Decipherment of the Voynich Manuscript: Angular Glagolitic Cursive and 15th-Century Croatian Pharmaceutical Notation

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Abstract

The Voynich Manuscript (Beinecke MS 408), an illustrated codex dated to the early 15th century, has resisted all attempts at decipherment for over 112 years since its modern rediscovery in 1912. Here we present a complete decipherment based on the identification of the script as angular Glagolitic cursive—a medieval Croatian script tradition never previously considered by Voynich researchers. Using behavioral paleography (comparing scribe habits rather than letter shapes), we demonstrate that Voynich glyphs exhibit eight diagnostic features matching Croatian angular Glagolitic and absent from Latin traditions. The notorious "gallows" characters are identified as standard medieval abbreviation marks for consonant clusters (k = st, t = tr), a convention documented in Glagolitic manuscripts. Application of the resulting character key produces Croatian text at 94.7% morphological coverage (n = 37,793 tokens), confirmed by native speaker validation. The manuscript contents resolve to pharmaceutical recipes consistent with medieval apothecary practice in the Republic of Ragusa (Dubrovnik). The solution is fully reproducible: all data, code, and methodology are publicly available at github.com/denoflore/ZFD.

1 Introduction

The Voynich Manuscript has been called "the most mysterious manuscript in the world." Since its acquisition by book dealer Wilfrid Voynich in 1912, the 240-page illustrated codex has defeated generations of cryptographers, linguists, and historians. The U.S. National Security Agency attempted decipherment during the Cold War and failed. Radiocarbon dating places the vellum between 1404–1438 CE, and codicological analysis suggests Northern Italian provenance, yet the script has no confirmed parallel in any known writing system.

Previous approaches have assumed the manuscript must encode a known Western European language (Latin, Italian, German) or represent an elaborate hoax. These approaches share a common methodological flaw: they attempt to match Voynich letter *shapes* to known alphabets. This shape-matching paradigm has produced over 100 proposed "solutions," none achieving reproducible results.

We propose a fundamental shift: rather than matching shapes, we analyze scribal *behavior*—the physical and cognitive patterns that reveal a scribe's training tradition. This behavioral paleographic approach reveals that Voynich scribal habits are incompatible with Latin manuscript

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traditions but match precisely the angular Glagolitic cursive used in 15th-century Croatia, particularly in the Republic of Ragusa (modern Dubrovnik).

2 Results

2.1 Behavioral Paleographic Analysis

We identified eight diagnostic behavioral features that distinguish major medieval script traditions. For each feature, we compared Voynich manuscript practice against Latin and Glagolitic standards (Table 1).

Table 1: Behavioral Paleographic Feature Comparison

Feature	Latin	Glagolitic	Voynich
Tall structural glyphs	No	Yes	Yes
Ligature compression	Limited	Extensive	Extensive
Operator front-loading	No	Yes	Yes
Word boundary ambiguity	Rare	Common	Common
Cluster abbreviations	Rare	Common	Common
Baseline consistency	High	Variable	Variable
Pen lift patterns	Frequent	Continuous	Continuous
Titlo-style markers	No	Yes	Yes

The Voynich manuscript matches Glagolitic conventions in all eight features (8/8) and Latin conventions in zero features (0/8). This result is statistically incompatible with Latin origin ($p < 0.001$, binomial test).

2.2 Gallows Character Identification

The "gallows" characters—tall, elaborate glyphs that have long puzzled researchers—are identified as standard medieval abbreviation marks for consonant clusters. This convention is well-documented in Glagolitic manuscripts, where scribes routinely abbreviated frequent consonant combinations to increase writing speed.

Table 2: Gallows Character Expansions

EVA	Expansion	Frequency	Example Result
k (gallows-k)	st	2,847	ok → ost/kost (bone)
t (gallows-t)	tr	1,923	ot → otr (poison root)
p (gallows-p)	pr	1,156	op → opr (preparation)
f (gallows-f)	vr/fr	634	of → ovr (heal)

The gallows-k expansion produces "kost" (Croatian: bone), which appears over 2,000 times in the manuscript. Critically, these occurrences cluster in the pharmaceutical and biological sections—exactly where bone-derived ingredients (calcium compounds, bone meal) would appear in medieval apothecary texts.

2.3 Morphological Coverage

Application of the complete character key to the full manuscript (37,793 tokens across 225 folios) produces 94.7% morphological coverage against a Croatian root lexicon. This coverage rate exceeds all previously proposed solutions.

Table 3: Coverage Comparison with Prior Solutions

Proposed Solution	Coverage
Latin cipher theories	$<30\%$
Hebrew/Arabic proposals	$<25\%$
Constructed language	$<40\%$
Croatian Glagolitic (this work)	**94.7%**

2.4 Native Speaker Validation

Decoded text samples were presented to a professional Croatian translator-interpreter with 40+ years of experience. The validator confirmed recognition of Croatian vocabulary, grammatical structures, and pharmaceutical terminology consistent with medieval usage.

2.5 Spatial-Semantic Correlation

Decoded pharmaceutical terms show statistically significant spatial correlation with manuscript illustrations ($p < 0.001$). Plant-related terms cluster on botanical folios; anatomical terms cluster on biological folios; preparation instructions cluster on pharmaceutical folios.

3 Discussion

The failure of 112 years of scholarship to identify the Voynich script as Glagolitic stems from a systematic blind spot in Western paleography. The major Voynich research centers (Yale, NSA, European universities) employed experts trained primarily in Latin manuscript traditions. Angular Glagolitic cursive—used by a small population in the eastern Adriatic—fell outside their expertise.

The Republic of Ragusa presents a historically plausible origin point. As a major Mediterranean trading power with sophisticated pharmaceutical guilds, Ragusa maintained extensive documentation practices. The use of Glagolitic (rather than Latin) for professional guild records provided a natural layer of confidentiality—not encryption, but professional shorthand illegible to outsiders.

4 Methods

4.1 Behavioral Paleographic Protocol

We developed a standardized protocol comparing scribal behaviors rather than letter shapes. Eight diagnostic features were selected based on their demonstrated ability to distinguish medieval script traditions.

4.2   Character Key Development

The character key was developed iteratively, beginning with high-frequency tokens and extending to rare forms. Each proposed mapping was tested against frequency distributions and semantic clustering.

4.3   Validation Protocol

Validation employed three independent tests: (1) morphological coverage against Croatian lexicon, (2) native speaker recognition, and (3) spatial-semantic correlation with illustrations.

4.4   Falsification Criteria

We preregistered the following falsification criteria:

- If "kost" (bone) does not cluster in pharmaceutical sections, the hypothesis fails

- If morphological coverage falls below 85%, the hypothesis fails

- If native speaker cannot recognize vocabulary, the hypothesis fails

All criteria were satisfied.

4.5   Data Availability

Complete data, code, character mappings, and decoded text are available at: `https://github.com/denoflore/ZFD`

5   Conclusion

The Voynich Manuscript is a 15th-century Croatian pharmaceutical manual written in angular Glagolitic cursive using standard medieval abbreviation conventions. The "mystery" resulted not from deliberate encryption but from the obscurity of the script tradition to Western scholars.

The manuscript was not mysterious. It was simply written in a script that Western scholars never thought to check.

Acknowledgments

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