Voynich Paleography

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Abstract

By applying the principles of Latin Paleography to the Voynichese writing system, it is possible to identify distinguishing features of individual scribes. This lecture will explain the principles of Latin paleography and demonstrate how these principles can be profitably applied to the writing system of the Voynich manuscript in order to 1) distinguish different scribal hands; 2) identify the scribal output of each hand; and 3) potentially identify abbreviations and ligatures in the writing system. Finally, the speaker will explain the implications of these conclusions for current and future research on the Voynich Manuscript.

Keywords

Manuscripts, paleography, codicology, Voynich

1. Introduction

Although significant progress is being made, Voynichologists continue to disagree as to some of the most fundamental questions about the manuscript. How many letterforms are there? How many scribes can be identified? Are there ligatures, majuscules, abbreviations, and other scribal conventions? These questions have never been satisfactorily answered. This paper will address some of these lingering questions by presenting the results of a formal paleographic analysis of the Voynich manuscript using the methodologies of Latin paleography. [2]

2. Background and Methodology

In the 1970s, Capt. Prescott Currier discerned two primary hands at work in the first – the botanical – section of the manuscript, Scribe 1 and Scribe 2, noting a direct correlation between what he called "Language A" and Scribe 1, and "Language B" and Scribe 2. The distinction between Scribe 1 and Scribe 2 is quite clear. The work of Scribe 1 is widely spaced and evenly written.[3] By contrast, the work of Scribe 2 hurried and crowded with a distinct upward cant to the line of writing.[4] Currier attempted to identify the hands elsewhere in the manuscript, but his work beyond the botanical section is incomplete, halfhearted, and somewhat unconvincing. No trained paleographer or codicologist has revisited the relationship between scripts, dialects, and structure in the Voynich manuscript since Currier publicized his observations in the 1970s. Currier himself once said that he wasn't entirely certain about his conclusions and that the problem required the attention of a trained paleographer.[5] René Zandbergen also put out the call on his website for a "expert paleographer" to address the question of scripts and scribes.[6] Hence the present project, undertaken by a trained medieval paleographer and codicologist.

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[2] Throughout this paper, references to Voynichese glyphs will use the EVA system and statistics will be gleaned from René Zandbergen's IVTFF transcription files.
[3] See [1], f. 32r.
[4] See [1], f. 31v.
[5] See [2] "Questions and Discussion."
[6] See [3] "The Handwriting."

The discipline of paleography involves three skillsets: 1) literacy: learning how to read letterforms and expand abbreviations in different scripts; 2) attribution: understanding the history of particular styles of script in order to establish date and place of origin; and 3) description: studying graphic features of letterforms as well as general script characteristics in order to classify and distinguish different hands. As far as the Voynich is concerned, number 1 cannot be accomplished, since no one can read the manuscript (yet). As for no. 2, attribution, we cannot compare the glyphset to other examples because there aren't any. The best we can do is to try to contexualize the glyphset by comparing the letterforms to other manuscripts. Huntington Library manuscript HM 58316 (Italy, early fifteenth century) is a good example, as many of the Voynich letterforms are somewhat analogous to letterforms in this codex. Although the early fifteenth-century Italian humanistic origin of the Huntington manuscript is consistent with the carbon-14 dating of the Voynich Manuscript's parchment, such correlations are suggestive but not determinative. The humanistic tendencies of the glyphset, the color palette, and style of the illustrations suggest an origin in the early fifteenth century and a stylistic zone that includes the Italian peninsula and the area around the Aegean (excluding Greece), and stretching northwards to Germany and parts of eastern Europe.

What of no. 3, description? Due to its unique nature, the Voynich presents an interesting paleographical problem, from a theoretical as well as a practical perspective. Can the methods and methodologies of Latin paleography be applied to the unique glyphset of the Voynich manuscript? Indeed they can, using a tool called Archetype.[7]

Archetype is an open-source application that allows users to annotate images with discoverable facets using a customizable data model, then search for annotations on combinations of those facets, pulling the resulting annotations out of their images and into a lightbox where they can be studied and manipulated. The local Archetype instance that I designed for my study of the Voynich glyphset is called VoynichPal. Archetype is not an AI engine. It does not analyze the annotations and draw conclusions about them. Rather, it is a tool that allows the human eye to more easily annotate and compare symbols of interest. When applied to the Voynich Manuscript, this methodology facilitates the study of individual glyphs, which then allows the identification of which hands wrote on which leaves, which bifolia, which quires, and which sections, and facilitates an analysis of how, and if, different scribes collaborated.

One of the principles of Latin paleography is that at any a particular place and time, scribal training and practice results in particular scribal forms, such as letters, numbers, abbreviations, or ligatures, being of particular use for distinguishing between scribes trained in the same region to write the same script. Like careless poker players, scribes have "tells." This fundamental principle echoes the principles of modern forensic handwriting analysis, especially as applied to rules governing evidence admissable in court. Neither paleography nor handwriting analysis are sciences. They rely on human expertise and experience. Neither results in absolute certainty but generates results along a spectrum of surety. The analysis of the scripts and scribes of the Voynich manuscript is a subjective analysis, based on the author's research, experience, and expertise.

As no professional paleographer had yet attempted a comprehensive analysis of the script and scribes of the manuscript, a new methodology was established: Voynich Paleography. Several dozen leaves were uploaded into Archetype, and multiple examples of symbols on each page were selected and annotated. Because the scribes on most of the first fifty-six leaves can be clearly identified as either Scribe 1 or Scribe 2, it was not necessary to upload all of those images for analysis. A representative sample of leaves written by scribes 1 and 2 in the herbal section were uploaded and annotated, along with leaves from all of the other sections of the manuscript. As with Latin scripts, it became clear that certain glyphs were going to be more useful than others for an initial establishment of criteria. The most common symbols – [o], [e], and [i] – for example, did not exhibit easily identifiable differences from one sample to the next. In general, the more rare the symbol, the more distinctive it is likely to be within the corpus of a particular scribe.

[7] See [4].

3. The Scribes

The first distinctive symbol in the analysis was [k]. For the initial analysis of hands, 225 examples of the one loop/two legs gallows glyph were annotated on seventy-four representative pages from throughout the manuscript. The annotations were then sent to the Archetype Lightbox for manual sorting and visual analysis. Several features distinguish scribal forms of the glyph:

- Are there feet at the bottom of either vertical?
- Are the ascending strokes in fact vertical or are they written at a slight angle?
- Is the glyph formed by one or two strokes?
- Is the cross-bar bowed or is it horizontal? This is directly related to the previous question, since a bowed bar tends to result from a smooth directional change from the top of the first vertical, while a horizontal crossbar is the result of lifting the quill after completing the vertical.
- Is the loop large or small, round or oval?

This preliminary analysis identified five hands – the two labeled by Currier as Scribe 1 and Scribe 2, and three newly-identified scribes, designated Scribes 3, 4, and 5. The [k] character in Scribe 1 is distinguished by a sharp angle at the top of the first vertical as the quill changes direction, a bowed crossbar, a round loop, and a very slight foot at the base of the second vertical. Scribe 2 uses a horizontal, straight crossbar (indicating a lift of the pen after the completion of the first vertical), an oval loop, and an upwardly-angled final tick. The [k] written by Scribe 3 is similar to that of Scribe 1, although slightly more compact. The [k] written by Scribe 4 has a horizontal crossbar, an oversize loop, and a prominent final foot, and Scribe 5 writes a tall, narrow [k]-glyph with a bowed cross-stroke that angles out from the very top of the vertical, a round loop, and a minuscule tick at the foot of the second vertical.

A single character, however, is not sufficient evidence on which to form confident conclusions. Additional analysis identified an even-more determinative glyph: EVA [n]. The [n] glyph is almost always at word-end, and is usually preceded by one or two minims or [i] glyphs, giving the [iin] or [in] combination that is extremely common at word-end. EVA [n] is formed by a slanted stroke that mirrors the [i], drawn from top left to lower right. The pen then turns to the right and curves around up and back to the left. This final curve, a finial flourish, varies significantly from one scribe to the next. In fact, the shape and endpoint of the final flourish of [n] are nearly sufficient to determine scribal identity in the Voynich Manuscript, especially when combined with other features such as the [k] and general characteristics like angle and spacing.

The initial analysis identified the same five scribes as did the study of the [k]-glyph. Scribe 1 is distinguished by an [n] finial that begins at a 90° angle from the bottom of the final minim, looping high and back to end above and to the left of the initial stroke. For Scribe 2, the angle of origin is much tighter, closer to 45°, and the flourish itself is lower and shorter, ending above the initial stroke. Scribe 3 uses a tighter final flourish that nearly closes at the top of the initial stroke. The finial written by Scribe 4 is brief and open, finishing above and to the right of the initial stroke. Scribe 5 ends the [n]-glyph with a long, low finial that finishes well to the left of the initial stroke.

After confirming the number of scribes by an analysis of two different glyphs, it was also necessary to test and, if justified, refine each scribe's extent of work in the manuscript. To test the scribal identifications, several hundred [n] annotations were extracted and faceted to create scribal collections, to test the methodology and make refinements as necessary. No outliers were observed in the glyph collections for Scribes 1, 2 and 4, leaving the initial folio assignments for these scribes unchanged. Outliers in the Scribe 3 inventory were observed on f. 66r, where the long, low [n] finials led to a re-attribution of this page to Scribe 5.

A final glyph was analyzed in order to test the previous attributions: the [f] glyph, the one-leg one-loop gallows. Scribal tendencies for [f] are consistent with the scribal corpora identified for [k] and [n]. Scribe 1 pulls the pen slightly to the left at the top of the ascender before cutting to the right for the upper crossbar, and the loop is canted at around a 45 degree angle. Scribe 2 uses a second stroke for the crossbar, starting just below the top of the ascender, with a fairly vertical loop. Scribe 3 pulls down and rightwards from the top of the ascender, resulting in a slightly bowed crossbar. Scribe 4 does the same, but with a deeper bow. Finally, Scribe 5 has a bowed crossbar and small round loop.

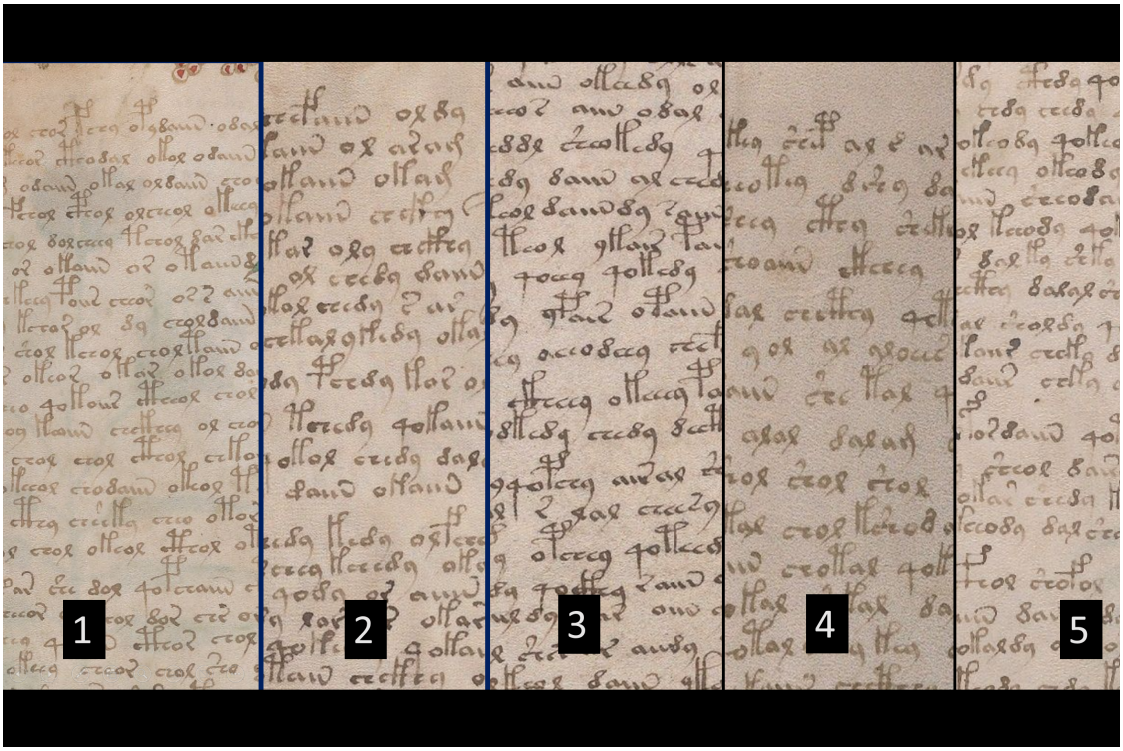

Figure 1: Scribes of the Voynich Manuscript

The identification of the number of scribes and their individual corpora in the Voynich Manuscript has important implications for understanding the conditions under which the manuscript was created and for suggesting new directions for linguistic research. These scribal assignments also demonstrate how scribal output relates to both codicological and textual structure, revealing the nature of scribal collaboration in the Voynich Manuscript.

4. Scribal Corpora

It is impossible to parse the relationship between scribal corpora and the structure of the Voynich Manuscript without a basic understanding of how medieval manuscripts are put together. Medieval European manuscripts are generally written on paper or parchment. The Voynich Manuscript is written on parchment, calfskin to be precise (the species was identified by amino-acid sequencing of ten sample leaves in 2012). After slaughtering and preparation of the skin, the sheet of parchment is cut into rectangular pieces, the size of which would be determined by the desired size of the final manuscript. Generally, the skin of a calf, for example, might yield two sheets for a manuscript of the size of the Voynich, although the foldouts are exceptional in size and format. Each sheet is folded in half to create a bifolium, two conjoint – or attached – leaves (folios). Each leaf, in turn, is comprised of two sides – or pages. The first side to be read is the recto, the other the verso. Bifolia are nested to create a gathering, or quire, and the quires are stacked and sewn onto perpendicular cords before being attached to their boards for binding. During the late-medieval period to which the Voynich Manuscript can likely be attributed, quires were generally comprised of four, five, or six nested bifolia, although depending on the needs of the particular codex, quires might have more bifolia or fewer.

The collation of the Voynich manuscript and the identification of the former positions of the known-to-be-missing leaves are greatly facilitated by the survival of quire numbers and foliation. The quire numbers likely date from an early rebinding; the foliation dates from the 17th-century, predating the removal of the missing leaves. There may have been leaves removed before the foliation was added, but there's no way to know for certain. The codex shows evidence of several re-bindings, including the current early-modern limp vellum, and it seems clear that some of the bifolia were mis-bound before the foliation was added and likely before the quiremarks were added as well. As others have noted,

some of the bifolia and single-leaf foldouts can be shown to have been reoriented either before the current foliation was added or after the quiremarks were written. For example, on the bifolium 78v/81r, the waterspouts at the left center of f. 78v spill across the gutter to meet corresponding streams with co-ordinating ranks of women in pools on the conjoint f. 81r, suggesting that this bifolium was originally both conjoint and consecutive, serving as the innermost bifolium of its quire and that it was mis-ordered before the foliation was added (it is currently the second bifolium from the center). In addition, the current configuration of Quire 9 – the foldout comprising ff. 67-68 – can be shown to be a later reorientation, as the quiremark is now in the wrong place and the sewing holes from the original configuration are still visible in the valley-fold on 67v. This reconfiguration took place after the quires were numbered but before the foliation was added.[8] Other interventions took place after the foliation was added, including the loss of at least fourteen leaves.

These observations are important because they have implications for interpreting the extent of work for each scribe and for understanding how the different scribes collaborated. By overlaying the scribal corpora onto the sections and quires, this becomes more clear. The Voynich Manuscript is traditionally divided into six thematic sections: botanical, astronomical/astrological, balneological, the "rose" foldout, recipes, and a textual section in which each paragraph is marked by a marginal star. These are distinct codicological units, although there are several "mixed" quires that are almost certainly misbound. This means that we can assign components of the collation statement to each section and scribe.

Scribes	Section	Collation
1, 2, 3, 5	Botanical (ff. 1-66)	1^{8}, 2^{8-1} (lacking f. 12), 3-7^{8}, 8^{10-6} (lacking ff. 59-64)
4	Astrological (ff. 67-74)	9-11^{2} , 12^{2-1} (lacking f. 74)
2	Balneological (ff. 75—84)	13^{10}
2, 4	Rose (ff. 85-86)	14^{1}
1, 3	Recipes (ff. 87-102)	15^{4}, [16: lacking], 17^{8-4} (lacking ff. 91-92, 97-98), [18: lacking], 19^{4}
3, 2	Stars (ff. 103-115v)	20^{14-2} (lacking ff. 109-110)

Figure 2: Scribes, Sections, and Quires

The botanical section extends from f. 1 through f. 66 and fills the first eight quires, each of which is (or was) comprised of four nested bifolia. It was Currier who first observed that, in the botanical section of the manuscript, Scribes 1 and 2 appear on separate bifolia that are mixed together in the quires. In Quire 4, for example, the innermost bifolium (ff. 28/29) was entirely written by Scribe 1. The next nested bifolium (ff. 27/30) was written by Scribe 1 as well. The next bifolium (ff. 26/31), however, was entirely written by Scribe 2. The outermost bifolium (ff. 25/32) is also by Scribe 1. Scribes 1, 2, and 5 all make an appearance on separate bifolia of Quire 6, and this mixing of bifolia continues through the end of Quire 7, f. 56. This very unusual collaboration method bears emphasizing: the scribal work in

[8] See [1], f. 78v, f. 81r, and f. 67r.

the botanical section varies by bifolia – not by page, text, or quire. This is utterly atypical and provides additional evidence that the current sequence of bifolia is not original.

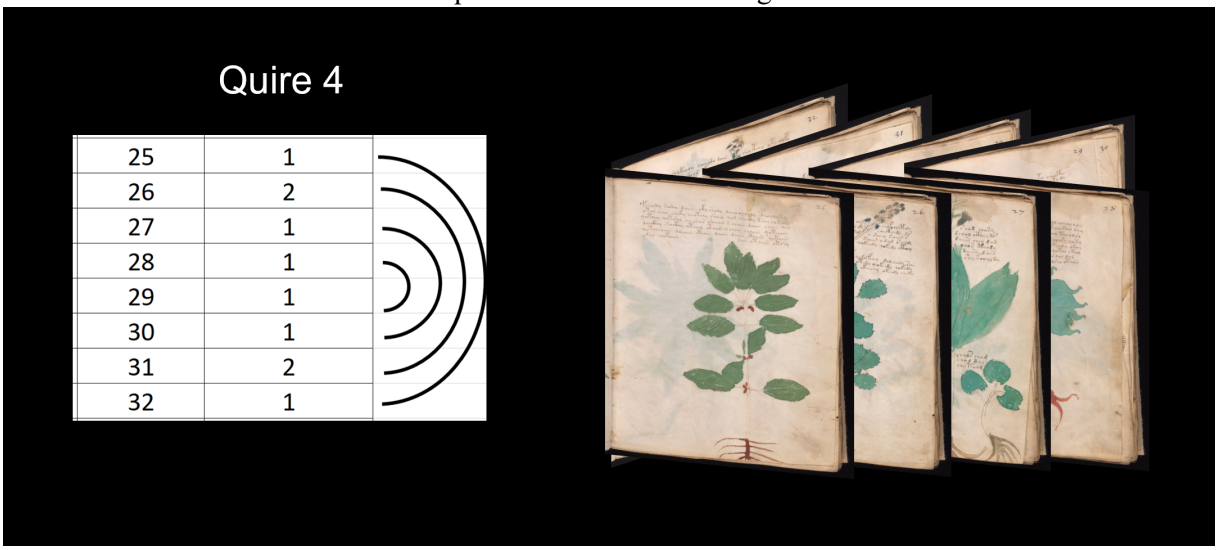

Figure 3: Quire 4 bifoliate structure

Quire 8 was originally five bifolia, but only the two outermost are extant. Here, we encounter a different method of collaboration: Scribe 5 writes the two botanical pages on the outer side of the outermost bifolium (57r and 66v) as well as the text on f. 66r. Scribe 1 writes folio 57v. Scribe 3 appears for the first time in this quire, writing the entirety of the next bifolium (ff. 58 and 65).

Scribe 4 writes the next four quires (9-12), the astronomical and zodiacal foldouts. Quire 13 (the balneological section) is entirely written by Scribe 2. Quire 14 is the famed "Rose" fold-out, with six panels on the obverse written by Scribe 2 and the 9-segment Rose on the other side written by Scribe 4. Quire 15 is comprised of two nested fold-outs written by Scribe 1. Both fold-outs are likely misbound: the outer foldout is a series of botanical pages that would seem to have been intended for the first section of the manuscript, while the inner foldout belongs to the recipe section. The next quire is numbered 17, suggesting that an entire quire is missing after number 15. Quire 17 was originally four nested bifolia but is missing its original outer two bifolia. Of the two botanical bifolia that are left, the outermost was written entirely by Scribe 1 and the inner entirely by Scribe 3. Quire 18 is also missing. Quire 19 (more recipes) is made up of two nested foldouts written by Scribe 1. The manuscript ends with the supersized Quire 20, originally seven nested bifolia on which are written several hundred starred paragraphs. The innermost bifolium is missing. The entire Quire is written by Scribe 3 with the exception of folio 115r, where the first twelve lines were written by Scribe 2.[9]

It was Currier who first determined that Scribe 1 writes in Language A and that Scribe 2 writes in Language B.[10] The other three scribes – 3, 4, and 5 – also use Language B, according to the tests developed by Currier and refined by René Zandbergen.[11] One of the tests for Language A is the frequency of word-initial [cth]. A test for Language B is the frequent use of word-final [dy] - a combination that is exceedingly common in Language B but much less so in Language A – and the bigram [ed], which shows the same pattern. Another pattern is confirmed by a refinement of Currier's tests. René Zandbergen has recently observed that the work of Scribe 4 (Language B) can be defined by two additional tests: the relatively small frequency of the [qo] bigram, and the equally small frequency of [ed].[12] In other words, in addition to the shape of the [k], [n], and [f], the frequency of [qo] and [ed] can help identify the work of Scribe 4. This additional layer of complexity may indicate that a re-assessment of the distinctions between Language A and B might be worthwhile, but such linguistic analysis is far beyond the scope of this essay.

[9] See [1], f. 115r.
[10] See [5], "1.2 Currier Languages."
[11] See [2], "2. The matter of 'language."
[12] See [6].

External evaluation supports these scribal distinctions. Claire Bowern and Luke Lindemann of Yale University have recently conducted an initial analysis of word-frequency patterns in the work produced by each of these five scribes and have identified distinctive word-use patterns for each of these hands.[13] Supporting evidence for these classifications is also found in the paper by Farrugia, Layfield, and van der Plas in these proceedings: "We have therefore found additional evidence for the division in scribes proposed by Davis using automatic methods from the area of authorship attribution. The few examples where all four classifiers agreed on a different attribution than the one proposed based on paleographic work may be interesting examples for further paleographic and stylometric study."[14] Two of these exceptions, on f. 116v and f. 66v, can be dismissed from consideration: f. 116v because it is demonstrably not written in Voynichese, and f. 66v because it is one of only three pages in which the hand of Scribe 5 is found, an extremely small sample that complicates the stylometric analysis. The remaining pages for which these authors recorded a disagreement between their analysis and the current study are pages that are here attributed to Scribe 2.[15]

5. Abbreviations and Ligatures (perhaps)

5.1. Abbreviations

Paleographical methods can also shed light on the even more unusual symbols used in the manuscript, by considering the possibility of the use of abbreviations and ligatures in Voynichese. Abbreviations are quite common in medieval manuscripts, replacing a sequence of letters with fewer letters or a single symbol to save space and make the writing process more efficient. A particular scribe's use of abbreviations is entirely discretionary; they may choose to abbreviate a particular word in one instance and to expand it in another. Ligatures represent a graphic connection of two or more letters, as in cursive scripts. Considering certain classes of Voynichese symbols as abbreviations or ligatures solves certain problems and may open up new avenues for future research and analysis.

Since serious study of the Voynich Manuscript began in 1912, researchers such as Zandbergen, Currier, D'Imperio, Pelling, Nill, Bowern, Lindemann, and others have noted the unusual behavior of the four gallows characters, otherwise known as [f], [p], [k], and [t] (in what follows, bench-gallows ([cth], [ckh], [cfh], and [cph]) are excluded from consideration, as they behave somewhat differently than gallows themselves). Some of these observations are explored in other papers in these Proceedings, in particular that [p] and [f] are over-represented as paragraph initials and in the toplines of paragraphs. Another important observation is that while the bigrams [ke] and [te] are extremely common, [pe] is exceedingly rare and [fe] is non-existent.[16]

To a paleographer, someone who studies the graphic, rather than linguistic or cryptographic, properties of historic and ancient handwriting, [p] and [f] in toplines are reminiscent of decorative, elaborate ascenders. Other have posited that the gallows that favor top-line positioning – the one-legged [p] and [f] – may be related somehow to the more common gallows, the two-legged [t] and [k]. The natural pairings are: [p] and [t] with two loops, [k] and [t] with two legs, [f] and [k] with one loop, and [f] and [p] with one leg. The pairings suggested here, however, may seem at first to be the most unlikely: [f] with [t], and [p] with [k]. The overrepresentation of [p] and [f] in toplines and the absence of [pe] and [fe] can be explained if [f] and [p] are considered to be abbreviations for [te] and [ke] respectively.

It may seem counterintuitive to affiliate one-legged one-looped [f] with two-legged two-looped [t], and one-legged two-looped [p] with two-legged one-looped [k]. Statistically, however, this association resolves several puzzles. As noted above, the bigraphs [te] and [ke] are extremely common, while [fe] and [pe] are essentially non-existent; there are only two examples of [pe], and none of [fe]. In addition, [k] is underrepresented in toplines, with a frequency of 4.8%. In the entire manuscript, [k]'s frequency is higher, at 5.2%. Substituting [ke] for [p] corrects this discrepancy, restoring the topline frequency to expected values. The [t] glyph is not underrepresented in toplines, but because there are so few [f]s in the manuscript, the substitution does not impact the frequency of [t] to the same degree. On the other hand, affiliating [t] with [p] results in [t] being significantly over-represented in toplines.

[13] [7]
[14] [8]
[15] See [1], ff. 34r, 34v, 75v, 76r, 77v, 85r, and 86v.
[16] [9] and [10].

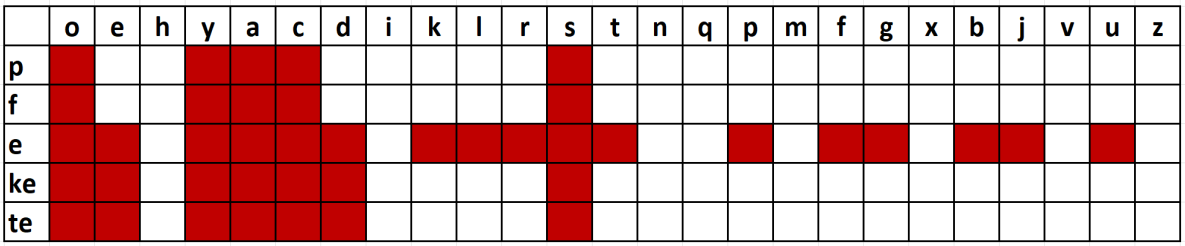

Figure 4: Observed [p]-, [f]-, and [e]-initial bigrams, and [te]- and [ke]-initial trigrams

This proposal is also supported by an examination of the contextual evidence. It is a well-established observation that Voynichese has rules, one of which is that certain bigrams, or two-letter pairings, are allowed, and others are not. Figure 4 demonstrates that the contextual possibilities of [te], [ke], [f], and [p] are nearly identical. In other words, with a few exceptions to be discussed below, the glyphs that may follow [f] and [p] are the same as those that may follow [te] and [ke]. For [p] and [f], the set of glyphs which follow those gallows is the same, and is quite limited: they may be followed by [o], [y], [a], [c], and [s]. And while [e] may be followed by a much larger group of glyphs, [te] and [ke] may not. In particular, some glyphs that are generally allowed to follow [e], such as [b], [l], and [r], may not follow [e] when it is preceded by [t] or [k]. For example, [eb] is allowable, but [teb], [keb], [pb], and [fb] are not. With a few exceptions to be discussed below, the bigram pairings for [p] and [f] are nearly the same as triples that begin with [te] and [ke]. Contextually [f], [p], [te], and [ke] are essentially identical.

If [f] abbreviates [te] and [p] abbreviates [ke], expanding these abbreviations in a transcription has important implications for linguistic and computational analyses, as it changes the frequency of [t], [k], and [e], and removes [f] and [p] from consideration entirely. For example, the very first word of the manuscript, [fachys], would be transcribed [teachys] and the first word of the last page (116r) would be [kchdkey] instead of [kchdpy].[17] Even the number of characters would change, since each instance of [p] or [f] would be replaced by two characters. There are other important implications, such as how this idea may affect word frequencies, word pairings, and especially the identification of crib candidates, that is, words identified by linguistic analysis as potentially associated with imagery on a particular page, such as star labels or the labels on the recipe pages. For example, in her 2021 master's thesis at the University of Malta, Adrianna Camilleri identified multiple crib candidates including [okealar] on f. 72r. The abbreviated version of that word – [opalar] – appears on f. 71v, the facing page, perhaps strengthening Camilleri's identification of this word as a crib candidate.[18]

There are three corollary rules governing these abbreviations:

1. Trigraphs that would result in a double-gallows if abbreviated are not allowed: [kef], [kep], [ket], [kek], [tef], [tep], [tet], and [tek]. It has often been observed that there are no double-gallows in the manuscript (there is one example on f. 104v, but there might be a space between those gallows). This means that trigraphs which, if abbreviated, would result in a double-gallows are also forbidden. In other words, [ke] and [te] cannot be followed by a gallows character, because the abbreviation of that triple would result in a double-gallows. For example, [ket] and [tep] would abbreviate to [kt] and [tp] respectively.[19] This rule is related to Julian Brunn's observations on his blog about the number of glyphs between gallows, which he finds to be generally more than one. But of the pairs of gallows that are only separated by one glyph, that one glyph is never [e]. It could be [i], [y], or [o], for example, but it is never [e].[20]

[17] See [11] for an EVA transcription that shows how the transcription would appear if these proposed abbreviations were expanded. Researchers are welcome to make use of this document, with proper credit.
[18] [12], 112.
[19] Illegal trigrams include [kef], [kep], [ket], [kek], [tef], [tep], [tet], and [tek], which, if abbreviated, would result in [pf], [pp], [pt], [pk], [ff], [fp], [ft], and [fk] respectively.
[20] [13].

2. The trigraphs [tee] and [kee] are common but never abbreviated (because [fe] and [pe] are not allowed).
3. The trigraphs [ted] and [ked] are common but never abbreviated (because [fd] and [pd] are not allowed). For example, [qokedy] is one of the most common words in the manuscript. One might expect to find many examples of the abbreviated version, [qopdy], and yet [qopdy] occurs only once in the entire manuscript, at the top of f. 75v. The same is true for the common word [otedy] – the abbreviated form [ofdy] is not found at all.

It is certainly true that in Latin manuscripts there are some words – generally of only two or three characters – that are rarely, if ever, abbreviated by particular scribes, so this practice of selective abbreviation would not be unprecedented. Perhaps these unabbreviated words are stop words, articles like "the" and "an," or other words of grammatical significance. These corollary behaviors cannot be explained a of yet, other than by attributing them to as-yet unexplained scribal or linguistic practices.

5.2. Ligatures

The unusual and complex glyphs known as "bridge gallows" may be interpretable when considered as ligatures. These bridge-gallows – rare, graceful, and beautiful – have been the cause of much headscratching over the years. The system here proposed interprets bridge-gallows as ligatures connecting gallows that are near one another. This idea may help to clarify many of the uncertain EVA readings and related linguistic and computational analyses.

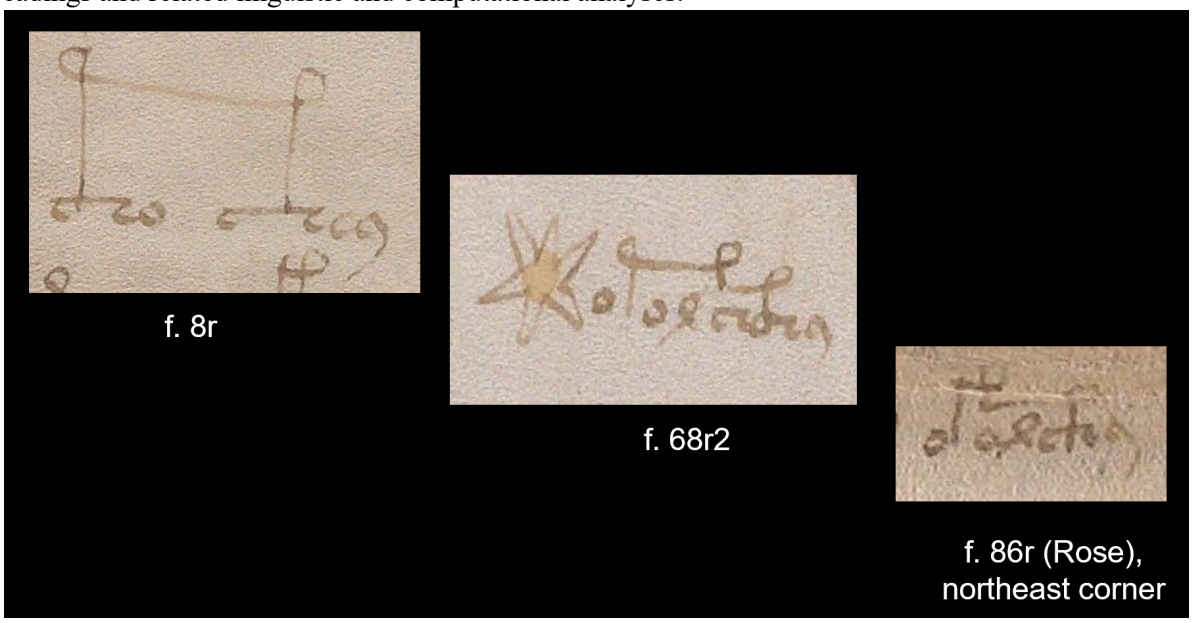

Figure 5: Examples of Bridge-Gallows

An example of the most common, and least complex, of these figures is shown at the left in Figure 5. This bridge-gallows occurs seven times in the manuscript, connecting two benched gallows that are near one another in a topline, each of which appears to be [cth]. The two words bridged by the ligature on f. 8r, for example, could be parsed as [ctho cthey], both of which are legitimate Voynichese words.

As the bridge-gallows become more complex, with multiple loops and legs, parsing them becomes more complex as well. By counting the number of loops and legs, it may be possible to unpack these ligatures into their constituent parts. For example, the bridge-gallows star-label on f. 68r2 (see Figure 5) is comprised of three loops and three legs. Therefore, in accordance with the proposed system, the bridge's constituent parts should together comprise three loops and three legs. Furthermore, whichever gallows is first, between the two [o]s, has a loop on its left side, which means it must be either [p] or [t]. The second gallows would have to be [f] or [k], with only one loop. The only other option is [t] and [f], again resulting in three loops and three legs. The expanded label would be either [opol chckhy] or [otol chcfhy]. If [p] does indeed expand to [ke], the first possibility can be unpacked even further by expanding the [p], resulting in [okeol chckhy].

Another bridge-gallows is found in the northeast compartment of the Rose foldout (f. 86r), to the left of the structure with the swallowtail merlons (Fig. 5). In this case, there are three legs but only two loops. The left-hand gallows has no loop at the left, so it must be one of the single-loop gallows [f] or [k]. In order to comprise the right number of legs and loops, an initial [k] would have to paired with [f], or an initial [f] would have to be paired with [k]. Those are the only possibilities. The potential readings would be [okalcfhy] or [ofalckhy]; the [f] in the second option can then be expanded to [te], resolving the second possibility to [otealckhy].

6. Conclusions

It is to be hoped that these ideas will be useful to all Voynichologists, whether they are linguists, cryptologists, botanists, or historians. Although, as the essays in these Proceedings show, there is significant progress being made, there are still many fundamental things we don't know about the Voynich Manuscript. On the other hand, there are some things that we can place fairly high on the certainty scale: the approximate date of origin (early 15th century), the scribal use of varying orthographic patterns, the provenance, the codicological structure. To these we can now add the number of scribes and an understanding of the collaborative nature of the manuscript's creation. Any potential "solution" or reading of the Voynich Manuscript should take such observations into account, combining them with an evidenced-based interpretation of the text and images, all of which must be consistent with the material and historical evidence. Only by accounting for all of the evidence – paleographical, codicological, linguistic, illustrative, historical, and material – can we successfully unravel the enigma that is the Voynich Manuscript.

7. Acknowledgements

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