar sequences: <f71v.R1.1>            **oṭar oṭam oteodar**            ("otar.otam.oteodar")  
   <f105r.P2.35>            **qoṭar oṭeodar oṭam**            ("(q)otar.oteodar.otam")

Similarities: <f41v.P.4> **oṭeodar** ("oteodar") | <f41v.P.5> **oṭeody** ("oteody")  
                 <f70r2.C.2> **oṭeodar** ("oteedar") ... **oṭeodar** ("oteodar") | <f70r2.C.3> **oṭeody** ("oteedy") | <f70r2.C.4> **oṭoy ar** ("otoy.ar")  
                 <f71v.R1.1> **oṭeodar** ("oteodar") ... **oṭeodaly** ("okeodaly")<sup>43</sup>  
                 <f72r1.R2.1> **oṭeodar** ("oteodar") ... **oṭeorar** ("oteorar")  
                 <f72r3.R1.1> **oṭeodar** ("o~~keo~~\*ar")<sup>44</sup> | <f72r3.R2.1> **oṭeodar** ("oteodar") ... **oṭeody** ("oteody") ... **oṭeody** ("o~~keo~~dy")  
                 <f72v2.S1.10> **oṭeodar** ("oteodar") | <f72v2.S1.14> **oṭeody** ("o~~keo~~dy")<sup>45</sup>  
                 <f105r.P2.29> **oṭeodar** ("oleedar") | <f105r.P2.34> **oṭar** ("otar") | <f105r.P2.35> **oṭar** ("otar") ... **oṭeodar** ("oteodar")

Word count: "otar" (F=141 times ED=3)<sup>46</sup>; "oteedy" (F=100 ED=3); "oteody" (F=39 ED=2); "o~~keo~~dy" (F=37 ED=3); "o~~keo~~dar" (F=4 ED=1); "otoy" (F=3) "otoy.ar" (ED=3); "o~~keo~~daly" (F=2 ED=3); "oleedar" (F=1 ED=3); "oteedar" (F=1 ED=1); "oteorar" (F=1 ED=1)

Result: 4 consecutive pages; 7 similarities (max. distance 3 lines); 2 similarities (standing next to each other)

---

<sup>43</sup> In line <f71v.R1.1> also a word "\*\*\*\*eodal" occurs in the transcription of Takahashi. From the scans available today this is probably **oṭeodaly** or **oṭeodaly** (see [http://www.jasondavies.com/voynich/#f71v\\_f72r1\\_f72r2\\_f72r3/0.269/0.526/6.00](http://www.jasondavies.com/voynich/#f71v_f72r1_f72r2_f72r3/0.269/0.526/6.00)).

<sup>44</sup> "o~~keo~~\*ar" in line <f72r3.R1.1> is probably **oṭeodar** ("o~~keo~~dar").

<sup>45</sup> **oṭeodar** ("oteodar") in <f72v2.S1.10> and **oṭeody** ("o~~keo~~dy") in <f72v2.S1.14> are used as labels.

<sup>46</sup> F=frequency, ED=edit distance

ጳጳሮዳ ("olkeedy") occurs twice on two consecutive sheets (>). ጳጳሮዳ occurs 7 times: <f51v.P.8> <f71r.R1.1> <f85r1.P.29> <f86v5.P.35> <f104r.P.17> <f105r.P.2.14> <f115v.P.25>.

Consecutive pages: f85r1.P.29 > f86v5.P.35  
f104r.P.17 > f105r.P.2.14

Similarities: <f51v.P.6> ሸሮዳ ("ctheody") | <f51v.P.7> ጳጳሮዳ ("qokcheody") | <f51v.P.8> ጳጳሮዳ ("olkeedy")  
<f71r.R1.1> ጳጳሮዳ ሰጣዳ ("olkeedy.okody") ... ሰጣሽ ሰጣዳ ("okeoky.oteody") ... ሰጣሽሰጣሽሰጣዳ ("okeokeokeody")  
<f85r1.P.25> ሰጣዳ ("oteody") | <f85r1.P.28> ሰጣረዳ ("okchdy") | <f85r1.P.29> ጳጳሮዳ ("olkeedy")  
[Not counted: <f86v5.P.30> ሰጣ ሰጣዳ ("ol.teody") | <f86v5.P.35> ጳጳሮዳ ("olkeedy")]  
<f104r.P.16> ጳጳሮዳ ("ykeodey") | <f104r.P.17> ጳጳሮዳ ("olkeedy") | <f104r.P.19> ጳጳረዳ ("olkchedy")  
<f105r.P.2.13> "keedy" ... ሰጣሽሰጣዳ ("oekeody") | <f105r.P.2.14> ሰጣረዳ ጳጳሮዳ ("okeedy.olkeedy")  
<f115v.P.19> ሰጣዳ ("keedy") | <f115v.P.22> ጳጳሮዳ ("qokeedy") | <f115v.P.25> ጳጳሮዳ ("olkeedy")

Word count: "qokeedy" (F=305 times ED=3); "okeedy" (F=105 times ED=2); "lkeedy" (F=41 ED=2); "oteody" (F=39 ED=3);  
"okchdy" (F=21 ED=3); "okeeody" (F=16 ED=1); "okody" (F=16 ED=3); "yteody" (F=9 ED=3); "teody" (F=8) "ol.teody" (ED=2);  
"keedy" (F=8 ED=2); "olkchedy" (F=6 ED=2); "lkeody" (F=4 ED=2); "qokcheody" (F=3 ED=3); "oekeody" (F=2 ED=3);  
"ykeodey" (F=1 ED=3)

Result: 2 consecutive pages; 6 similarities (max. distance 3 lines); 3 similarities (standing next to each other)

---

ጳጳጠ ("goain") occurs 7 times: <f17v.P.17> <f50v.P.4> <f103v.P.38> <f111r.P.22> <f112r.P.23> <f114r.P.1.30> <f116r.P.12>

Consecutive pages: f111r.P.22 > f112r.P.23

Similarities: <f17v.P.12> ጳጳጠ ("koaiin") | <f17v.P.17> ጳጳጠ ("goain") | <f17v.P.19> ጳጳጠ ("goaiin")  
<f50v.P.3> ሰጳጠ ("okain") | <f50v.P.4> ጳጳጠ ("goain")  
<f103v.P.38> ጳጳጠ ("goain") | <f103v.P.39> ጳጳጠ ("goar")  
<f111r.P.19> ሰጳጠ ("oaiin") | <f111r.P.22> ጳጳጠ ("goain") | <f111r.P.23> ሰጳጠ ("okain") | <f111r.P.26> ጳጳጠ ("soaiin")  
<f112r.P.20> ጳጳጠ ("goaiin") | <f112r.P.23> ጳጳጠ ጳጳጠ ("goain.qoiin")  
<f114r.P.1.30> ጳጳጠ ("goaiin") ... ጳጳጠ ሰጳጠ ("goain.ain") | <f114r.P.1.31> ሰጳጠ ("okain") | <f114r.P.1.32> ጳጳጠ ("qokaiin")  
<f116r.P.11> ሰጳጠ ("aiin") ... ጳጳጠ ("qotain") | <f116r.P.12> ጳጳጠ ("goain") | <f116r.P.13> ጳጳጠ ("qokain")

Word count: "aiin" (F=469 ED=3); "qokain" (F=279 times ED=1); "qokaiin" (F=262 ED=2); "okain" (F=212 ED=3); "otaiin" (F=154 ED=3);  
"okain" (F=144 ED=2); "aiin" (F=89 ED=2); "qotain" (F=64 ED=1); "oaiin" (F=26 ED=2); "goaiin" (F=23 ED=1);  
"goar" (F=12 ED=1); "qodain" (F=11 ED=1); "oain" (F=11 ED=1); "koaiin" (F=3 ED=3); "qoiin" (F=3 ED=2)

Result: 1 consecutive page; 7 similarities (max. distance 3 lines); 5 similarities (standing next to each other)

---



ᄀᄃᄃᄃ ("godal") occurs for four consecutive sheets (>) and twice on page <f53v> (=). ᄀᄃᄃᄃ occurs seven times: <f51v.P.4> <f52r.P.6> <f53v.P.9> <f53v.P.10> <f54v.P.9> <f85r1.P.8> <f104r.P.35>.

Consecutive pages: f51v.P.4 > f52r.P.6 > f53v.P.9 = f53v.P.10 > f54v.P.9

Similarities: <f51v.P.1> ᄀᄃᄃᄃᄃᄃ ("qokodar") | <f51v.P.2> ᄀᄃᄃᄃ ("qokol") | <f51v.P.4> ᄀᄃᄃᄃ ("godal")  
<f52r.P.2> ᄃᄃᄃᄃᄃ ("koldal") ... ᄃᄃᄃ "dal" | <f52r.P.3> ᄀᄃᄃᄃᄃ ("gotam") | <f52r.P.4> ᄃᄃᄃᄃ ("dar") | <f52r.P.6> ᄀᄃᄃᄃ ("godal")  
<f53v.P.4> ᄀᄃᄃᄃ ("qokol") | <53v.P.9> ᄀᄃᄃᄃ ("godal")  
| <53v.P.10> ᄀᄃᄃᄃ ("godal")  
<f54v.P.8> ᄃᄃᄃᄃ ("okal") | <f54v.P.9> ᄀᄃᄃᄃ ("godal") ... ᄃᄃᄃᄃ ("okal") | <f54v.P.10> ᄀᄃᄃᄃᄃ ("gokal")  
<f85r1.P.7> ᄀᄃᄃᄃᄃᄃ ("qopar") | <f85r1.P.8> ᄀᄃᄃᄃ ("godal") ... ᄃᄃᄃᄃ ("dal")  
<f104r.P.33> ᄀᄃᄃᄃᄃ ("qokal") | <f104r.P.34> ᄀᄃᄃᄃᄃ ("qokal") | <f104r.P.35> ᄀᄃᄃᄃ ("godal") | <f104r.P.36> ᄀᄃᄃᄃᄃᄃ ("gotaly")

Word count: "dar" (F=318 times ED=3); "dal" (F=215 ED=2); "qokal" (F=191 ED=2); "qokar" (F=152 ED=3); "okal" (F=138 ED=3);  
"qokol" (F=104 ED=3); "gotam" (F=12 ED=3); "qopar" (F=5 ED=3); "gotaly" (F=5 ED=3); "koldal" (F=2 ED=3);  
"qokodar" (F=1 ED=3)

Result: 4 consecutive pages; 7 similarities (max. distance 3 lines); 4 similarities (standing next to each other)

---

ᄀᄃᄃᄃᄃ ("goeey") occurs seven times: <f5r.P.6> <f68v2.P.3> <f86v3.P1.2> <f102v2.P2.16> <f104v.P.4> <f106v.P.13> <f112v.P.19>

Similarities: <f5r.P.6> ᄀᄃᄃᄃᄃ ᄀᄃᄃᄃᄃᄃᄃ ("goeey.qoykeey") | <f5r.P.7> ᄀᄃᄃᄃᄃᄃ ("qotoeey")  
<f68v2.P.2> ᄀᄃᄃᄃᄃ ("qokeey") | <f68v2.P.3> ᄀᄃᄃᄃᄃ ("goeey")  
<f86v3.P1.1> ᄀᄃᄃᄃᄃᄃ ("qokeedy") | <f86v3.P1.2> ᄀᄃᄃᄃᄃ ("goeey") | <f86v3.P1.4> ᄀᄃᄃᄃᄃ ("goeedy")  
<f102v2.P2.15> ᄃᄃᄃᄃᄃ ("okeey") | <f102v2.P2.16> ᄀᄃᄃᄃᄃᄃ ("goeey")  
<f104v.P.3> ᄀᄃᄃᄃᄃᄃ ("qokeedy") | <f104v.P.4> ᄃᄃᄃᄃ ("chey") ... ᄀᄃᄃᄃᄃ ᄀᄃᄃᄃᄃᄃᄃ ("goeey.qokeedy")  
<f106v.P.10> ᄃᄃᄃᄃᄃ ("oteey") | <f106v.P.11> ᄃᄃᄃᄃᄃᄃ ("sheedy") | <f106v.P.12> ᄀᄃᄃᄃᄃᄃ ("goeedy") | <f106v.P.13> ᄀᄃᄃᄃᄃᄃ ("goeey")  
<f112v.P.18> ᄃᄃᄃᄃ ᄀᄃᄃᄃᄃᄃ ᄀᄃᄃᄃᄃᄃᄃ ("chey.qokeedy.qokeey") | <f112v.P.19> ᄀᄃᄃᄃᄃᄃ ("goeey")

Word count: "chey" (F=344 times ED=3); "qokeey" (F=308 ED=2); "qokeedy" (F=305 ED=3); "okeey" (F=177 ED=3); "oteey" (F=140 ED=3);  
"qokeey" (F=26 ED=1); "goeedy" (F=20 ED=2); "oey" (F=6 ED=2); "qokeey" (F=2 ED=1); "qotoeey" (F=2 ED=3);  
"qoykeey" (F=1 ED=2)

Result: 0 consecutive pages; 7 similarities (max. distance 3 lines); 5 similarities (standing next to each other)

---

ᄒᄒᄒᄒ ("gockhy") occurs seven times: <f4v.P.4> <f13v.P.9> <f37v.P.1> <f54v.P.10> <f89r1.P.1.2> <f90r1.P.7> <f107r.P.32>  
Consecutive pages: f89r1.P.1.2 > f90r1.P.7

Similarities: <f4v.P.2> ᄒᄒᄒᄒ ("cthy") | <f4v.P.4> ᄒᄒᄒᄒ ᄒᄒᄒᄒ ("gokshy.gockhy") | <f4v.P.9> ᄒᄒᄒᄒ ("chcthy")  
<f13v.P.8> ᄒᄒᄒᄒ ("otchy") | <f13v.P.9> ᄒᄒᄒᄒ ("gockhy") | <f14r.P.2> ᄒᄒᄒᄒ ("gokchy")  
[No similarities found: <f37v.P.1> "gockhy"]  
<f54v.P.9> ᄒᄒᄒᄒ ("gockhey") | <f54v.P.10> ᄒᄒᄒᄒ ("chckhy") ... ᄒᄒᄒᄒ ("gockhy") | <f54v.P.11> ᄒᄒᄒᄒ ("gockhy")  
[Not counted: <f89r1.P.1.2> ᄒᄒᄒᄒ ("gockhy") | <f89r1.P.2.6> ᄒᄒᄒᄒ ("gocphey")]  
<f90r1.P.5> ᄒᄒᄒᄒ ("ckhy") | <f90r1.P.7> ᄒᄒᄒᄒ ᄒᄒᄒᄒ ("gockhy.gokcho")  
<f107r.P.32> ᄒᄒᄒᄒᄒᄒ ("gockhedy") ... ᄒᄒᄒᄒ ("gockhy")

Word count: "cthy" (F=111 times ED=2); "chcthy" (F=79 ED=3); "gokchy" (F=69 ED=2); "ckhy" (F=39 ED=3); "gockhy" (F=20 ED=1);  
"gokshy" (F=10 ED=3); "gokcho" (F=10 ED=3); "gockhedy" (F=4 ED=3); "gocphey" (F=1 ED=2)

Result: 1 consecutive pages; 5 similarity (max. distance 3 lines); 2 similarities (standing next to each other)

---

For ᄒᄒᄒᄒᄒᄒ ("gockhol") there is a sequence of four sheets. There are similar sequences, this time in  
reverse order ᄒᄒᄒᄒᄒᄒ ᄒᄒᄒᄒᄒᄒ vs. ᄒᄒᄒᄒᄒᄒ ᄒᄒᄒᄒᄒᄒ. ᄒᄒᄒᄒᄒᄒ occurs seven times: <f83r.P.12> <f88v.P.2.8>  
<f93v.P.3> <f99v.P.3.13> <f100r.P.2.6> <f101r1.P.1> <f101v2.P.6>  
Consecutive pages: f99v.P.3.13 > f100r.P.2.6 > f101r1.P.1 > f101v2.P.6

Similar sequences: <f101r1.P.1> ᄒᄒᄒᄒᄒᄒ ᄒᄒᄒᄒᄒᄒ ("gockhol.(s)hor.yteol")  
<f101v2.P.6> ᄒᄒᄒᄒᄒᄒ ᄒᄒᄒᄒᄒᄒ ("yteol.chor.gockhol")

Similarities: <f83r.P.12> ᄒᄒᄒᄒᄒᄒ ("gockhol") ... ᄒᄒᄒᄒᄒᄒ ("gokeal")  
<f88v.P.1.3> ᄒᄒᄒᄒᄒᄒ ("goekeol") | <f88v.P.2.8> ᄒᄒᄒᄒᄒᄒ ᄒᄒᄒᄒ ("gockhol.okol")  
<f93v.P.2> ᄒᄒᄒᄒᄒᄒ ("gotchol") | <f93v.P.3> ᄒᄒᄒᄒᄒᄒ ("gockhol") | <f93v.P.4> ᄒᄒᄒᄒᄒᄒ ("gokchol")  
<f99v.P.3.11> ᄒᄒᄒᄒᄒᄒ ("gokeeor") | <f99v.P.3.11c> ᄒᄒᄒᄒᄒᄒ ("gokeol") | <f99v.P.3.13> ᄒᄒᄒᄒᄒᄒ ("gockhol")  
<f100r.P.1.3> ᄒᄒᄒᄒᄒᄒ ("gokeol") | <f100r.P.1.4> ᄒᄒᄒᄒᄒᄒ ("gokeeor") | <f100r.P.2.5> ᄒᄒᄒᄒᄒᄒ ("ycheol.cphol")  
| <f100r.P.2.6> ᄒᄒᄒᄒᄒᄒ ᄒᄒᄒᄒᄒᄒ ᄒᄒᄒᄒᄒᄒ ("chol.cphol.shol.shol.gockhol")  
<f101r1.P.1> ᄒᄒᄒᄒᄒᄒ ("gockhol") | <f101r1.P.2> ᄒᄒᄒᄒᄒᄒ ("gokeol") | <f101r1.P.4> ᄒᄒᄒᄒᄒᄒ ("gockheol")  
<f101v2.P.3> ᄒᄒᄒᄒᄒᄒ ("keeor") ... ᄒᄒᄒᄒᄒᄒᄒ ("\*\*opcheol") | <f101v2.P.4> ᄒᄒᄒ ᄒᄒᄒᄒᄒᄒ ("gok.ykeol")  
| <f101v2.P.5> ᄒᄒᄒᄒᄒᄒ ᄒᄒᄒᄒᄒᄒ ("gokeor.qkhol") | <f101v2.P.6> ᄒᄒᄒᄒᄒᄒ ("gockhol") | <f101v2.T.9> ᄒᄒᄒᄒᄒᄒ ("cthol")

Word count: "gokeol" (F=52 times ED=2); "gokchol" (F=18 ED=1); "cphol" (F=15 ED=3); "gotchol" (F=13 ED=2); "gokeeor" (F=11 ED=2);  
"gokeeor" (F=10 ED=3); "gokeor" (F=5 ED=3); "gockheol" (F=4 ED=1); "gokeal" (F=1 ED=3); "goekeol" (F=1 ED=1);  
"qkhol" (F=1 ED=2)

Result: 3 consecutive pages; 7 similarities (max. distance 3 lines); 4 similarities (standing next to each other)

---

ᄡᄢᄠᄠᄡᄢ ("golkeedy") occurs seven times: <f76v.P.18> <f79r.P.24> <f79v.P.5> <f79v.P.11> <f83v.P.2.16> <f84v.P.25> <f115v.P.26>  
Consecutive pages: f79r.P.24 >= f79v.P.5 = f79v.P.11  
f83v.P.2.16 > f84v.P.25

Similarities: <f76v.P.14> ᄡᄠᄠᄠᄡᄢ ("gokeedy") ... ᄡᄠᄠᄠᄡᄢ ("qoteedy") | <f76v.P.16> ᄡᄠᄠᄠᄡᄢ ("qokedy")  
| <f76v.P.18> ᄡᄠᄠᄠᄡᄢ ᄡᄠᄠᄠᄡᄢ ("golkeedy.qokedy")  
<f79r.P.24> ᄡᄠᄠᄠᄡᄢ ᄡᄠᄠᄠᄡᄢ ᄡᄠᄠᄠᄡᄢ ("golkeey.golkeedy.qokedy") | <f79r.P.26> ᄡᄠᄠᄠᄡᄢ ᄡᄠᄠᄠᄡᄢ ("olteedy.qotchey")  
<f79v.P.2> ᄡᄠᄠᄠᄡᄢ "qoteedy" | <f79v.P.4> ᄡᄠᄠᄠᄡᄢ ᄡᄠᄠᄠᄡᄢ ("gokeedy.gokeedy") | <f79v.P.5> ᄡᄠᄠᄠᄡᄢ ᄡᄠᄠᄠᄡᄢ ("golkeedy.qokedy")  
| <f79v.P.7> ᄡᄠᄠᄠᄡᄢ ᄡᄠᄠᄠᄡᄢ ᄡᄠᄠᄠᄡᄢ ("gokeedy.qol.kedy.gokeedy") | <f79v.P.9> ᄡᄠᄠᄠᄡᄢ ("gokeedy")  
| <f79v.P.10> ᄡᄠᄠᄠᄡᄢ ("gokeey") | <f79v.P.11> ᄡᄠᄠᄠᄡᄢ ("golkeedy")  
<f83v.P.2.16> ᄡᄠᄠᄠᄡᄢ ᄡᄠᄠᄠᄡᄢ ᄡᄠᄠᄠᄡᄢ ("solkeedy.gokeedy.gokeedy") ... ᄡᄠᄠᄠᄡᄢ ᄡᄠᄠᄠᄡᄢ ("gokeedy.golkeedy")  
| <f83v.P.2.17> ᄡᄠᄠᄠᄡᄢ ᄡᄠᄠᄠᄡᄢ ("golteedy.gokeedy")  
<f84v.P.25> ᄡᄠᄠᄠᄡᄢ ("golkeedy") | <f84v.P.26> ᄡᄠᄠᄠᄡᄢ ("qokedy")  
<f115v.P.25> ᄡᄠᄠᄠᄡᄢ ("olkeedy") ... ᄡᄠᄠᄠᄡᄢ ("gokeedy") | <f115v.P.26> ᄡᄠᄠᄠᄡᄢ ("golkeedy")

Word count: "gokeey" (F=308 times ED=2); "gokeedy" (F=305 times ED=1); "qokedy" (F=272 ED=2); "okeedy" (F=105 ED=2);  
"qoteedy" (F=74 ED=2); "olkeedy" (F=7 ED=2); "golkeedy" (F=6 ED=1); "solkeedy" (F=5 ED=2); "qol.kedy" (F=2 ED=1);  
"golteedy" (F=1 ED=1)

Result: 3 consecutive pages; 7 similarities (max. distance 3 lines); 7 similarities (standing next to each other)

---

ᄡᄠᄡᄢ ("qoly") occurs seven times: <f75r.P.26> <f75v.P.3.26> <f79r.P.16> <f79v.P.20> <f80v.P.4> <f80v.P.34> <f82r.P.2.19>  
Consecutive pages: f75r.P.26 >= f75v.P.3.26  
f79r.P.16 >= f79v.P.20 > f80v.P.4 = f80v.P.34

Similarities: <f75r.P.26> ᄡᄠᄡᄢ ("qoly") | <f75r.P.27> ᄡᄠᄠᄢ ("goty")  
<f75v.P.2.23> ᄡᄠᄡᄢ ("qol") | <f75v.P.3.26> ᄡᄠᄡᄢ ("qoly") | <f75v.P.3.27> ᄡᄠᄡᄢ ("qol") ... ᄡᄠᄡᄢ ᄡᄠᄡᄢ ("oldy.oly")  
<f79r.P.14> ᄡᄠᄡᄢ ("qol") | <f79r.P.15> ᄡᄠᄠᄢ ("qokl") | <f79r.P.16> ᄡᄠᄡᄢ ("qoly") | <f79r.P.19> ᄡᄠᄡᄢ ("oly")  
<f79v.P.16> ᄡᄠᄡᄢ ("qol") ... ᄡᄠᄡᄢ ("oly") | <f79v.P.17> ᄡᄠᄠᄢ ("qoky") | <f79v.P.20> ᄡᄠᄠᄢ ("oty") ... ᄡᄠᄡᄢ ("qoly")  
<f80v.P.1> ᄡᄠᄡᄢ ("roly") | <f80v.P.2> ᄡᄠᄡᄢ "daly" | <f80v.P.3> ᄡᄠᄡᄢ ("qol") | <f80v.P.4> ᄡᄠᄡᄢ ("qoly") | <f80v.P.5> ᄡᄠᄡᄢ ("ol")  
| <f80v.P.30> ᄡᄠᄠᄢ ("qolky") | <f80v.P.32> ᄡᄠᄠᄢ ("olky") | <f80v.P.34> ᄡᄠᄡᄢ ("qoly") | <f80v.P.35> ᄡᄠᄡᄢ ("qol")  
<f82r.P.1.17> ᄡᄠᄡᄢ ("ory") | <f82r.P.2.19> ᄡᄠᄡᄢ ("qoly") | <f82r.P.2.20> ᄡᄠᄡᄢ ("qol") | <f82r.P.2.21> ᄡᄠᄡᄢ ("qol")

Word count: "ol" (F=537 times ED=2); "qol" (F=151 ED=1); "qoky" (F=147 ED=2); "oty" (F=115 ED=3); "goty" (F=87 ED=2);  
"oly" (F=57 ED=1); "daly" (F=30 ED=3); "oldy" (F=28 ED=2); "olky" (F=22 ED=2); "ory" (F=17 ED=2); "qolky" (F=4 ED=1);  
"roly" (F=3)

Result: 4 consecutive pages; 7 similarities (max. distance 3 lines); 3 similarities (standing next to each other)

---

ՂԶւծց ("rshedy") occurs seven times: <f75r.P.40> <f78v.P.2> <f78v.P.16> <f79r.P.3> <f82r.P.2.26> <f82v.P.16> <f84r.P.11>

Consecutive pages: f78v.P.2 = f78v.P.16 > f79r.P.3  
f82r.P.2.26 >= f82v.P.16

Similarities: <f75r.P.39> ցԶւծց ("yshedy") | <f75r.P.40> ՂԶւծց ("rshedy") | <f75r.P.42> ճԶւծց ("dshedy")  
<f78v.P.2> օղԶւծց ("olshedy") ... ՂԶւծց ("rshedy") | <f78v.P.3> գօղԶւծց ("golshedy") | <f78v.P.4> չԶւծց ("lshedy")  
| <f78v.P.16> չԶււց ՂԶւծց ("lshey.rshedy") | <f78v.P.17> գօղ Զււծց ("gol.sheedy") | <f78v.P.19> չաւծց ("lchedy")  
<f79r.P.2> չԶւծց ("lshdy") | <f79r.P.3> ՂԶւծց ("rshedy") ... Ղաւծց ("rchedy")  
<f82r.P.2.26> փԶւծց ("pchedy") ... ՂԶւծց ("rshedy") | <f82r.P.2.28> չաւծց ("lchedy") ... չաւծց Ղաւծց ("lchedy.rchedy")  
<f82v.P.11> Ղաւծց փԶւծց ("rchedy.pchedy") | <f82v.P.16> ՂԶւծց ("rshedy") | <f82v.P.19> ցԶւծց ("yshedy")  
<f84r.P.9> չԶւծց ("lshedy") | <f84r.P.11> ՂԶւծց ("rshedy") | <f84r.P.13> փԶւծց ("pchedy")

Word count: "lchedy" (F=119 times ED=2); "sheedy" (F=84 ED=2); "lshedy" (F=42 ED=1); "pchedy" (F=34 ED=2); "dshedy" (F=36 ED=1);  
"dchedy" (F=27 ED=2); "olshedy" (F=23 ED=2); "lshey" (F=18 ED=2); "rchedy" (F=11 ED=1); "yshedy" (F=10 ED=2);  
"sshedy" (F=5 ED=1); "lshdy" (F=2 ED=2); "golshedy" (F=2 ED=3)

Result: 3 consecutive pages; 7 similarities (max. distance 3 lines); 3 similarities (standing next to each other)

---

For Ղաւծց ("schedy") two sets of consecutive sheets exists. Ղաւծց occurs seven times: <f40v.P.11> <f77v.P.32> <f78r.P.7> <f80v.P.3>  
<f81v.P.7> <f83r.P.6> <f106v.P.14>

Consecutive pages: f77v.P.32 > f78r.P.7  
f80v.P.3 > f81v.P.7

Similarities: <f40v.P.10> փԶւծց ("tchedy") | <f40v.P.11> Ղաւծց ("schedy") | <f40v.P.14> կԶւծց ("kchedy")  
<f77v.P.31> Զւծց ("shedy") | <f77v.P.32> Ղաւծց ("schedy") | <f77v.P.33> Զւծց ("shedy") | <f77v.P.34> կԶւծց ("kchedy")  
<f78r.P.6> ճԶւծց ("dshedy") | <f78r.P.7> Ղաւծց ("schedy") | <f78r.P.8> ճԶւծց ("dshedy")  
<f80v.P.2> փԶւծց ("tshedy") | <f80v.P.3> Ղաւծց ("schedy")  
<f81v.P.6> աւծց ("chedy") | <f81v.P.7> Ղաւծց ("schedy") | <f81v.P.8> փԶւծց ("cphedy")  
<f83r.P.5> ճԶււց ("dsheey") | <f83r.P.6> Ղաւծց աւծա ("schedy.chedchy")  
<f106v.P.11> կԶւծց ("kshedy") | <f106v.P.13> կԶւծց ("kchedy") | <f106v.P.14> Ղաւծց ("schedy")

Word count: "chedy" (F=501 times ED=1); "shedy" (F=426 ED=2); "dshedy" (F=36 ED=2); "pchedy" (F=34 ED=2); "tchedy" (F=33 ED=2);  
"kchedy" (F=22 ED=2); "cphedy" (F=8 ED=2); "tshedy" (F=8 ED=2); "dsheey" (F=8 ED=3); "kshedy" (F=6 ED=2);  
"chedchy" (F=1 ED=3)

Result: 2 consecutive pages; 7 similarities (max. distance 3 lines); 5 similarities (standing next to each other)

---

𐌸𐌶𐌹 ("sham") occurs twice on a single page and on two subsequent sheets. Furthermore, in five out of seven cases it is the last group within a line. 𐌸𐌶𐌹 occurs seven times: <f24r.P.16> <f24r.P.17> <f78v.P.25> <f85r1.P.17> <f106v.P.11> <f115v.P.38> <f116r.Q.37>

Consecutive pages: f24r.P.16 = f24r.P.17  
f115v.P.38 > f116r.Q.37

Similarities: <f24r.P.14> 𐌸𐌶𐌹 ("char") | <f24r.P.16> 𐌸𐌶𐌹 ("sham") ... 𐌸𐌶𐌹 ("dam") | <f24r.P.17> 𐌸𐌶𐌹 ("sham")  
<f78v.P.24> 𐌸𐌶𐌹 ("shol") | <f78v.P.25> 𐌸𐌶𐌹 ("sham")  
<f85r1.P.17> 𐌸𐌶𐌹 ("shor") ... 𐌸𐌶𐌹 ("sham") | <f85r1.P.18> 𐌸𐌶𐌹 ("dam") | <f85r1.P.19> 𐌸𐌶𐌹 𐌸𐌶𐌹 ("dam.lam")  
<f106v.P.9> 𐌸𐌶𐌹 𐌸𐌶𐌹 ("sheas.am") | <f106v.P.11> 𐌸𐌶𐌹 ("sham")  
<f115v.P.35> 𐌸𐌶𐌹 𐌸𐌶𐌹 ("lcham") | <f115v.P.38> 𐌸𐌶𐌹 ("sham")  
<f116r.Q.37> 𐌸𐌶𐌹 𐌸𐌶𐌹 ("cheam.sham") | <f116r.Q.42> 𐌸𐌶𐌹 ("cham")

Word count: "shol" (F=186 ED=2); "dam" (F=98 ED=3); "shor" (F=97 ED=2); "char" (F=72 ED=2); "cham" (F=20 ED=1); "am" (F=8 ED=2); "lam" (F=6 ED=3); "cheam" (F=5 ED=2); "lcham" (F=1 ED=2); "sheas" (F=1 ED=2)

Result: 2 consecutive pages; 7 similarities (max. distance 3 lines); 2 similarities (standing next to each other)

---

𐌸𐌸𐌸𐌸 ("shcthey") occurs seven times: <f10v.P.4> <f21r.P.9> <f31r.P.9> <f68v2.P.1> <f77r.P.3> <f83r.P.11> <f111v.P.19>

Similarities: <f10v.P.1> 𐌸𐌸𐌸𐌸 ("cthor") | <f10v.P.2> 𐌸𐌸𐌸𐌸 ("cthy") | <f10v.P.4> 𐌸𐌸𐌸𐌸 ("shcthey") | <f10v.P.6> 𐌸𐌸𐌸𐌸 ("shcthy")  
<f21r.P.9> 𐌸𐌸𐌸𐌸 ("shcthey") | <f21r.P.10> 𐌸𐌸𐌸𐌸 ("ctheey") | <f21r.P.11> 𐌸𐌸𐌸𐌸 ("chcthy")  
<f31r.P.7> 𐌸𐌸𐌸𐌸 ("checkhey") | <f31r.P.8> 𐌸𐌸𐌸𐌸 ("checthy") | <f31r.P.9> 𐌸𐌸𐌸𐌸 ("shcthey")  
<f68v2.P.1> 𐌸𐌸𐌸𐌸 ("shcthey") ... 𐌸𐌸𐌸𐌸 ("shocthy") | <f68v2.P.2> 𐌸𐌸𐌸𐌸 ("shekeey") ... 𐌸𐌸𐌸𐌸 ("sheetey")  
| <f68v2.P.3> 𐌸𐌸𐌸𐌸 ("shekeey")  
<f77r.P.2> 𐌸𐌸𐌸𐌸 ("chetey") | <f77r.P.3> 𐌸𐌸𐌸𐌸 ("shcthey")  
<f83r.P.11> 𐌸𐌸𐌸𐌸 ("shcthey") | <f83r.P.12> 𐌸𐌸𐌸𐌸 ("sheckhy") ... 𐌸𐌸𐌸𐌸 ("cseckhdy")  
<f111v.P.16> 𐌸𐌸𐌸𐌸 ("chckhey") | <f111v.P.17> 𐌸𐌸𐌸𐌸 ("chckhy") | <f111v.P.19> 𐌸𐌸𐌸𐌸 ("shcthey")  
| <f111v.P.20> 𐌸𐌸𐌸𐌸 ("shcthy")

Word count: "chckhy" (F=140 times ED=3); "cthy" (F=111 ED=3); "chcthy" (F=79 ED=2); "sheckhy" (F=35 ED=3); "shcthy" (F=31 ED=1); "chckhey" (F=30 ED=2); "checthy" (F=28 ED=3); "shocthy" (F=12 ED=2); "shckhey" (F=12 ED=1); "chcphy" (F=11 ED=3); "checkhey" (F=10 ED=2); "shekeey" (F=6 ED=2); "chetey" (F=5 ED=3); "sheetey" (F=2 ED=2); "cseckhdy" (F=1 ED=3)

Result: 0 consecutive pages; 7 similarities (max. distance 3 lines); 2 similarities (standing next to each other)

---

αὐλλῆγ ("choteey") occurs seven times: <f49v.P.21> <f68r1.P.1> <f68v2.R.2> <f70v2.R3.1> <f72r3.R1.1> <f73r.R1.1> <f108v.P.33>  
Consecutive pages: f68r1.P.1 > f68v2.R.2  
f72r3.R1.1 > f73r.R1.1

Similarities: [Not counted: <f49v.P.12> οὐλλῆγ ("ochokeey") | <f49v.P.15> αὐλλῆγ ("chokchy") | <f49v.P.16> ἡαὐλλῆγ ("tchotchey")  
| <f49v.P.21> αὐλλῆγ ("choteey")]  
<f68r1.P.1> αὐλλῆγ αὐλλῆγ ("chteey.choteey") | <f68r1.P.2> αὐλλῆγ ("cheeteey")  
<f68v2.P.1> ἑαὐλλῆγ ("shcthey") ... ἑαὐλλῆγ ("shochthy") | <f68v2.C.1> αὐλλῆγ ("chokeey")  
| <f68v2.R.2> αὐλλῆγ ("choteey") | <f68v2.R.3> οὐλλῆγ ("otey")  
<f70v2.R3.1> οὐλλῆγ ("otey") ... αὐλλῆγ αὐλλῆδγ ("choteey.choeteedy")  
<f72r3.R1.1> οὐλλῆγ ("okey") ... ἑαὐλλῆγ αὐλλῆγ ("shochthy.choteey")  
<f73r.S0.2> αὐλλῆγ ("chockhy") | <f73r.R1.1> αὐλλῆγ ("chotch") ... αὐλλῆγ αὐλλῆγ ("choteey.cheteey")  
<f108v.P.32> οὐλλῆγ ("oteey") | <f108v.P.33> αὐλλῆγ ("choteey")

Word count: "okey" (F=177 times ED=3); "oteey" (F=140 ED=2); "otey" (F=57 ED=3); "chockhy" (F=21 ED=2); "chokchy" (F=16 ED=2);  
"chotch" (F=12 ED=1); "shochthy" (F=12 ED=3); "cheeteey" (F=4 ED=3); "chteey" (F=3 ED=1); "cheteey" (F=3 ED=1);  
"chokeey" (F=2 ED=3); "ochokeey" (F=1 ED=2); "tchotchey" (F=1 ED=3); "choeteedy" (F=1 ED=2)

Result: 2 consecutive pages; 6 similarities (max. distance 3 lines); 5 similarities (standing next to each other)

---

αὐλλῆδγ ("chcthedy") occurs seven times: <f34r.P.15> <f66r.R.22> <f75r.P.33> <f76v.P.5> <f104r.P.2> <f111r.P.38> <f115v.P.32>  
Consecutive pages: f75r.P.33 > f76v.P.5

Similarities: <f34r.P.13> αὐλλῆγ ("chckhy") | <f34r.P.15> αὐλλῆδγ ("chcthedy") | <f34r.P.16> αὐλλῆδγ ("cheolchcthy")  
<f66r.R.22> αὐλλῆδγ ("chcthedy") | <f66r.R.23> ἑαὐλλῆγ ("sheochthy")  
<f75r.P.31> αὐλλῆγ ("chckhy") | <f75r.P.33> αὐλλῆδγ ("chcthedy")  
[No similarities found: <f76v.P.5> "chcthedy"]  
[No similarities found: <f104r.P.2> "chcthedy"]  
<f111r.P.37> αὐλλῆγ ("chckhy") | <f111r.P.38> αὐλλῆδγ ("chcthedy") | <f111r.P.39> αὐλλῆδγ ("chckhedy")  
<f115v.P.32> αὐλλῆδγ ("chcthedy") | <f115v.P.33> αὐλλῆγ ("chcthy") | <f115v.P.35> αὐλλῆγ ("checthey")

Word count: "chckhy" (F=140 times ED=3); "chcthy" (F=79 ED=2); "chckhedy" (F=11 ED=1); "checthey" (F=4 ED=2); "cheolchcthy"  
(F=1 ED=3)<sup>47</sup>; "sheochthy" (F=1 ED=3)

Result: 1 consecutive page; 5 similarities (max. distance 3 lines); 2 similarities (standing next to each other)

---

<sup>47</sup> The edit distance for the whole glyph group "cheolchcthy" would be 7. The value 3 is calculated by splitting the word into two parts "cheol" and "chcthy". This results in 2 for the substring "chcthy" and +1 for the splitting.



**αϥαϥ** ("chcthhhy") occurs seven times: <f46r.P.7> <f70r2.P.11a> <f72v3.S2.4> <f78r.P.4> <f79v.P.39> <f104v.P.16> <f111r.P.4>

Consecutive pages: f78r.P.4 > f79v.P.39

Similarities: <f46r.P.7> αϥαϥ ("chcthhhy") | <f46r.P.8> αϥϥ ("chckhy")  
<f70r2.P.9> ϥαϥαϥ ("shocthhhy") | <f70r2.P.11a> αϥαϥ ("chcthhhy")  
[No similarities found: <72v3.S2.4> αϥαϥ ("chcthhhy")]  
[No similarities found: <f78r.P.4> αϥαϥ ("chcthhhy")]  
[No similarities found: <f79v.P.39> αϥαϥ ("chcthhhy")]  
<f104v.P.15> αϥαϥ ("chocthy") | <f104v.P.16> αϥαϥ ("chcthhhy")  
<f111r.P.2> αϥϥ ("chcthy") | <f111r.P.4> αϥαϥ ("chcthhhy")

Word count: "chckhy" (F=140 times ED=2); "cthy" (F=111 ED=3); "chcthy" (F=79 ED=1); "checkhy" (F=47 ED=3); "chocthy" (F=18 ED=2); "chckhedy" (F=11 ED=3); "shocthhhy" (F=1 ED=2)

Result: 1 consecutive page; 4 similarities (max. distance 3 lines); 0 similarities (standing next to each other)

---

**αϥαϥ** ("chcthey") occurs seven times: <f30r.P.9> <f49v.P.18> <f82r.P2.27> <f86v3.Q.14> <f111v.P.8> <f112r.P.21> <f114v.P.26>

Consecutive pages: f111v.P.8 > f112r.P.21

Similarities: <f30r.P.9> αϥαϥ ("chcthey") | <f30r.P.10> αϥα ("chctho")  
[Not counted: <f49v.P.7> αϥαϥ ("chotchy") | <f49v.P.18> αϥαϥ ("chcthey")]  
[Not counted: <f82r.P2.27> αϥαϥ ("chcthey") | <f82r.P2.31> αϥαϥ ("chckhey")]  
[No similarities found: <f86v3.Q.14> αϥαϥ ("chcthey")]  
[Not counted: <f111v.P.8> αϥαϥ ("chcthey") | <f111v.P.12> αϥαϥ ("checkhy")]  
<f112r.P.21> αϥαϥ ("chcthey") | <f112r.P.24> αϥαϥ ("cheeteey")  
<f114v.P.26> αϥαϥ ("chcthey") | <f114v.P.27> αϥαϥ ("chokeey")

Word count: "checkhy" (F=47 times ED=3); "chckhey" (F=13 ED=2); "chotchy" (F=12 ED=3); "chokeey" (F=11 ED=3); "shckhey" (F=12 ED=2); "cheeteey" (F=4 ED=3); "chctho" (F=3 ED=2); "cheocthey" (F=1 ED=3); "tchotchy" (F=1 ED=3)

Result: 1 consecutive page; 3 similarities (max. distance 3 lines); 2 similarities (standing next to each other)

---

ᠪᠢᠰᠠᠨᠠᠨᠢᠨ ("cphaiin") occurs seven times: <f4r.P.10> <f8r.P3.18> <f37v.P.14> <f44v.P.5> <f44v.P.10> <f52v.P.1> <f104r.P.27>

Consecutive pages: f44v.P.5 = f44v.P.10

Similarities: <f4r.P.10> ᠪᠢᠰᠠᠨᠠᠨᠢᠨ ("cphaiin") | <f4r.P.12> ᠴᠢᠠᠨᠢᠨ ᠴᠢᠠᠨᠢᠨ ("chain.chain")  
<f8r.P3.17> ᠴᠢᠠᠨᠢᠨ ("chain") | <f8r.P3.18> ᠪᠢᠰᠠᠨᠠᠨᠢᠨ ᠴᠢᠠᠨᠢᠨ ("cphaiin.chain")  
[Not counted: <f37v.P.8> ᠴᠢᠠᠨᠢᠨ ("choiin") | <f37v.P.14> ᠪᠢᠰᠠᠨᠠᠨᠢᠨ ("cphaiin")]  
<f44v.P.4> ᠰᠢᠠᠨᠢᠨ ("shaiin") | <f44v.P.5> ᠪᠢᠰᠠᠨᠠᠨᠢᠨ ("cphaiin") ... ᠴᠢᠠᠨᠢᠨ ("cthaiin") | <f44v.P.6> ᠶᠲᠠᠢᠨᠢᠨ ("ytaiin")  
| <f44v.P.7> ᠲᠴᠢᠠᠨᠢᠨ ("tchaiin") | <f44v.P.8> ᠴᠢᠠᠨᠢᠨᠢᠨ ("cthaiin") | <f44v.P.10> ᠪᠢᠰᠠᠨᠠᠨᠢᠨ ("cphaiin")  
[No similarities found: <f52v.P.1> "cphaiin"]  
[No similarities found: <f104r.P.27> "cphaiin"]

Word count: "chain" (F=45 times ED=1); "ytaiin" (F=44 times ED=3); "shaiin" (F=20 ED=2); "choiin" (F=13 ED=2);  
"cthaiin" (F=13 ED=1); "cthaiin" (F=4 ED=2); "tchaiin" (F=1 ED=2)

Result: 1 consecutive page; 4 similarities (max. distance 3 lines); 2 similarities (standing next to each other)

---

ᠳᠠᠢᠶᠢᠳᠢ ("daiidy") occurs seven times: <f3v.P.2> <f42r.P2.11> <f47v.P.2> <f57r.P.9> <f68v3.P.0.1> <f81v.P.9> <f114r.P1.20>

Similarities: [Not counted: <f3v.P.2> ᠳᠠᠢᠶᠢᠳᠢ ("daiidy") | <f3v.P.10> ᠳᠠᠢᠶᠢᠳᠢ ("daiim") | <f3v.P.12> ᠴᠢᠳᠠᠢᠶᠢᠳᠢ ("chodair")]  
[Not counted: <f42r.P1.2> ᠳᠠᠢᠶᠢᠳᠢ ("daiiry") | <f42r.P2.11> ᠳᠠᠢᠶᠢᠳᠢ ("daiidy")]  
<f47v.P.2> ᠳᠠᠢᠶᠢᠳᠢ ("daiidy") ... ᠳᠠᠢᠶᠢᠳᠢ ("daiiy") | <f47v.P.7> ᠳᠠᠢᠶᠢᠳᠢ ("dair")  
<f57r.P.7> ᠳᠠᠢᠶᠢᠳᠢ ("daiis") | <f57r.P.9> ᠳᠠᠢᠶᠢᠳᠢ ("daiidy")  
[Not counted: <f68v3.P.0> ᠳᠠᠢᠶᠢᠳᠢ ("daiidy") | <f68v3.0.1> ᠳᠠᠢᠶᠢᠳᠢ ("dais")]  
[No similarities found: <f81v.P.9> "daiidy"]  
[No similarities found: <f114r.P1.20> "daiidy"]

Word count: "dair" (F=106 times ED=3); "daiim" (F=5 ED=2); "daiis" (F=5 ED=2); "dais" (F=4 ED=3); "daiiry" (F=1 ED=1) |  
"daiiy" (F=1 ED=1)

Result: 0 consecutive pages; 2 similarities (max. distance 3 lines); 0 similarities (standing next to each other)

---

დავაფ ("dalam") occurs seven times: <f58r.P.38> <f65v.P.2>, <f67v2.S.1> <f70r2.P.8> <f86v6.P.4> <f107v.P.13> <f108v.P.36>

Consecutive pages: f107v.P.13 > f108v.P.36

Similarities: <f58r.P.38> დავაფ ("dalam") | <f58r.P.39> არამ ("aram")

[Not counted: <f65r.L.1> ავაფ ("alam") | <f65v.P.2> დავაფ ("dalam")]

[Not counted: <f67v2.C.2b> ოდაფ ("odam") | <f67v2.S.1> დავაფ ("dalam")]

<f70r2.P.6> დაფ ("dal") | <f70r2.P.8> ავაფ დავაფ ("alal.dalam")

<f86v6.P.2> რვაფ ("lram") | <f86v6.P.4> დავაფ ("dalam") | <f86v6.P.8> დაფ ("dam")

[No similarities found: <f107v.P.13> "dalam"]

[Not counted: <f108v.P.34> რედაფ ("lchedam") | <f108v.P.36> დავაფ ("dalam") | <f108v.P.37> ოლაფ ("otam")]

Word count: "dal" (F=253 ED=2); "dam" (F=98 ED=2); "aram" (F=12 ED=2); "alam" (F=8 ED=1); "odam" (F=6 ED=3); "alal" (F=5 ED=2); "lram" (F=1 ED=3); "araram" (F=1 ED=3), "lchedam" (F=2 ED=5)

Result: 1 consecutive page; 3 similarities (max. distance 3 lines); 2 similarities (standing next to each other)

---

#### IV. Glyph groups occurring eight times

As a second control sample, glyph groups occurring eight times were used. Glyph groups which also appear as subgroups of other groups are excluded. The sample consists of 9 words: 𐑏𐑏𐑏𐑏𐑏, 𐑏𐑏𐑏, 𐑏𐑏𐑏𐑏𐑏, 𐑏𐑏𐑏𐑏𐑏, 𐑏𐑏𐑏𐑏, 𐑏𐑏𐑏, 𐑏𐑏𐑏𐑏, 𐑏𐑏𐑏𐑏, 𐑏𐑏𐑏𐑏. For this sample 19 consecutive pages (19/((8-1)\*9)=30%) and 64 similarities (64/(8\*9)=89,0%) can be found. In 25 cases (25/(8\*9)=34,7%) the similar words appear together in the same line or in two consecutive lines one above the other.

---

𐑏𐑏𐑏𐑏𐑏 ("gokedar") occurs 8 times: <f34v.P.4> <f39r.P.7> <f76r.R.31> <f78r.P.4> <f83v.P1.4> <f108v.P.31> <f111v.P.4> <f112v.P.15>

Consecutive pages: f111v.P.4 > f112v.P.15

Similarities: <f34v.P.4> 𐑏𐑏𐑏𐑏𐑏 ("gokedar") ... 𐑏𐑏𐑏𐑏 ("qoldar") | <f34v.P.5> 𐑏𐑏𐑏𐑏 ("qokar")  
 [Not counted: <f39r.P.3> 𐑏𐑏𐑏𐑏𐑏 ("gokeedar") | <f39r.P.7> 𐑏𐑏𐑏𐑏𐑏 ("gokedar")]  
 <f76r.R.28> 𐑏𐑏𐑏𐑏𐑏 ("okeyr.ar") | <f76r.R.31> 𐑏𐑏𐑏𐑏𐑏 ("gokedar") | <f76r.R.32> 𐑏𐑏𐑏𐑏 ("gokal")  
 <f78r.P.4> 𐑏𐑏𐑏𐑏𐑏 ("gotal.dol") ... 𐑏𐑏𐑏𐑏𐑏 ("gokedar") | <f78r.P.5> 𐑏𐑏𐑏𐑏𐑏𐑏 ("gokedy.dal")  
 <f83v.P1.2> 𐑏𐑏𐑏𐑏𐑏 ("gotedar") | <f83v.P1.4> 𐑏𐑏𐑏𐑏𐑏 ("gokedar")  
 <f108v.P.31> 𐑏𐑏𐑏𐑏𐑏 ("gokedar") | <f108v.P.32> 𐑏𐑏𐑏𐑏𐑏 ("gokeedar")  
 <f111v.P.4> 𐑏𐑏𐑏𐑏𐑏 ("gokedar") | <f111v.P.5> 𐑏𐑏𐑏𐑏𐑏 ("gotedal")  
 [Not counted: <f112v.P.15> 𐑏𐑏𐑏𐑏𐑏 ("gokedar") | <f112v.P.27> 𐑏𐑏𐑏𐑏𐑏 ("okedal")]

Word count: "gokedy" (F=271 times)<sup>48</sup> "gokedy.dal" (ED=3); "gokal" (F=191 ED=3); "qokar" (F=152 ED=2); "okedal" (F=7 ED=2);  
 "gokeedar" (F=6 ED=1); "gotedar" (F=3 ED=1); "gotedal" (F=3 ED=2); "qoldar" (F=1 ED=3); "okeyr" (F=1) "okeyr.ar" (ED=3)

Result: 1 consecutive page; 6 similarities (max. distance 3 lines); 2 similarities (standing next to each other)

---



---

<sup>48</sup> F=frequency, ED=edit distance

ገብጎል ("gokan") occurs 8 times: <f75r.P.9> <f78r.P.12> <f79v.P.35> <f80r.P.35> <f95v2.P.3> <f103v.P.25> <f111v.P.33> <f116r.Q.42>  
Consecutive pages: f78r.P.12 > f79v.P.35 > f80r.P.35

Similarities: <f75r.P.7> ገብጎል ("qokar") | <f75r.P.8> ገብጎል ("qokain") | <f75r.P.9> ገብጎል ("gokan") | <f75r.P.10> ገብጎል ("qokain")  
<f78r.P.11> ገብጎል ("qokain") | <f78r.P.12> ገብጎል ("gokan") | <f78r.P.13> ግብጎል ("olkain")  
<f79v.P.33> ግብጎል ("otar") | <f79v.P.34> ገብጎል ("otain") | <f79v.P.35> ገብጎል ("gokan") | <f79v.P.37> ገብጎል ("qokal")  
<f80r.P.31> ገብጎል ("qokar") | <f80r.P.32> ገብጎል ("qokain") | <f80r.P.33> ገብጎል ("qokar")  
| <f80r.P.35> ገብጎል ("gokan") | <f80r.P.36> ገብጎል ("qokain")  
<f95v2.P.2a> ግብጎል ("okar") | <f95v2.P.3> ገብጎል ("gokan")  
<f103v.P.24> ግብጎል ግብጎል ግብጎል ("olan.otan.otain.otain") | <f103v.P.25> ገብጎል ("gokan") ... ገብጎል ግብጎል ("gotain.otai")  
<f111v.P.31> ገብጎል ("qokain") | <f111v.P.33> ግብጎል ("okan") ... ገብጎል ("gokan") | <f111v.P.34> ገብጎል ("qokain")  
<f116r.Q.40> ገብጎል ("qokain") | <f116r.Q.41> ግብጎል ("okain")  
| <f116r.Q.42> ገብጎል ("qokain") ... ገብጎል ("gokan") | <f116r.Q.43> ገብጎል ("qokam")

Word count: "gokain" (F=279 times ED=1); "qokal" (F=191 ED=1); "qokar" (F=152 ED=1); "otar" (F=141 ED=3); "okar" (F=129 ED=2);  
"otain" (F=96 ED=3); "gotain" (F=64 ED=2); "olkain" (F=33 ED=3); "qokam" (F=25 ED=1); "okan" (F=5 ED=1);  
"otan" (F=5 ED=2); "gotan" (F=2 ED=1); "olan" (F=1 ED=3)

Result: 2 consecutive pages; 8 similarities (max. distance 3 lines); 4 similarities (standing next to each other)

---

ገብጎሮ ("gokshey") occurs 8 times: <f79v.P.7> <f85r1.P.18> <f85r2.P.5> <f86v6.P.33> <f86v6.P.45> <f86v3.Q.10> <f94v.P.9> <f103v.P.33>

Consecutive pages: f85r1.P.18 = f85r2.P.5 > f86v6.P.33 = f86v6.P.45 = f86v3.Q.10

Similarities: <f79v.P.2> ገብጎሮ ("qokchey") | <f79v.P.3> ገብጎሮ ("qokshedy") | <f79v.P.7> ገብጎሮ ("gokshey")  
| <f79v.P.9> ገብጎሮ ("qokechey")  
<f85r1.P.17> ግብጎሮ ("ofchey") | <f85r1.P.18> ገብጎሮ ገብጎሮ ("otshey.gokshey")  
<f85r2.P.2> ገብጎሮ ("qokshedy") | <f85r2.P.5> ገብጎሮ ገብጎሮ "gokshey.goseey"  
<f86v6.P.30> ገብጎሮ ("qopchey") | <f86v6.P.31> ግብጎሮ ("olkchey") | <f86v6.P.33> ገብጎሮ ("gokshey")  
| [(Not counted: <f86v6.P.45> ገብጎሮ "gokshey")]  
<f86v3.Q.10> ገብጎሮ ("gokshey") | <f86v3.Q.11> ገብጎሮ ("qokchey") | <f86v3.Q.12> ገብጎሮ ("qokchdy")  
<f94v.P.7> ጎሮ ("shey") | <f94v.P.9> ገብጎሮ ("gokshey")  
<f103v.P.33> ገብጎሮ ("gokshey") | <f103v.P.35> ጎሮ ("oshey") | <f103v.P.36> ጎሮ ገብጎሮ ("shey.gokeshe")

Word count: "qokeey" (F=308 ED=2); "shey" (F=283 ED=3); "qokchdy" (F=56 ED=3); "qokchey" (F=30 ED=1); "qokshedy" (F=11 ED=1);  
"qopchey" (F=10 ED=2); "oshey" (F=7 ED=2); "otshey" (F=7 ED=2); "ofchey" (F=5 ED=3); "olkchey" (F=4 ED=3);  
"gokeshe" (F=1 ED=2); "qokechey" (F=1 ED=2); "goseey" (F=1 ED=2)

Result: 4 consecutive pages; 7 similarities (max. distance 3 lines); 3 similarities (standing next to each other)

---

Σολχεδῆ ("solchedy") occurs 8 times: <f75v.P4.31> <f76r.R.5> <f77r.P.19> <f79v.P.7> <f80r.P.6> <f83r.P.29> <f83r.P.40> <f113v.P.12>

Consecutive pages: f75v.P4.31 > f76r.R.5 > f77r.P.19  
f79v.P.7 > f80r.P.6  
f83r.P.29 = f83r.P.40

Similarities: <f75v.P3.34> ολχεδῆ ("olchedy") | <f75v.P4.31> Σολχεδῆ Σολκῆδῆ ("solchedy.solkedy")  
<f76r.R.3> ολ χεδῆ ("ol.chedy") | <f76r.R.5> Σολχεδῆ ("solchedy") ... Σολ Σῆδῆ ("sol.shedy")  
<f77r.P.19> Σολχεδῆ ("solchedy") | <f77r.P.20> ολχεῖ ("olchey")  
<f79v.P.4> Σολ χεδῆ ("sol.chedy") | <f79v.P.6> ολσῆδῆ ("olshedy")  
| <f79v.P.7> Σολχεδῆ ("solchedy") | <f79v.P.10> ὀπχεδῆ ὀπχεδῆ ("opchedy.pchedy")  
<f80r.P.5> ολχεδῆ ("olchedy") | <f80r.P.6> Σολχεδῆ ("solchedy") ... ολ χεδῆ ("ol.chedy")  
<f83r.P.29> Σολχεδῆ ("solchedy") | <f83r.P.30> Σολκῆδῆ ("sokeedy")  
| <f83r.P.40> Σολχεδῆ ("solchedy.olchedy")  
<f113v.P.12> Σολχεδῆ ("solchedy") ... ολχεῖ ("olchey") | <f113v.P.14> ολχεδῆ ("olchedy")

Word count: "opchedy" (F=50 times ED=3); "olchedy" (F=38 ED=1); "olchey" (F=29 ED=2); "olshedy" (F=23 ED=2); "ol.chedy" (F=22 ED=2);  
"sol.shedy" (F=6 ED=2); "solkeedy" (F=5 ED=3); "solkedy" (F=3 ED=3); "sol.chedy" (F=2 ED=1)

Result: 4 consecutive pages; 8 similarities (max. distance 3 lines); 5 similarities (standing next to each other)

---

Σελῆ ("sheety") occurs 8 times: <f75r.P.35> <f75r.P.37> <f77r.P.7> <f77r.P.9> <f78r.P.9> <f78v.P.30> <f89v2.P2.5> <f103v.P.26>

Consecutive pages: f75r.P.35 = f75r.P.37  
f77r.P.7 = f77r.P.9 > f78r.P.9 >= f78v.P.30

Similarities: <f75r.P.35> Σελῆ ("sheety") | <f75r.P.37> Σελῆ ("sheety")  
<f77r.P.6> Σῆδῆ ("shedy") | <f77r.P.7> Σελῆ ("sheety") | <f77r.P.9> Σῆδ ("sheed") ... Σελῆ ("sheety")  
[No similarities found: <f78r.P.9> "sheety"]  
<f78v.P.27> Σῆ ("sheey") | <f78v.P.28> χελῆ ("chcthy") | <f78v.P.30> Σελῆ ("sheety")  
<f89v2.P2.5> Σελῆ ("sheety") | <f89v2.P2.8> χῆ ("cthy") ... χελῆ ("chcthy")  
<f103v.P.26> Σελῆ ("sheety") | <f103v.P.28> Σελῆ ("shckhy") | <f103v.P.28a> χελῆ ("chcthy")

Word count: "shedy" (F=426 times ED=3); "sheey" (F=144 ED=1); "cthy" (F=111 ED=3); "chcthy" (F=79 ED=3); "shckhy" (F=60 ED=3);  
"chckhdy" (F=13 ED=5); "sheed" (F=6 ED=3)

Result: 4 consecutive pages; 7 similarities (max. distance 3 lines); 1 similarity (standing next to each other)

---

ꝛꝑꝑ ("chkey") occurs 8 times: <f25v.P.7> <f48v.P.8> <f68v2.C.1> <f70r2.P.1> <f96r.P.7> <f101r1.P.2> <f102r2.P.12> <f112r.P.40>  
Consecutive pages: f101r1.P.2 > f102r2.P.12

Similarities: <f25v.P.5> ꝛꝑꝑꝑ ("chakeey") | <f25v.P.7> ꝛꝑꝑ ("chkey")  
<f48v.P.2> ꝛꝑꝑꝑ ("chety") | <f48v.P.7> ꝛꝑꝑ ("chey") | <f48v.P.8> ꝛꝑꝑꝑ ("chkey") | <f48v.P.9> ꝛꝑꝑꝑ ("chey")  
<f68v2.P.3> ꝛꝑꝑꝑꝑ ꝛꝑꝑꝑꝑ ("shekeey.shkeey") | <f68v2.C.1> ꝛꝑꝑꝑꝑ ("chkey") ... ꝛꝑꝑꝑ ("chey")  
<f70r2.C.3> ꝛꝑꝑꝑꝑ ("ctheey") | <f70r2.P.1> ꝛꝑꝑꝑꝑ ("chkey") | <f70r2.P.2> ꝛꝑꝑꝑꝑꝑ ("chotey")  
<f96r.P.5> ꝛꝑꝑꝑꝑ ("cthey") | <f96r.P.7> ꝛꝑꝑꝑꝑꝑ ("chkey")  
<f101r1.P.1> ꝛꝑꝑꝑꝑ ("shey") | <f101r1.P.2> ꝛꝑꝑꝑꝑ ꝛꝑꝑꝑꝑꝑ ("chkey.cthey") | <f101r1.P.9> ꝛꝑꝑꝑꝑꝑ ("chety")  
<f102r2.P.12> ꝛꝑꝑꝑꝑ ꝛꝑꝑꝑꝑꝑ ("chkey.chey") | <f102r2.P.13> ꝛꝑꝑꝑꝑꝑ ("shey")  
<f112r.P.40> ꝛꝑꝑꝑꝑꝑ ("chkey") | <f112r.P.41> ꝛꝑꝑꝑꝑꝑ ("cheey")

Word count: "chey" (F=344 times ED=1); "shey" (F=283 ED=2); "cheey" (F=174 ED=2); "chey" (F=65 ED=1); "cthey" (F=50 ED=2);  
"chety" (F=25 ED=2); "ctheey" (F=13 ED=3); "shekeey" (F=6 ED=3); "shkeey" (F=3 ED=2); "chakeey" (F=1 ED=2)

Result: 1 consecutive page; 8 similarities (max. distance 3 lines); 3 similarities (standing next to each other)

---

ꝛꝑꝑꝑꝑꝑ ("chekar") occurs 8 times: <f33r.P.6> <f34r.P.16> <f72r3.R1.1> <f75r.P.43> <f84r.P.29> <f94r.P.5> <f95r1.P.7> <f108r.P.10>  
Consecutive pages: f33r.P.6 > f34r.P.16  
f94r.P.5 > f95r1.P.7

Similarities: [Not counted: <f33r.P.6> ꝛꝑꝑꝑꝑꝑ ꝑꝑꝑꝑꝑꝑ ("chekar.okaiin") | <f33r.P.7> ꝛꝑꝑꝑꝑꝑꝑꝑ ("cheekaiin")]  
<f34r.P.13> ꝑꝑꝑꝑꝑ ("okor") | <f34r.P.15> ꝑꝑꝑꝑꝑ ("kar") | <f34r.P.16> ꝛꝑꝑꝑꝑꝑ ꝛꝑꝑꝑꝑ ꝛꝑꝑꝑꝑꝑꝑꝑ ("chekar.chey.shek")  
<f72r3.R1.1> ꝛꝑꝑꝑꝑꝑ ꝑꝑꝑꝑꝑꝑꝑ ("chekar.okar")  
<f75r.P.43> ꝛꝑꝑꝑꝑꝑꝑ ("chekar") ... ꝛꝑꝑꝑꝑꝑꝑꝑ ("chkar")  
[Not counted: <f84r.X.2> ꝑꝑꝑ ꝛꝑꝑꝑꝑꝑꝑ ("or.shekar")<sup>49</sup> | <f84r.P.28> ꝑꝑꝑꝑꝑꝑꝑ ("qokal")  
| <f84r.P.29> ꝑꝑꝑꝑꝑꝑ ꝛꝑꝑꝑꝑꝑ ꝑꝑꝑꝑꝑꝑꝑ ("qotar.chekar.or")]  
[No similarities found: <f94r.P.5> "chekar"]  
<f95r1.P.7> ꝛꝑꝑꝑꝑꝑꝑꝑ ("chekar") ... ꝑꝑꝑꝑꝑꝑꝑꝑ ("okar")  
<f108r.P.7> ꝑꝑꝑꝑꝑꝑꝑꝑ ("okar") | <f108r.P.10> ꝛꝑꝑꝑꝑꝑꝑꝑꝑ ("chekar")

Word count: "okar" (F=129 ED=3); "chey" (F=63 ED=2); "kar" (F=52 ED=3); "chkar" (F=12 ED=1); "cheekaiin" (F=2 ED=4)

Result: 2 consecutive pages; 5 similarities (max. distance 3 lines); 2 similarities (standing next to each other)

---

<sup>49</sup> There is a label ꝑꝑꝑ ꝛꝑꝑꝑꝑꝑꝑꝑ ("or.shekar") in <f84r.X.2> and there is a sequence ꝛꝑꝑꝑꝑꝑ ꝑꝑꝑꝑꝑꝑꝑꝑ ("chekar.or") in line <f84r.P.29>.



ገላጭ ("ykchdy") occurs 8 times: <f34r.P.9> <f46v.P.1> <f53r.P.6> <f66r.R.28> <f68r1.S.28> <f89r1.P2.12> <f100v.M.3> <f104r.P.43>  
 Similarities: <f34r.P.7> ገላጭ ("gokedy") ... ገላጭ ገላጭ ("ykedy.gokchdy") | <f34r.P.9> ገላጭ ("ykchdy") | <f34r.P.11> ገላጭ "otchdy"  
 <f46v.P.1> ገላጭ ("ytedy") ... ገላጭ ("yfchey") ... ገላጭ ("ykchdy") | <f46v.P.2> ገላጭ ("otchdy") ... ገላጭ ("otedy")  
 <f53r.P.5> ገላጭ ("ykody") | <f53r.P.6> ገላጭ ("ykchdy") | <f53r.P.7> ገላጭ ("ykchody") | <f53r.P.8> ገላጭ ("ykeed")  
 <f66r.R.23> ገላጭ ("oteedy") | <f66r.R.27> ገላጭ ("otchdy") | <f66r.R.28> ገላጭ ("ykchdy")  
 <f68r1.P.2> ገላጭ ("yteody") | <f68r1.S.18> ገላጭ ("ytchody")<sup>50</sup> | <f68r1.S.28> ገላጭ ("ykchdy")  
 <f89r1.P2.8> ገላጭ ("ykeedy") | <f89r1.P2.12> ገላጭ ገላጭ ("gokchy.ykchdy") | <f89r1.P2.13> ገላጭ ገላጭ ("gockhedy.yty")  
 <f100v.M.2> ገላጭ ("ykchochdy") | <f100v.M.3> ገላጭ ("ykchdy")  
 <f104r.P.41> ገላጭ ("yteedy") | <f104r.P.43> ገላጭ ገላጭ ("ykchdy.pchedy")

Note: <f68r1.S.18> and <f68r1.S.28> are labels.

Word count: "gokedy" (F=272 times ED=3); "otedy" (F=155 ED=3); "oteedy" (F=100 ED=3); "gokchy" (F=69 ED=3); "gokchdy" (F=56 ED=2);  
 "pchedy" (F=34 ED=3); "ykeedy" (F=33 ED=1); "otchdy" (F=30 ED=2); "yteedy" (F=28 ED=2); "ytedy" (F=24 ED=3);  
 "ykedy" (F=23 ED=2); "ytchey" (F=12 ED=3); "ytchody" (F=5 ED=2); "ykchody" (F=4 ED=1); "yfchey" (F=3 ED=3);  
 "ykody" (F=2 ED=2); "ykeed" (F=2 ED=3); "ykchochdy" (F=1 ED=3)

Result: 0 consecutive pages; 8 similarities (max. distance 3 lines); 3 similarities (standing next to each other)

ገላጭ ("dsheey") occurs 8 times: <f8r.P2.9> <f47v.P.2> <f83r.P.5> <f84v.P.16> <f104v.P.25> <f108v.P.49> <f111v.P.39> <f116r.Q.40>

Consecutive pages: f83r.P.5 > f84v.P.16

Similarities: <f8r.P2.9> ገላጭ ("pcheey") ... ገላጭ ("dsheey") | <f8r.P2.10> ገላጭ ("cheey")  
 <f47v.P.2> ገላጭ ("dsheey") | <f47v.P.4> ገላጭ ("sheey") | <f47v.P.13> ገላጭ ("dcheey")  
 <f83r.P.2> ገላጭ ("cheey") | <f83r.P.5> ገላጭ ("dsheey")  
 [Not counted: <f84v.P.12> ገላጭ ("dshey") | <f84v.P.16> ገላጭ ("dsheey") | <f84v.P.20> ገላጭ ("oshey")]  
 <f104v.P.24> ገላጭ ("cheey") | <f104v.P.25> ገላጭ ("dsheey")  
 <f108v.P.46> ገላጭ ("ycheey") | <f108v.P.49> ገላጭ ("dsheey")  
 <f111v.P.38> ገላጭ ("ycheey") | <f111v.P.39> ገላጭ ("dsheey") | <f111v.P.42> ገላጭ ("cheeo")  
 <f116r.Q.38> ገላጭ ("lshey") | <f116r.Q.39> ገላጭ ("chey") | <f116r.Q.40> ገላጭ ገላጭ ("dsheey.shey")

Word count: "chey" (F=344 times ED=3); "shey" (F=283 ED=2); "cheey" (F=174 ED=2); "sheey" (F=144 ED=1); "ycheey" (F=24 ED=2);  
 "lshey" (F=18 ED=2); "cheeo" (F=16 ED=3); "dshey" (F=14 ED=1); "dcheey" (F=13 ED=1); "cheey" (F=9 ED=3);  
 "oshey" (F=7 ED=3); "pcheey" (F=4 ED=3); "dcheedy" (F=4 ED=2); "dcheey" (F=1 ED=2)

Result: 1 consecutive page; 7 similarities (max. distance 3 lines); 2 similarities (standing next to each other)

<sup>50</sup> ገላጭ ("ytchody") in line <f68r1.S.18> and ገላጭ ("ykchdy") in line <f68r1.S.28> are labels.

## V. Grid

For the grid the transcription by Takeshi Takahashi was used.

### 𐌅𐌆𐌆- or 𐌆-series

#### [daiin]

daiin (863)	aiin (469)	dain (211)	ain ( 89)	daiiin ( 17)	aiiin ( 41)
daiir ( 23)	aiir ( 23)	dair (106)	air ( 74)		
daiim ( 5)	aiim ( 3)	daim ( 11)	aim ( 7)		
daiis ( 5)	aiis ( 3)	dais ( 4)	ais ( 1)		
daiil ( 1)	aiil ( 1)	dail ( 2)	ail ( 5)		
doiin ( 19)	oiin ( 33)	doin ( 4)	oin ( 4)	doiiin ( 3)	oiiin ( 10)
doiir ( 8)	oiir ( 3)	doir (---) <sup>51</sup>	oir ( 2)		
dairal ( 2)	airal ( 1)	dairal ( 5)	airal ( 2)		
odaiin ( 60)	oaiin ( 26)	odain ( 18)	oain ( 11)	odaiiin ( 4)	
odaiir ( 2)	oaiir ( 4)	odair ( 5)	oair ( 3)		
odaiil ( 1)	oaiil ( 1)				
odaiim ( 1)	oaiim (---)				
dodaiin ( 1)	doaiin ( 3)				
ydaiin ( 21)		ydain ( 5)			
ydaiir (---)		ydair ( 2)			
ydaiil ( 1)		ydail (---)			
saiin (144)		sain ( 68)		saiiin ( 1)	
soiin ( 21)		soin ( 4)		soiirn ( 6)	
saiir ( 6)		sair ( 28)			
soiir ( 1)		soir ( 1)			
saiim ( 1)		saim ( 2)			
oraiin ( 38)		orain ( 27)		oraiiin ( 4)	
osaiin ( 8)		osain ( 3)		osaiiin ( 1)	
oraiir (---)		orair ( 5)			
ysaiin ( 4)		ysain (---)			
yraiin ( 1)		yrain (---)			
rain ( 75)		rain ( 26)		raiirn ( 1)	
raiir (---)		rair ( 6)			
rariin (---)		rarain ( 6)		rariirn ( 1)	
roraiin (---)		rorain ( 1)			
soraiin ( 7)		sorain ( 2)			
saraiin ( 4)		sarain ( 3)			
soaiin ( 4)		soain ( 1)			
daiidy ( 7)	aiidy ( 2)	daidy (---) <sup>52</sup>	aidy (---)	daiiidy ( 1)	
daiiny ( 1)	aiiny ( 4)	dainy ( 1)	ainy ( 2)	daiiiny ( 1)	
daiiry ( 1)	aiiry ( 1)	dairy ( 4)	airy ( 1)		
daiindy ( 3)					
dan ( 20)	da ( 9)	an ( 7)			
don (---)	do ( 16)	on (---)			

<sup>51</sup> "----" stands for a glyph group which does not exist within the VM.

<sup>52</sup> There is one instance of 𐌅𐌆𐌆 ("daidy") in line <f27v.P.2>. Takahashi transcribes this glyph group as 𐌅𐌆 𐌆𐌆 ("da dy").

[ch + daiin]

chaiin ( 45)	chain ( 18)	chaiiin ( 1)	choiin ( 13)
chodaiin ( 44)	chodain ( 9)		pchodaiin ( 5)   pchodain ( 3)
chokaiin ( 17)	chokain ( 11)		
chotaiin ( 9)	chotain ( 4)		
choraiin ( 5)	chorain ( 2)		
chosaiin ( 4)	chosain (---)		
choaiin ( 7)	choain (---)		
cheaiin ( 3)	cheain ( 2)		
chedaiin ( 32)	chedain ( 19)	chedaiiin ( 2)	qochedaiin (1)
chekaiin ( 8)	chekain ( 7)	chekaiiin ( 1)	
chetaiin ( 3)	chetain ( 5)		
chepaiin ( 1)	chepain (---)		
pchedaiin ( 4)	pchedain ( 2)		opchedaiin ( 4)   qopchedaiin (1)
kchedaiin ( 1)	kchedain (---)		okchedaiin ( 1)
tchedaiin ( 1)	tchedain (---)		otchedain ( 1)
pchdaiin ( 3)	kchdain (---)		opchdain ( 1)
kchdaiin ( 1)			qokchdaiin (1)
tchdaiin ( 2)			otchdaiin ( 1)   qotchdain (1)
cheedaiin ( 4)	cheedain ( 2)		
cheodaiin ( 11)	cheodain ( 8)		
cheekaiin ( 2)	cheekain ( 3)		
cheokaiin ( 2)	cheokain ( 4)		
cheotaiin ( 1)	cheotain ( 1)		
cheepaiin ( 1)	cheepain (---)		
cheopaiin ( 1)	cheopain (---)		
cheoaiin ( 2)	cheoain ( 1)		
chdaiin ( 16)	chdain ( 9)		
chkaiin ( 18)	chkain ( 12)		
chtaiin ( 4)	chtain ( 3)		
chpaiin ( 1)	chpain (---)		
chfaiin ( 1)	chfain (---)		
ckhaiin ( 3)	ckhain ( 1)	ckhoiin ( 1)	chckhaiin ( 3)
cthaiin ( 13)	cthain ( 4)	cthoiin ( 2)	chcthaiin ( 1)
cphaiin ( 7)	cphain ( 1)		
dchaiin ( 5)	dchain ( 1)		
kchaiin ( 3)	kchain ( 1)		
tchaiin ( 3)	tchain ( 1)		
pchaiin ( 1)	pchain (---)		
shaiin ( 20)	shain ( 8)	shaiiin ( 1)	shoiin ( 6)
sheaiin ( 9)	sheain ( 2)		
shoaiin ( 4)	shoain (---)		
shedaiin ( 15)	shedain ( 11)	shedaiiin ( 1)	
shekaiin ( 2)	shekain ( 5)	shekaiiin ( 1)	
shodaiin ( 23)	shodain ( 5)		
shokaiin ( 3)	shokain ( 1)		
shotaiin ( 2)	shotain (---)		
shosaiin ( 5)	shosain (---)		
shkaiin ( 4)	shkain ( 3)		
shdaiin ( 3)	shdain (---)		
shtaiin ( 1)	shtain (---)		
kshaiin ( 1)	kshain (---)		
tshaiin ( 1)	tshain (---)		
sheodaiin ( 5)	sheodain (---)		

[qo + daiin]

qokain (279)	qokaiin (262)	gokaiiin ( 2)	qolkain ( 5)	qolkaiin ( 2)
qotain ( 64)	qotaiin ( 79)	qotaiiin ( 2)		
qodain ( 11)	qodaiin ( 42)	qodaiiin ( 2)		
qorain ( 4)	qoraiin ( 1)	qoraiiin (---)		
qokair ( 17)	qokaiir ( 3)			
qotair ( 6)	qotaiir (---)			
qodair ( 3)	qodaiir (---)			
qoain ( 7)	qoaiin ( 23)			
qoair ( 4)	qoaiir ( 1)			
qoin ( 1)	qoiin ( 3)	qoiin ( 4)		
okain (144)	okaiin (212)	okaiiin ( 4)		
otain ( 96)	otaiin (154)	otaiiin ( 1)		
opain ( 2)	opaiin ( 13)		qopaiin ( 6)	
	ofaiin ( 5)		qofaiin ( 1)	
	okoiin ( 9)		qokoiin ( 6)	
otoin ( 1)	otoiin ( 3)		qotoiin ( 3)	
	opoiin ( 1)		qopoiin ( 1)	
	ofoiin (---)		qofoiin ( 1)	
	ykoiiin ( 4)			
	ytoiin ( 4)	ytoiin ( 1)		
okair ( 22)	okaiir ( 6)	okais ( 1)	okaiis ( 1)	okail ( 1)
otair ( 21)	otaiir ( 4)	otais ( 4)		otail ( 1)
opair ( 4)	opaiir ( 1)		opaiis ( 1)	opail ( 1)
ofair ( 1)	ofaiir (---)	ofais ( 1)	ofaiis ( 1)	
ykain ( 10)	ykaiin ( 45)	ykaiiin ( 1)	yaiin ( 6)	
ytain ( 13)	ytaiin ( 43)			
ykair ( 8)	ykaiir ( 2)		yaiir ( 2)	yair ( 2)
ytair ( 3)	ytaiir ( 1)			
ypair ( 3)	ypaiir (---)			
yfair ( 1)	yfaiir (---)			
kain ( 48)	kaiin ( 65)	kaiiin ( 3)	koiin ( 5)	
tain ( 16)	taiin ( 42)	taiiin ( 1)	toiin ( 2)	
pain (---)	paiin ( 8)			
kair ( 14)	kaiir (---)			
tair ( 13)	taiir (---)			
pair ( 2)	paiir ( 2)			
skain ( 1)	skaiin ( 3)			
spain (---)	spaiin ( 1)			
kodain ( 1)	kodaiin ( 3)	okodaiin ( 2)		
todayn ( 2)	todayin ( 9)	otodayin ( 5)	teodayin ( 2)	
podain (---)	podaiin ( 5)	opodayin ( 2)		
tedain (---)	tedaiin ( 3)	otedaiin ( 3)	otedaiin ( 8)	
	qokedain ( 4)	qokedaiin ( 3)		
		qotedaiin ( 3)	qotedaiin ( 1)	
		qokodaiin ( 1)		
		gotodaiin ( 1)		
podair ( 2)	podaiir ( 2)			pchdair ( 4)
korain ( 2)	koraiin ( 2)	okoraiin ( 2)		
torain ( 1)	toraiin (---)	otoraiin ( 1)		
porain ( 2)	poraiin ( 3)	oporaiin ( 2)		
akain ( 1)	akaiin ( 1)			
atain (---)	ataiin ( 1)			
arain ( 1)	araiin ( 10)			

**[l + daiin]**

olaiin ( 52)	olain ( 13)	olaiiin ( 1)	cholaiin ( 4)	polaiin ( 8)
oloiin ( 5)	oloin ( 1)			
lkaiin ( 49)	lkain ( 35)	lkaiiin ( 1)		
ldaiin ( 3)	ldain ( 2)	ldaiiin ( 1)		
lraiin ( 1)	lrain ( 1)			
ltaiin ( 1)	ltain ( 2)			
lkaiir ( 2)	lkair ( 4)			
laiin ( 13)	lain ( 5)	laiiin ( 2)		
loiin ( 4)	loin (---)	loiin ( 1)		
roiin ( 4)	roin (---)			
olkaiin ( 31)	olkain ( 33)	cholkaiin ( 4)	cholkain ( 2)	
oltaiin ( 2)	oltain ( 2)	choltaiin ( 1)		cheoltain ( 1)
oldaiin ( 9)	oldain ( 2)	choldaiin ( 1)		cheoldain ( 1)
olkaiir ( 1)	olkair ( 4)			
alaiin ( 4)	alain ( 4)	alaiiin ( 2)		
alkaiin ( 5)	alkain ( 7)		chalkain ( 1)	
aldaiin ( 3)	aldain (---)			

## ox- or x-series

### [ol]

ol (537)	al (260)	dol (117)	dal (253)	dl (20)	odl (4)
or (363)	ar (350)	dor (73)	dar (318)	dr (1)	odr (1)
om (22)	am (88)	dom (7)	dam (98)	dm (2)	
os (29)	as (5)	dos (1)	das (4)	ds (2)	ods (1)
od (5)		dod (1)		dd (1)	
sol (75)	sal (55)	osol (---)	osal (3)	sl (1)	
sor (57)	sar (84)	osor (---)	osar (2)		
sos (8)	sas (2)	osos (1)	osas (---)		
som (1)	sam (10)	osom (---)	osam (---)		

### [ch + ol]

chol (396)	cheol (172)	cheeol (9)	cholo (3)		
chor (219)	cheor (100)	cheeor (14)			
chos (38)	cheos (33)	cheeos (7)			
chom (15)	cheom (10)	cheeom (---)			
dchor (24)	dcheor (4)	dchol (26)	dcheol (8)	dcho (5)	dcheo (7)
kchor (20)	kcheor (4)	kchol (21)	kcheol (5)	kcho (5)	kcheo (4)
tchor (19)	tcheor (3)	tchol (13)	tcheol (6)	tcho (7)	tcheo (7)
pchor (12)	pcheor (5)	pchol (8)	pcheol (11)	pcho (2)	pcheo (3)
fchor (3)	fcheor (---)	fchol (3)	fcheol (1)	fcho (1)	fcheo (---)
ochor (6)	ocheor (1)	ochol (5)	ocheol (1)		
ychor (16)	ycheor (9)	ychol (12)	ycheol (14)		
kchos (3)	kcheos (---)	okchos (1)			
tchos (4)	tcheos (2)	otchos (4)			
	ocheos (2)	ochos (1)			
chdar (20)	chedar (30)	chdal (18)	chedal (24)	chda (1)	cheda (1)
chkar (12)	chekar (8)	chkal (13)	chekal (12)	chka (1)	cheka (---)
chtar (3)	chetar (6)	chtal (6)	chetal (1)		
chpar (1)	chepar (4)	chpal (2)	chepal (---)		
	cheedar (5)				
chkam (3)	chekam (1)	chokam (4)			
chtam (1)	chetam (1)	chotam (5)			
tchdar (---)	tchedar (2)	tchdal (---)	tchedal (2)		
kchdar (1)	kchedar (1)				
kchdal (2)	kchedal (2)				
pchdar (5)	pchedar (11)	pchdal (1)	pchedal (5)	pchdam (2)	
	ychedar (4)		ychedal (2)		
	ochedar (1)		ochedal (1)		
choar (3)	cheoar (5)	choal (1)	cheoal (2)		
choor (2)	cheoor (1)	chool (2)	cheool (---)		
	chodar (14)	chodor (---)	chodal (7)	chodol (2)	
	chokar (7)	chokor (6)	chokal (9)	chokol (4)	
	chotar (11)	chotor (4)	chotal (9)	chotol (7)	
		chokeor (1)		chokeol (5)	
		choteor (---)		choteol (3)	
		choteos (1)		chokeos (2)	
	tchodar (2)		tchodal (---)	tchodol (1)	
	pchodar (2)		pchodal (1)	pchodol (2)	
	chedar (4)		chedal (7)		
	cheokar (1)		cheokal (2)		
	cheotar (1)		cheotal (11)		
	tcheodar (1)		tcheodal (1)		
	kcheodar (1)		kcheodal (---)		
	pcheodar (3)		pcheodal (1)		
chdam (10)	chodam (1)				
chedam (6)	chedam (2)				
chdor (8)	chedor (2)	chdol (2)	chedol (6)	chdo (1)	chedo (2)
chkor (1)	chekor (1)	chkol (3)	chekol (3)	chko (1)	cheko (---)
chtor (2)	chetor (---)	chtol (5)	chetol (---)		
chpor (2)	chepor (---)	chpol (---)	chepol (1)		
otchor (17)	otcheor (4)	otchol (28)	otcheol (1)		
okchor (20)	okcheor (2)	okchol (14)	okcheol (1)		
opchor (6)	opcheor (2)	opchol (6)	opcheol (7)		
otchar (6)		otchal (4)		otcham (6)	
okchar (4)		okchal (3)			
opchar (2)		opchal (3)			

ofchar ( 2)		ofchal (---)			
ytchor ( 13)		ytchol ( 6)			
ykchor ( 5)	ykcheor ( 3)	ykchol ( 6)			
ypchor ( 2)		ypchol ( 3)			
yfchor ( 1)		yfchol (---)			
gotchor (14)	gotcheor (---)	gotchol ( 13)			
qokchor (11)	qokcheor ( 2)	qokchol ( 17)	chokchor ( 1)	chokchol ( 4)	
qopchor ( 3)	qopcheor (---)	qopchol ( 6)			
qofchor ( 1)	qofcheor (---)	qofchol ( 2)			
qotcho ( 11)	qotcheo ( 4)				
qokcho ( 10)	qokcheo ( 3)				
cho ( 68)	cheo ( 65)	cheeo ( 16)			
chl ( 26)	chel (---)	cheel ( 1)			
chr ( 9)	cher ( 5)	cheer ( 2)			
chs ( 18)	ches ( 36)	chees ( 33)	cheees ( 1)		
chm (---)	chem ( 1)	cheem ( 1)			
ch ( 4)	che ( 2)	chee ( 1)			
ycho ( 5)	ycheo ( 15)	ycheeo ( 8)			
ocho ( 2)	ocheo (---)	ocheeo (---)			
schol ( 5)	scheol ( 2)	scheeol ( 1)			
schor ( 3)	scheor ( 2)				
schos ( 1)	scheos ( 1)				
schom (---)	scheom ( 1)				
<b>[sh + ol]</b>					
shol (186)	sheol (114)	sheeol ( 14)	sholo ( 1)		
shor ( 97)	sheor ( 51)	sheeor ( 9)			
shos (10)	sheos ( 17)	sheeos ( 1)			
shom ( 4)	sheom ( 4)				
dshor ( 14)	dsheor ( 3)	dshol ( 5)	dsheol ( 9)	dsho ( 9)	dsheo ( 2)
kshor ( 2)	ksheor (---)	kshol ( 3)	ksheol ( 2)	ksho ( 8)	ksheo ( 4)
tshor ( 4)	tsheor (---)	tshol ( 6)	tsheol (---)	tsho ( 5)	tsheo (---)
		pshol ( 5)			
oshor ( 2)	osheor (---)	oshol ( 1)	osheol ( 1)		
yshor ( 2)	ysheor ( 4)	yshol ( 2)	ysheol ( 1)		
shdar ( 9)	shedar ( 7)	shdal ( 4)	shedal ( 11)	shda ( 1)	
shkar ( 2)	shekar ( 2)	shkal ( 1)	shekal ( 4)	shka ( 1)	
	shokar ( 3)		shokal ( 4)		
shtar ( 1)	shetar ( 1)	shtal ( 3)	shetal (---)		
shkam (---)	shekam ( 2)				
shtam (---)	shetam ( 1)				
tshdar ( 1)	tshedar ( 2)	tshdal (---)	tshedal ( 1)		
pshdar ( 2)	pshedar ( 1)	pshdal ( 1)			
shoar ( 3)	shodar (---)	shoal (---)	shodal ( 3)		
sheoar (---)	sheodar ( 1)	sheoal ( 1)	sheodal ( 4)		
	tsheodar ( 1)		tsheodal ( 1)		
shdam ( 1)	shodam ( 1)				
shedam ( 2)	sheodam ( 1)				
shdor ( 1)	shedor ( 1)	shdol ( 1)	shedol ( 1)	shdo ( 1)	
shkor (---)	shekor ( 1)	shkol ( 2)	shekol ( 1)	shko ( 1)	
shtor ( 1)	shetor (---)	shtol ( 1)	shetol (---)		
sho (130)	sheo ( 47)	sheeo ( 8)			
shs ( 4)	shes ( 13)	shees ( 9)	sheees ( 2)		
shl ( 3)	shel (---)				
shr ( 2)	sher ( 3)				
sh ( 15)	she ( 25)	shee ( 13)	cs ( 4) <sup>53</sup>		
ysho ( 3)	ysheo ( 2)	ysheeo ( 2)			
sshol ( 1)	ssheol ( 1)				
sshor ( 1)	ssheor (---)				

<sup>53</sup> Takahashi transcribes  $\text{ㄹ}^2$  ("sh") as "cs" if the additional ㄹ-stroke is at the end of the  $\text{ㄹ}^2$ -glyph.



**[ch + al]**

chal ( 48)	cheal ( 30)	cheeal ( 2)	
char ( 72)	chear ( 51)	cheear ( 1)	
cham ( 20)	cheam ( 5)		charam ( 4)
chan ( 11)	chean ( 2)		
chas ( 1)	cheas ( 1)		
cha ( 2)	chea (---)	cheea ( 1)	
dchar ( 4)	dchal ( 2)		
kchar ( 2)	kchal ( 1)		
tchar ( 4)	tchal ( 2)		
pchar ( 3)	pchal ( 3)		
shar ( 34)	shear ( 21)	sheear ( 2)	
shal ( 15)	sheal ( 19)	sheeal ( 1)	
sham ( 7)	sheam ( 2)		
shan ( 5)	shean (---)		
shas (---)	sheas ( 1)		
sha ( 1)	shea ( 1)		
kshar ( 4)			
tshar ( 1)			
pshar ( 1)			

**[cth + ol]**

cthol (60)	cthor ( 45)	cthom ( 9)	cthos ( 1)	ctho ( 15)	cth ( 5)
ckhol (22)	ckhor ( 9)	ckhom (---)	ckhos ( 3)	ckho ( 4)	
cphol (15)	cphor ( 6)	cphom ( 1)	cphos (---)	cpho ( 2)	
cfhol ( 6)	cfhor (---)				
cthod ( 4)					
ckhod ( 1)					
ctheol (10)	ctheor ( 6)				
ckheol ( 7)	ckheor ( 1)				
cpheol ( 3)	cpheor ( 4)				
cfheol ( 2)	cfheor (---)				
ctholy ( 4)	cthory ( 2)				
ckholy ( 1)	ckhory ( 1)				
chcthol (---)	chcthor ( 1)				
chckhol ( 2)	chckhor ( 2)	chckhom ( 1)			
chcphol ( 1)	chcphor (---)				
chcfhol ( 1)	chcfhor ( 1)				

**[cth + al]**

cthal ( 7)	cthar ( 20)	ctham ( 1)	
ckhal ( 4)	ckhar ( 3)	ckham ( 3)	
cphal ( 2)	cphar ( 4)		
chcthal ( 2)	chcthar ( 1)	chctham ( 2)	
chckhal ( 5)	chckhar (---)	chckham ( 1)	
	cthear ( 1)		
	ckhear ( 1)		

**[qo + os]**

qokos ( 1)	qokeos ( 5)	qokeeos ( 4)	qokees ( 8)	qokeees ( 3)
qotos ( 1)	qoteos ( 1)	qoteeos ( 3)	qotees ( 4)	qoteees ( 2)
okos ( 8)	okeos ( 14)	okeeos ( 6)	okees ( 16)	okes ( 3)
otos ( 4)	oteos ( 29)	oteeos ( 10)	otees ( 10)	otes ( 5)
	oeos ( 1)	oeeos ( 2)	oes ( 9)	oeees ( 9)
			ees ( 6)	eees ( 9)
ykos (---)	ykeos ( 3)	ykeeos ( 3)	ykees ( 4)	
ytos ( 1)	yteos ( 3)	yteeos ( 1)	ytees ( 1)	
kos ( 3)	keos ( 1)	keeos ( 4)		
tos ( 4)	teos ( 3)	teeos ( 3)		
kas ( 4)				
tas ( 1)				

[qo + ol]

qol (151)	qo ( 29)	qoly ( 7)			
qor ( 22)	god ( 8)	qos ( 4)			
qok ( 9)	got ( 7)	qop ( 4)	qof ( 1)		
qokol (104)	qokeol ( 52)	qokeeol ( 11)	qokeo ( 7)	qokeeo (23)	qoko (9)
qotol ( 47)	qoteol ( 12)	qoteeol ( 5)	qoteo ( 5)	qoteeo ( 3)	qoto (3)
qokor ( 36)	qokeor ( 21)	qokeeor ( 10)			
qotor ( 29)	qoteor ( 5)	qoteeor (---)			
qopol ( 6)					
qopor ( 4)					
qofol ( 2)					
	qockhol ( 7)	qockheol ( 3)	ockhol ( 1)		
	qockhor ( 1)	qockheor ( 1)	ockhor ( 1)		
	qocthol ( 2)	qoctheol ( 1)	octhol ( 1)		
	qoctor ( 1)	qoctor ( 1)	octhor ( 1)		
	qockhos ( 1)	qockheos ( 1)		octhos ( 1)	
okol ( 82)	okeol ( 66)	okeeol ( 18)	ok ( 4)		
okor ( 34)	okeor ( 22)	okeeor ( 14)			
otol ( 86)	oteol ( 42)	oteeol ( 9)	ot ( 9)		
otor ( 46)	oteor ( 12)	oteeor ( 4)			
opol ( 4)					
opor ( 8)					
ofor ( 2)					
ofol ( 1)					
ykor ( 10)	ykeor ( 8)	ykeeor ( 4)			
ykol ( 14)	ykeol ( 14)	ykeeor ( 13)			
ytor ( 14)	yteor ( 3)	yteeor ( 1)	yto ( 5)		
ytol ( 12)	yteol ( 6)	yteeol ( 1)			
yfor ( 1)					
kol ( 37)	keol ( 20)	keeol ( 13)			
kor ( 26)	keor ( 10)	keeor ( 8)			
tol ( 48)	teol ( 15)	teeol ( 5)			
tor ( 23)	teor ( 4)	teeor ( 1)			
pol ( 24)					
por ( 8)					
fol ( 3)					
odol ( 2)	odeol (---)		godol ( 1)		
odor ( 8)	odeor ( 1)		godor ( 2)		
okom ( 7)	okeom ( 6)		qokom ( 2)	gokeom ( 2)	
otom ( 1)	oteom ( 2)		qotom ( 1)		
gotedor ( 2)	otedor ( 1)				
gotedol ( 1)	otedol ( 3)				
qokedor (---)	okedor ( 3)	okeodor ( 1)	ykedor ( 1)		
qokedol ( 1)	okedol (---)				
qololal (---)		qokoral ( 1)	qokorar ( 2)		
qokolol (---)			qokoror ( 1)		
qotolol ( 1)					
qofolol (---)					qoforum (1)
okolal (---)	okolar ( 2)	okoral ( 1)			
otolal (---)			otorar ( 1)	otolam ( 2)	otoram (1)
opolal (---)			oporar ( 1)		
ofolal (---)					oforam (1)
otolol ( 1)	otolor ( 2)			otolom ( 1)	
ykolol (---)	ykolor ( 1)				
ypolol ( 1)					

[qo + al]

qokal (191)	qokeal ( 4)	qokeeal ( 1)	qokl ( 9)		
qokar (152)	qokear ( 6)	qokeear ( 2)			
qotal ( 59)	qoteal ( 2)	qoteeal ( 1)	qotl ( 2)		
qotar ( 63)	qotear ( 2)	qoteear (---)			
qopal ( 2)					
qopar ( 5)					
okal (138)	okeal ( 12)	okeeal ( 2)			
okar (129)	okear ( 7)	okeear ( 4)	okas ( 4)		
otal (143)	oteal ( 6)	oteeal ( 2)			
otar (141)	otear ( 4)	oteear (---)	otas ( 4)		
opal ( 9)					
opar ( 10)					
ofal ( 4)					
ofar ( 4)			ofas ( 1)		
opam ( 4)					
ykal ( 16)	ykeal ( 1)	ykeeal (---)			
ylar ( 36)	ykear (---)	ykeear ( 2)			
ytal ( 19)	yteal ( 1)	yteeal (---)			
ylar ( 26)	ytear ( 1)	yteear (---)			
ypal ( 2)	ypar ( 4)	yfal ( 1)			
kal ( 23)	keal (---)	keaal (---)			
kar ( 52)	kear (---)	keear ( 3)			
tal ( 20)	teal (---)	teeal ( 1)			
tar ( 43)	tear ( 2)	teear ( 1)			
pal ( 2)	par ( 5)	far ( 3)			
qokam ( 25)	okam ( 26)	ykam ( 5)			
qotam ( 12)	otam ( 47)	ytam ( 13)			
qokan ( 8)	okan ( 5)	ykan ( 1)			
qotan ( 2)	otan ( 5)	ytan (---)			
qodal ( 7)	odal ( 13)	ydal ( 3)	adal ( 1)	sodal ( 5)	
qodar ( 11)	odar ( 24)	ydar ( 2)	adar ( 1)	sodar ( 6)	
qodam ( 3)	odam ( 6)	ydam ( 1)	adam ( 2)		
kam ( 9)	olkam ( 9)	lkam ( 7)	alkam ( 6)		
tam ( 5)	oltam ( 1)	ltam ( 1)			
kan ( 3)	olkan (---)	lkan ( 1)			
tan ( 1)	oltan (---)	ltan (---)			
qoar ( 12)	qoear ( 3)	qoeear ( 2)	ear ( 1)	qear ( 1)	gear ( 1)
qoor ( 8)	qoeor ( 2)	qoeeor ( 3)	eeor ( 4)	qeeor ( 1)	
qoal ( 4)	qoeal (---)	qoeaal (---)		qeeal ( 1)	
qool ( 4)	qoeol ( 5)	qoeool ( 2)	eeol ( 2)		qeol ( 1)
qoos ( 3)	qoeos (---)	qoeeos (---)	eeos ( 1)		
okod ( 3)	okeod ( 6)	okeeod (---)			
oar ( 16)	oear (---)	oeear ( 3)			
oal ( 3)	oeal (---)	oeaal ( 2)			
oor ( 3)	oeor ( 2)	oeeor ( 2)			
qotedar ( 3)	otedar ( 11)	oteodar ( 7)	ytedar ( 3)		
qotedal ( 3)	otedal ( 4)	oteodal ( 6)			
qokedar ( 8)	okedar ( 6)	okeodar ( 3)	ykedar ( 1)	kyedar ( 2)	
qokedal ( 3)	okedal ( 7)	okeodal ( 3)			
qoteedar ( 3)	oteedar ( 3)	oteeodar ( 1)			
qoteedal (---)	oteedal ( 2)	oteeodal (---)			
qokeedar ( 6)	okeedar ( 2)	okeeodar ( 1)			
qokeedal ( 3)	okeedal ( 3)	okeeodal ( 1)			
	tedar ( 1)	teodar ( 3)	teoar ( 1)		
	tedal ( 1)	teodal ( 3)			
	kedar ( 3)	keodar ( 2)	keoar ( 1)		
	kedal ( 1)	keodal ( 1)			
qokalal (---)	qokalar ( 1)		qokalam ( 1)	qokaram ( 2)	
qotalal ( 1)					
okalal ( 6)	okalar ( 6)	okaral ( 5)	okarar ( 1)	okalam ( 2)	okaram ( 3)
otalal ( 3)	otalar ( 3)	otaral ( 3)	otarar ( 5)	otalam ( 3)	otaram ( 4)
opalal ( 2)	opalar ( 1)	oparal ( 1)	oparar (---)	opalam ( 1)	oparam ( 1)
ofalal (---)	ofalar ( 1)	ofaral ( 1)	ofarar (---)	ofalam (-)	ofaram ( 1)
okalol ( 3)	okalor ( 3)	okarol ( 2)			
otalol (---)	otalor ( 4)			otalom ( 1)	
opalol (---)	opalor ( 2)				
ytalal (---)	ytalar ( 1)		ytarar ( 1)		

[1 + ol]

lol ( 44)	olol ( 18)	alol ( 9)	dalol ( 7)	dolol ( 1)
lor ( 43)	olor ( 31)	alor ( 7)	dalor ( 8)	dolor ( 2)
rol ( 20)	orol ( 15)	arol ( 12)	darol ( 3)	dorol ( ---)
ror ( 17)	oror ( 5)	aror ( 6)	daror ( 3)	doror ( 1)
los ( 5)	olos ( 2)	alos ( 2)		
ros ( ---)	oros ( ---)	aros ( 1)		
rom ( 4)	orom ( 5)	arom ( 1)	darom ( 3)	
lom ( 5)	olom ( 3)	alom ( 6)	dalom ( 2)	
oly ( 57)	aly ( 29)	doly ( 3)	daly ( 30)	ly ( 14)
ory ( 17)	ary ( 26)	dory ( 4)	dary ( 24)	ry ( 13)
olo ( 5)	alo ( 3)	dolo ( 1)	dalo ( 3)	lo ( 15)
oro ( 5)	aro ( 1)	doro ( ---)	daro ( 3)	ro ( 10)
loly ( 7)	ololy ( 1)	aloly ( 3)		
lory ( 2)	olory ( ---)	alory ( 1)		
roly ( 3)	oroly ( 1)		raly ( 2)	
rory ( 2)	orory ( 1)		rary ( 4)	
rosy ( 1)	orosy ( ---)			
lkol ( 5)	olkol ( 5)	alkol ( 1)		
lkor ( 4)	olkor ( 4)			
lkeol ( 5)	olkeol ( 7)	lkeeol ( 4)	olkeeol ( 1)	
lkeor ( 1)	olkeor ( 1)	lkeeor ( 2)	olkeeor ( 2)	
		lkeeos ( 1)	olkeeos ( 1)	
lkeo ( 3)	olkeo ( ---)	lkeeo ( 4)	olkeeo ( 4)	
soly ( 3)	saly ( 5)			
sory ( 5)	sary ( 8)		osary ( 1)	osaro ( 1)
somy ( 1)	samy ( ---)			
lr ( 12)	olr ( 6)	alr ( ---)	dolr ( 1)	dalr ( 2)   dlr ( 1)
ls ( 10)	ols ( 18)	als ( 4)	dols ( ---)	dals ( 6)   dls ( 1)
rl ( 2)	orl ( ---)	arl ( 4)	dorl ( 1)	darl ( ---)
lchor ( 6)	lcheor ( 2)	lshor ( 1)		
lchol ( 4)	lcheol ( 8)	lshol ( ---)	lsheol ( 2)	
lcho ( 3)	lcheo ( 4)	lsho ( 2)	lsheo ( 1)	
olchor ( 3)	olcheor ( 3)	olshor ( ---)	olsheor ( 2)	
olchol ( ---)	olcheol ( 7)	olshol ( ---)	olsheol ( 4)	
olcho ( 1)	olcheo ( 2)	olsho ( 3)	olsheo ( ---)	

[1 + al]

rar ( 21)	orar ( 7)	arar ( 7)	darar ( 3)	dorar ( 2)
ral ( 17)	oral ( 10)	aral ( 16)	daral ( 2)	doral ( 1)
lar ( 6)	olar ( ---)	alar ( 6)	dalar ( 5)	dolar ( 2)
lal ( 7)	olal ( 7)	alal ( 5)	dalal ( 5)	
ram ( 14)	oram ( 10)	aram ( 12)	daram ( 7)	
lam ( 6)	olam ( 6)	alam ( 8)	dalam ( 7)	
sorol ( 1)	soral ( 3)	sarol ( 4)	saral ( 6)	
solor ( 1)	solar ( ---)	salor ( ---)	salar ( 2)	
solol ( 1)	solal ( 1)	salol ( 2)	salal ( 2)	
soror ( ---)	sorar ( ---)	saror ( ---)	sarar ( 4)	
rorol ( 3)	roral ( 1)	rarol ( ---)	raral ( 2)	
lkar ( 30)	olkar ( 19)	alkar ( 4)	dalkar ( 3)	
lkal ( 5)	olkal ( 11)	alkal ( 11)	dalkal ( 1)	lkl ( 9)
ltar ( 1)	oltar ( 3)			
ltal ( ---)	oltal ( 2)			
ldar ( 5)	oldar ( 6)			
ldal ( ---)	oldal ( 3)			
ldam ( ---)	oldam ( 6)		doldam ( 1)	
lchar ( 3)	lchear ( 1)	lshar ( 1)		
lchal ( 6)	lcheal ( 2)			
olchar ( 2)	olchear ( 2)			
olchal ( 1)	olcheal ( ---)			
olcha ( 1)	olchea ( ---)			
chlal ( 1)	cholal ( 4)	chalal ( 1)		
chlar ( 2)	cholar ( 2)			
chrar ( ---)	chorar ( 1)			

## ꞨꞨꞨ- or Ꞩ-series

### [chedy]

chedy (501)	cheedy ( 59)	shedy (426)	sheedy ( 84)	csedy ( 6) <sup>54</sup>	
chey (344)	cheey (174)	shey (283)	sheey (144)	cheeey ( 9)	sheeey (6)
chy (155)	chdy (150)	shy (104)	shdy ( 46)	chd ( 7)	shd (7)
chchy ( 2)	shchy ( 5)	chshy ( 2)	shshy ( 1)		
chody ( 94)	choy ( 13)	shody ( 55)	shoy ( 2)	cheoy ( 4)	sheoy (4)
	coy ( 1)	sody ( 5)	soy ( 4)		
choly ( 15)	chaly ( 5)	sholy ( 4)	shaly ( 1)	cholor ( 5)	cholody (5)
chory ( 12)	chary ( 6)	shory ( 6)	shary (---)	choror ( 3)	chorody (1)
cheody ( 89)	cheody ( 12)	sheody ( 50)	sheeody ( 3)		
cheoly ( 5)	cheeoly (---)	sheoly ( 1)	sheeoly ( 1)		
cheky ( 65)	cheeky ( 24)	sheky ( 36)	sheeky ( 14)	eky ( 1)	
chety ( 25)	cheety ( 25)	shety ( 9)	sheety ( 8)	ety ( 7)	
chepy ( 7)	cheepy (---)	shepy ( 1)	sheeepy (---)		
dchy ( 30)	dchdy ( 8)	dshy ( 8)	dshdy ( 2)		
ched ( 23)	cheed ( 2)	shed ( 18)	sheed ( 6)		
chod ( 9)	cheod ( 5)	shod ( 11)	sheod ( 11)		
chok ( 5)	cheok ( 2)	shok ( 5)	sheok (---)		
chot ( 4)	cheot ( 1)	shot ( 3)	sheot ( 1)		
chop ( 2)	cheop ( 1)	shop (---)	sheop (---)		
chof ( 1)	cheof (---)	shof (---)	sheof (---)		
chek ( 3)	cheek (---)	shek ( 11)	sheek ( 3)		
chet ( 1)	cheet ( 1)	shet ( 1)	sheet ( 3)		
chep ( 4)	cheep (---)	shep ( 1)	sheep ( 1)		
chef ( 1)	cheef ( 2)	shef (---)	sheef (---)		
choldy ( 10)	cheoldy ( 5)	sholdy ( 8)	sheoldy ( 2)		
ychey ( 17)	ycheey ( 24)	yshey ( 12)	ysheey ( 10)	yrchey ( 1)	
ochey ( 8)	ocheey ( 3)	oshey ( 7)	osheey ( 2)		
ychedy ( 13)	ycheedy ( 7)	yshedy ( 10)	ysheedy ( 6)		
ochedy ( 8)	ocheedy ( 1)	oshedy ( 3)	osheedy ( 1)		
ychy ( 4)	ychdy ( 2)	yshy ( 1)	yshdy (---)		
ochy ( 5)	ochdy ( 1)	oshy (---)	oshdy ( 1)		
dchey ( 18)	dcheey ( 13)	dshey ( 14)	dsheey ( 8)		
dchedy ( 26)	dcheedy ( 4)	dshedy ( 36)	dsheedy ( 4)		
dchody ( 2)	dcheody ( 2)	dshody ( 2)	dsheody ( 2)		
chekchy ( 5)	chokchy ( 16)	shekchy ( 5)	shokchy ( 9)		
chetchy ( 4)	chotch ( 12)	shetchy ( 2)	shotchy ( 3)		
chedchy ( 1)	chodchy ( 4)	shedchy ( 1)			
chepchy ( 4)	chopchy ( 5)	shepchy ( 2)	shopchy ( 2)		
chefchy ( 3)	chofchy ( 2)				
chechy ( 1)	chochy ( 4)	shechy ( 2)	shochy ( 1)		

<sup>54</sup> Takahashi transcribes ꞨꞨꞨ ("shedy") as "csedy" if the additional Ꞩ-stroke is at the end of the Ꞩ-glyph.

[ch + chedy]

chckhy (140)	chckhdy ( 13)	chckhedy ( 11)	ckhedy ( 4)		
chcthy ( 79)	chcthdy ( 7)	chcthedy ( 7)	cthedy ( 10)		
chcphy ( 11)	chcphdy ( 2)	chcphedy ( 3)	cphedy ( 8)		
chcfhy ( 2)	chcfhdy ( 1)	chcfhedy (---)	cfhedy (---)		
	chckhhy ( 9)		ckhhy ( 5)		
	chcthhy ( 7)		cthhy ( 3)		
	chcphhy ( 3)		cphhy ( 1)		
	chcfhhy ( 3)		cfhhy (---)		
shckhy ( 60)	shckhdy ( 2)	shckhedy ( 6)	sheckhedy ( 4)	checkhedy ( 1)	
shcthy ( 31)	shcthdy ( 1)	shcthedy ( 1)	shecthedy ( 1)	checthedy ( 2)	
shcphy ( 2)	shcphdy (---)	shcphedy (---)	shecphedy (---)	checphedy ( 1)	
ckhey (131)	cthey ( 50)	cphey ( 6)	cfhey ( 2)		
ckheey ( 11)	ctheey ( 13)	cpheey ( 2)	cfheey ( 1)		
qockhey ( 18)	qocthey ( 5)	qocphey ( 1)	qocfhey ( 1)	qockheey ( 4)	
qockhy ( 19)	qocthy ( 7)	qocphy ( 2)			
ockhey ( 7)	octhey ( 6)	ocphey ( 1)	ocfhey ( 1)		
chockhey ( 5)	chocthey ( 6)				
shockhey ( 3)	shocthey ( 1)		shocfhey ( 1)		
ckhoy ( 1)	cthoy (---)	cphoy ( 2)	cfhoy ( 1)		
ockhy ( 13)	octhy ( 10)	ocphy ( 3)	ocfhy (---)		
aikhy ( 2)	aithy ( 5)	aiphy ( 1)	aifhy ( 1) <sup>55</sup>		
cthy (111)	cthdy ( 8)	cthody ( 18)	ctheody ( 6)	cty (5)	cto (4)
ckhy ( 39)	ckhdy ( 4)	ckhody ( 4)	ckheody ( 5)	cky (2)	cko (-)
cphy ( 16)	cphdy (---)	cphody ( 2)	cpheody ( 3)	cpy (1)	cpo (-)
cfhy ( 6)	cfhdy ( 1)	cfhody (---)	cfheody ( 3)	cfy (-)	cfo (-)
chckh ( 3)	chckhd ( 4)	chckhod ( 1)			
chcth ( 3)	chcthd ( 1)	chcthod ( 1)			
checkhy ( 47)	chckhey ( 30)	chockhy ( 21)	checkhdy ( 2)	checkhey ( 10)	
checthy ( 28)	chcthey ( 7)	chocthy ( 18)	checthdy ( 1)	checthey ( 4)	
	chcphedy ( 3)	chocphy ( 3)	checphdy ( 2)	checphedy ( 4)	
	chcfhey ( 1)	chocfhy ( 1)	checfhdy (---)		
sheckhy ( 35)	shckhey ( 12)	shockhy ( 5)	sheckhdy ( 1)	sheckhey ( 4)	
shecthy ( 20)	shcthey ( 7)	shocthy ( 12)	shecthdy (---)	shecthey ( 1)	
shecphy ( 3)	shcphedy (---)	shocphy (---)	shecphhdy ( 1)		
shecfhy (---)	shcfhedy (---)	shocfhy ( 2)	shecfhdy (---)		
		choikhy ( 2) <sup>55</sup>			
		choiphy ( 1)			
		shoikhy ( 4)			
		shoifhy ( 1)			

<sup>55</sup> Takahashi transcribes Ꝣ ("ckh") as "ikh", ꝣ ("cth") as "ith", "cph" as "iph" and "cfh" as "ifh" if the Ꝣ ("c") is drawn as a plain quill stroke Ꝣ.

[qo + chedy]

qokeedy (305)	qokedy (272)	qokeeedy ( 5)		
qoteedy ( 74)	qotedy ( 91)	qoteeedy ( 3)		
qodeedy ( 3)	qodedy (---)			
qokeed ( 15)	qoked ( 7)			
qoteed ( 3)	qoted ( 4)			
okeed ( 3)	oked ( 2)			
oteed ( 8)	oted ( 1)			
okeedy (105)	okedy (118)	okeeedy ( 9)	chokeedy ( 3)	chokedy ( 3)
oteedy (100)	otedy (155)	oteeedy ( 3)	choteedy ( 1)	chotedy ( 2)
keedy ( 53)	kedy ( 44)	keeedy ( 3)	chkeedy ( 2)	chkedy ( 5)
teedy ( 13)	tedy ( 42)	teeedy ( 4)	chteedy (---)	chtedy ( 2)
ekeedy (---)	ekedy ( 1)		chekeedy ( 4)	chekedy ( 4)
eteedy ( 1)	etedy ( 1)		cheteedy ( 1)	chetedy ( 3)
eedy ( 6)	edy (---)	eeedy ( 8)		
oeeedy ( 7)	oedy ( 2)	oeeedy ( 1)		
deedy ( 7)	dey ( 1)	deedy ( 1)		
oeeey ( 6)	oey (---)	oeeey ( 3)		
oeeo ( 3)	oeeo ( 1)	oeeeo ( 1)		
ykeedy ( 30)	ykedy ( 23)	ykeeedy ( 4)		
yteedy ( 28)	ytedy ( 24)	yteeedy ( 1)		
qokeedy (308)	qokedy (107)	qokeeedy ( 26)		
qoteedy ( 42)	qotedy ( 24)	qoteeedy ( 4)		
qokeody ( 32)	qokody ( 9)	qokeeody ( 13)	qokoy ( 2)	
qoteody ( 12)	qotody ( 11)	qoteeody ( 6)	qotoy ( 2)	
qokeod ( 8)	qokod ( 7)	qokeeod ( 2)		
qoteod (---)	qotod ( 2)	qoteeod ( 1)		
qoeedy ( 15)	qoedy (---)	qoeeedy ( 7)	qochey ( 6)	
qoeedy ( 20)	qoedy ( 4)	qoeeedy ( 3)		
qoeody (---)	qoody ( 1)	qoeeody ( 3)		
okeody ( 37)	okody ( 16)	okeeody ( 16)	chokeody ( 5)	shokeody (---)
oteody ( 39)	otody ( 14)	oteeody ( 11)	choteody ( 1)	shoteody (---)
ykeody ( 16)	ykody ( 2)	ykeeody ( 12)	chykeody (---)	shykeody ( 1)
yteody ( 14)	ytody ( 9)	yteeody ( 9)	chyteody ( 1)	shyteody (---)
oteotey ( 4)	oteoteotsho (1)			
okeoky ( 1) <sup>56</sup>	okeokeokeody (1)			
okeoy ( 2)	okoy ( 4)	koy (---)	ykoy (---)	
oteoy ( 1)	otoy ( 3)	toy ( 5)	ytoy ( 2)	
keody ( 21)	kody ( 7)	keeody ( 8)	chkeody ( 1)	shkeody ( 1)
teody ( 8)	tody ( 8)	teeody ( 4)	chteody ( 1)	shteody ( 1)
okeedy (177)	okeey ( 63)	okeeedy ( 27)	chokeedy ( 11)	chokey ( 7)
oteedy (140)	oteey ( 57)	oteeedy ( 8)	choteedy ( 7)	chotey ( 9)
ekeedy ( 1)	ekey ( 2)	ekeeedy (---)	chekeedy ( 6)	chekey ( 7)
eteedy (---)	etey (---)	eteeedy (---)	cheteedy ( 3)	chetey ( 5)
			shokeedy ( 3)	shokey ( 5)
				shotey ( 1)
			shekeedy ( 6)	shekey ( 5)
				shetey ( 1)
			cheekey ( 6)	sheekey ( 1)
			cheetey ( 3)	sheetey ( 2)
			cheekey ( 1)	sheekey ( 2)
			cheeteedy ( 4)	sheeteedy ( 1)
			cheokey ( 3)	sheokey ( 4)
			cheokeedy ( 5)	sheokeedy ( 2)
			chkeedy ( 13)	chkey ( 8)
key ( 44)	key ( 14)	keeey ( 11)	chteedy ( 3)	chtey ( 1)
teey ( 20)	tey ( 11)	teeey ( 1)	chykey ( 2)	
ykeedy ( 58)	ykey ( 8)	ykeeedy ( 6)		
yteedy ( 28)	ytkey ( 13)	yteeedy ( 3)		
ykeedy ( 7)	ykeo ( 3)			
yteedy ( 3)	yteo ( 1)			
okeedy ( 15)	okeo ( 14)	okeeedy ( 2)	chokeedy ( 1)	chokeo ( 2)
oteedy ( 12)	oteo ( 13)	oteeedy ( 1)		
keedy ( 9)	keo ( 4)	keeedy ( 1)		
teedy ( 1)	teo ( 2)	teeedy (---)		

<sup>56</sup> *oꝛoꝛ* ("oteedy") occurs on page <f71r> in line <f71r.R1.1> side by side with *oꝛoꝛ* ("okeoky") and above of *oꝛoꝛ* ("oteotey") in line <f71r.S1.9>.



[qo + k + dy]

dy (270)	sy ( 35)	so ( 5)	sa ( 4)	
ody ( 46)	odchy ( 1)	oy ( 6)		
qody ( 17)	qodchy ( 2)	qoy ( 9)		
qokdy (147)	goty ( 87)	qopy ( 6)		
qokdy ( 4)	gotdy (---)	qopdy ( 1)		
loky (---)	loty ( 4)	lopy (---)		
oky (102)	okchy ( 39)	choky ( 39)	cheoky ( 10)	cheockhy ( 10)
oty (115)	otchy ( 48)	choty ( 37)	cheoty ( 5)	cheocthy ( 5)
opy ( 7)	opchy ( 15)	chopy ( 3)	cheopy ( 1)	cheocphy ( 1)
ofy ( 2)	ofchy ( 3)	chofy (---)	cheofy (---)	cheocfhy (---)
	okshy ( 10)	shoky ( 8)	sheoky ( 6)	sheockhy ( 2)
	otshy ( 4)	shoty ( 8)	sheoty ( 1)	sheocthy ( 2)
	opshy (---)	shopy (---)	sheopy (---)	sheocphy ( 2)
yty ( 24)	ytchy ( 29)	chyty ( 4)	chytchy ( 1)	ytcho ( 2)
yky ( 18)	ykchy ( 19)	chyky ( 6)	chykchy ( 3)	ykcho ( 6)
	ypchy ( 4)	chypy (---)	chypchy ( 1)	ypcho (---)
	ytshy ( 3)	shyty (---)	shytchy ( 2)	yksho ( 1)
	ykshy ( 2)	shyky (---)	shykchy ( 2)	ytsho ( 2)
dyky ( 5)	dyty ( 2)			
ydy ( 8)		chydy ( 2)		
oko ( 8)	okcho ( 9)	choko ( 2)	chokcho ( 2)	
oto ( 9)	otcho ( 11)	choto ( 3)	chotcho ( 1)	
	oksho ( 4)	shoko ( 1)	shokcho (---)	
	otsho ( 2)	shoto ( 1)	shotcho ( 1)	
ky ( 25)	kchy ( 29)	chky ( 18)	chkchy ( 6)	yk ( 5)
ty ( 16)	tchy ( 24)	chty ( 13)	chtchy ( 2)	
py ( 2)	pchy ( 2)	chpy ( 1)	chpchy ( 4)	
	kshy ( 5)	shky ( 13)	chkshy ( 1)	
	tshy ( 5)	shty ( 4)	chtshy ( 1)	
	pshy ( 1)			
qokaly ( 18)	okaly ( 24)	okealy ( 1)	kaly ( 2)	chkaly ( 2)
qotaly ( 5)	otaly ( 19)	otealy (---)	taly ( 1)	chtaly ( 1)
qokary ( 1)	okary ( 11)	okeary (---)	kary ( 5)	
qotary ( 1)	otary ( 5)	oteary (---)	tary (---)	
qokoly ( 1)	okoly ( 5)	okeoly ( 6)	okeeoly ( 2)	
qotoly ( 1)	otoly ( 11)	oteoly ( 2)	oteeoly ( 1)	
qokory ( 1)	okory ( 3)	okeory ( 1)		
qotory ( 1)	otory ( 4)	oteory ( 1)		
	ykaly ( 6)			
	ytaly ( 5)			

[qo + k + chedy]

qokchedy (39)	qokchdy (56)	qokshedy (11)	qokshdy ( 4)	qokcheedy ( 2)
qotchedy (24)	qotchdy (23)	qotshedy ( 3)	qotshdy ( 3)	qotchedy ( 4)
qopchedy (32)	qopchdy (15)	qopshedy ( 4)	qopshdy (--)	qopcheedy ( 2)
qofchedy ( 8)	qofchdy ( 3)			
qotchody ( 3)	qokchody ( 2)	qopchody ( 1)		
qotchod ( 2)	qokchod ( 4)			
qokechedy ( 4)	qokechdy ( 3)	qokeshedy ( 1)	qokeshdy ( 1)	
okechedy ( 4)	okechdy ( 4)	okeshedy ( 1)		
otechedy ( 1)	otechdy ( 5)			
qockhedy ( 4)	qockhdy ( 1)	qockhody ( 1)		
qocthedy ( 3)	qocthdy ( 1)	qocthody ( 1)		
qocphedy (--)	qocphdy ( 1)	qocphody ( 1)		
okchedy (25)	okchdy (21)	okshedy ( 3)	okshdy ( 1)	
otchedy (34)	otchdy (30)	otshedy (13)	otshdy ( 3)	otchedy ( 1)
opchedy (50)	opchdy (19)	opshedy ( 2)	opshdy ( 1)	opcheedy ( 3)
ofchedy ( 7)	ofchdy ( 5)	ofshedy (--)	ofshdy ( 1)	ofcheedy (--)
otchody ( 6)		otshody (--)		
okchody ( 3)		okshody ( 1)		
opchody ( 2)		opshody ( 1)		
ockhedy ( 6)		ockhody ( 2)		
octhedy ( 2)	octhdy ( 2)	octhody ( 4)		
ocphedy ( 1)				
ytchedy (10)	ytchdy (10)	ytshedy ( 2)		
ykchedy ( 7)	ykchdy ( 8)	ykshedy ( 1)		
ypchedy (12)	ypchdy ( 6)	ypshedy ( 1)		ypcheedy ( 1)
yfchedy ( 1)	yfchdy ( 1)	yfshedy (--)		
ytchody ( 5)				
ykchody ( 4)				
kchedy (22)	kchdy (20)	kshedy ( 6)	kshdy ( 5)	kcheedy ( 1)
tchedy (33)	tchdy (15)	tshedy ( 8)	tshdy ( 4)	tcheedy (--)
pchedy (34)	pchdy (11)	pshedy ( 3)	pshdy ( 1)	pcheedy ( 2)
fchedy (11)	fchdy ( 4)	fshedy ( 2)		
kechdy ( 4)		keshdy ( 1)		
kchody ( 6)	kcheody ( 5)	kshody ( 4)	ksheody ( 5)	
tchody ( 8)	tcheody ( 6)	tshody (--)	tsheody ( 2)	
pchody ( 5)	pcheody ( 7)	pshody ( 1)	psheody ( 5)	
fchody (--)	fcheody ( 2)	fshody ( 1)	fsheody (--)	
okched (--)	okchd ( 6)	okshed ( 1)	okshd ( 2)	
qokchey (30)	qokchy (69)	qokshedy ( 8)	qokshy (10)	
qotchey (19)	qotchdy (63)	qotshedy ( 3)	qotshy ( 5)	
qopchey (10)	qopchy (11)			qopcheedy ( 4)
qofchey ( 1)	qofchdy ( 2)	qofshedy ( 1)	qofshy ( 1)	
qokechy (13)		qokeshdy ( 1)		
qokeechy ( 6)		qokeeshdy ( 1)		
qotechy ( 2)		qoteshy ( 1)		
okchey (32)		okshedy ( 9)		okcheedy ( 7)
otchey (31)		otshedy ( 7)		otchedy ( 3)
opchey (29)		opshedy ( 1)		opcheedy ( 5)
ofchey ( 5)		ofshedy (--)		ofcheedy (--)
okechy ( 6)		okeshdy ( 3)		
okeechy ( 1)		okeeshdy ( 2)		
otechy ( 4)		oteshy ( 1)		
ykchey ( 6)				
ytchey (12)				
ypchey ( 5)				
yfchey ( 3)				
ykechy (--)		ykeshy ( 1)		
ytechy ( 1)				
ykeechy ( 3)		ykeeshdy ( 2)		
kchey (21)		ksheody ( 6)		kcheedy ( 5)
tchey (22)		tshedy ( 9)		tcheedy ( 6)
pchey (12)				pcheedy ( 4)
fchey ( 2)				fcheedy ( 4)
kechy ( 4)				keechy ( 3)
techy ( 1)				teechy (--)
qokched ( 1)	qokchd ( 6)	qokshed (--)	qokshd ( 3)	
qotched ( 5)	qotchd ( 4)	qotshed (--)	qotshd (--)	

[1 + chedy]

lchedy (119)	olchedy ( 38)	qolchedy ( 10)	alchedy ( 4)	
rchedy ( 11)	orchedy ( 2)			
schedy ( 7)				
lcheedy ( 9)	olcheedy ( 3)	qolcheedy ( 2)		
	solchedy ( 8)		salchedy ( 2)	
	dolchedy ( 3)		dalchedy ( 4)	
	polchedy ( 6)		palchedy (---)	
	tolchedy ( 1)		talchedy (---)	
	kolchedy ( 1)		kalchedy ( 1)	
lchdy ( 18)	olchdy ( 8)	qolchdy ( 1)	alchdy ( 2)	dalchdy ( 5)
lchey ( 45)	olchey ( 29)	qolchey ( 11)	alchey ( 4)	solchey ( 4)
rchey ( 9)	orchey ( 6)			
schey ( 5)				
lcheey ( 13)	olcheey ( 13)	qolcheey ( 1)	alcheey ( 1)	
rchey ( 4)	orchey ( 2)			
scheey ( 2)				
lchody ( 3)	olchody (---)			
lcheody ( 3)	olcheody ( 2)			
lchy ( 8)	olchy ( 8)	qolchy ( 2)	alchy ( 1)	
rchy ( 4)				
ldy ( 25)	oldy ( 27)		aldy ( 14)	
	doldy ( 2)		daldy ( 17)	
	dody ( 7)		dady ( 5)	
ld ( 4)	old ( 3)		ald ( 3)	
lched ( 6)	olched ( 3)		alched ( 1)	
lody ( 3)	olody ( 1)	qolody ( 1)	alody ( 6)	
rody ( 2)	orody (---)	qorody (---)	arody ( 13)	
qokoldy ( 3)	okoldy ( 8)	qokaldy ( 9)	okaldy ( 9)	okalody ( 3)
gotoldy ( 1)	otoldy ( 1)	gotaldy ( 1)	otaldy ( 7)	otalody ( 1)
	opaldy ( 1)			
	ykoldy ( 1)		ykaldy ( 1)	
	ytoldy ( 5)			
	koldy ( 7)		kaldy ( 4)	
	toldy ( 2)			
	poldy ( 2)			
lkchedy ( 16)	olkchedy ( 6)	lkshedy ( 4)	olkshedy ( 1)	olkshdy ( 1)
ltchedy (---)	oltchedy ( 1)		oltshedy ( 1)	
lpchedy ( 6)	olpchedy ( 4)		olpshedy ( 1)	
lfchedy ( 2)	olfchedy ( 4)			
lkchdy ( 5)	olkchdy ( 4)			
ltchdy ( 1)	oltchdy ( 1)			
lpchdy ( 2)	olpchdy ( 1)			

[1 + shedy]

lshedy ( 42)		olshedy (23)		qolshedy ( 2)		alshedy ( 1)	
rshedy ( 7)		orshedy (--)					
sshedy ( 5)							
lsheedy ( 6)		olsheedy ( 4)		qolsheedy ( 2)			
rsheedy ( 3)		orsheedy ( 1)					
lsheody ( 3)		olsheody ( 1)					
lshody ( 1)							
lshdy ( 2)		olshdy ( 4)		qolshdy ( 1)		alshdy ( 1)	
lsheey ( 8)		olsheey ( 7)		qolsheey ( 1)			
lshey ( 18)		olshey (11)		qolshey ( 1)		alshey ( 4)	
rshey ( 2)							
sshey ( 6)							
lshy ( 3)		olshy ( 3)		qolshy ( 2)		alshy ( 2)	
lkeedy ( 41)		olkeedy (42)		qolkeedy ( 7)			solkeedy ( 5)
lteedy ( 5)		olteedy ( 3)		qolteedy ( 1)			solteedy ( 1)
lkeody ( 4)		olkeody ( 2)					
lteody ( 1)		olteody ( 2)					
		alkeedy ( 4)					
lkeeody ( 6)		olkeeody ( 7)					
lkeey ( 41)		olkeey (40)		qolkeey ( 6)			solkeey ( 4)
lteey ( 2)		olteey ( 2)		qolteey (---)			
lkedy ( 29)		olkedy (27)		qolkedy ( 1)			
ltedy ( 7)		oltedy ( 5)		qoltedy ( 1)			
lkey ( 7)		olkey (12)		qolkey ( 1)			
ltey (---)		oltey ( 1)		qoltey (---)			
lkeeedy ( 4)		olkeeedy ( 3)					
lteeedy (---)		olteeedy ( 1)					
lkeeeey ( 8)		olkeeeey ( 9)					
lkchey ( 8)		olkchey ( 4)		lkchy ( 1)		olkchy ( 4)	
ltchey ( 1)		oltchey ( 2)		ltchy (---)		oltchy ( 2)	
lpchey ( 1)		olpchey ( 2)					
lky ( 17)		olky (22)		qolky ( 4)		cholky ( 4)	
lty ( 2)		olty ( 1)				cholty ( 1)	

## VI. Statistics for graph 2

	repeated words	compared words	same words in %
Line 0	2523	35821	6.8%
Line -1	2250	35812	6.3%
Line -2	2090	35803	5.8%
Line -3	1823	35794	5.1%
Line -4	1746	35785	4.9%
Line -5	1710	35780	4.8%
Line -6	1712	35779	4.8%
Line -7	1634	35772	4.6%
Line -8	1646	35763	4.6%
Line -9	1562	35759	4.4%
Line -10	1568	35756	4.4%

Table 1: repeated words within the previous 20 lines for each line of the VM

## VII. Statistics for graph 3

	similar words	compared words	similar words in %
Line 0	9105	35821	25.4%
Line -1	8771	35812	24.5%
Line -2	7818	35803	21.8%
Line -3	7360	35794	20.6%
Line -4	6823	35785	19.1%
Line -5	6728	35780	18.8%
Line -5	6649	35779	18.6%
Line -7	6646	35772	18.6%
Line -8	6242	35763	17.5%
Line -9	6321	35759	17.7%
Line -10	6233	35756	17.4%

Table 2: similar words within the previous 20 lines for each line of the VM

VIII. Code table as described by Trithemius

	Polygraphiae III-5	Polygraphiae III-15
a	pafa	mastra
b	pafe	mastre
c	pafi	mastri
d	pajo	mastro
e	paju	mastru
f	pasan	mastran
g	pasen	mastrén
h	pasin	mastrin
i	pason	mastron
k	pasun	mastrun
l	pasas	mastral
m	pasés	mastrél
n	pasís	mastríl
o	pasos	mastról
p	pasús	mastrúl
q	pasal	mastras
r	pasel	mastrés
s	pasil	mastrís
t	pasol	mastrós
u	pasul	mastrús
z	pasar	mastraff
y	pasfer	mastréff
z	pasir	mastríff
w	pasor	mastróff

Table 3: code table as described by Trithemius [Hermes: p. 143]