Beinecke MS 408

1 Introduction

In Section 2, some basic analyses are presented. First, in Section 2.1, glyph frequencies are counted. In Section 2.2, then, entropy is calculated.

In Section 3, mainly to promote easier readability and comparability, a transcription of the manuscript is provided, based on a transliteration by Takahashi (1999). Takahashi's transliteration is obtained in an automatically capitalized version of the *European* or *Extensible Voynich Alphabet* (EVA) using the *Interlinear Transcription Archive Extractor* by Schwerdtfeger (2004). It is then converted back into glyphs using a font by Bettencourt (2019).

Using the manuscript's reproduction in Clemens (2016) and the scans provided by Yale University's Beinecke Rare Book and Manuscript Library (2004), Takahashi's transliteration is compared with what I am able to make out of the manuscript. Glyphs that I interpret in another way than Takahashi are printed in orange, showing my interpretation. When a glyph has been deleted without replacement, this is indicated by \mathscr{L} . Removed spaces are marked with \sim and added spaces are indicated by \sim . For the sake of simplicity, places where the writing is interrupted by illustrations are also marked by spaces. Especially the recognition of spaces in running text is sometimes very difficult; therefore, my adjustments in this – just as in any other – regard should be taken with a certain amount of caution. In total, I made changes in 148 places of Takahashi's transliteration.

Each transcription line is preceded by a locator in square brackets, informing the reader about the element a line is part of (i.e., paragraph, title, or label) and assigning the line a number. For example, a line located at [P2, 9] is part of the page's second paragraph (P2) and is counted as the overall ninth line (9) on this page.

Schwerdtfeger (2004) builds on an online archive of Voynich transcriptions maintained by Jorge Stolfi (1998). For a general overview of transcription efforts, see Zandbergen (2023).

2 Analysis

2.1 Glyph Frequencies

Based on a transliteration by Takahashi (see Section 1), a first basic analysis of frequencies can be performed, by simply counting each Latin letter of the transliteration. This results in Table 1, listing all letters that are used.

| Letter | Glyph | Count |
|--------------|-------------|--------|
| 0 | 0 | 25,468 |
| e | С | 20,070 |
| h | τ | 17,856 |
| У | 9 | 17,655 |
| a | а | 14,281 |
| \mathbf{c} | C | 13,314 |
| d | 8 | 12,973 |
| i | \ | 11,660 |
| 1 | ۶ | 10,518 |
| k | ľ | 9,996 |
| r | 5 | 7,456 |
| n | ð | 6,141 |
| \mathbf{t} | 11 | 5,968 |
| q | 1 | 5,423 |
| \mathbf{S} | † ሪ የ | 4,501 |
| \mathbf{s} | S | 2,886 |
| p | ₽ | 1,406 |
| \mathbf{m} | В | 1,116 |
| ${ m T}$ | Ħ | 976 |
| K | Ħ | 938 |
| \mathbf{f} | ₽* | 425 |
| P | * | 224 |
| g | අ | 96 |
| \mathbf{F} | £ | 80 |
| I | τ | 72 |
| x | ᆽ | 35 |
| v | ٨ | 9 |
| z | ۲f | 2 |
| | | |

Table 1: Letter frequencies in Takahashi's transliteration.

Determining what counts as one glyph, though, is in some cases an interpretative act. It seems straightforward to assume that c and c are one glyph (i.e., c). Likewise, c and c could be interpreted as another glyph (i.e., c). Additionally, one might interpret instances of cffc, cffc, cfc, or cfc as representing c (or c), on the one hand, and f, f, or f, on the other. Concerning those "gallows" characters, as they have come to be called, it is not clear whether f and f or f and f are variations of the same glyphs, only diverging in one small loop (as Tiltman 1967 seems to have interpreted them). In the following, the four gallows will be treated as distinct glyphs, as has become customary. Accordingly, Table 2 gives frequencies for several c combinations, taking into account four forms of "pedestalled gallows". The table also includes three instances that bear some resemblance to Latin abbreviations (also see D'Imperio 1978, p. 95).

Furthermore, while there are instances of a single χ , it is not clear whether instances like $\chi \chi$ and $\chi \chi \chi$ or combinations with $\tilde{\chi}$ like $\chi \tilde{\chi}$ or $\chi \chi \tilde{\chi}$ represent separate glyphs. Table 3 gives frequencies for several of those χ combinations. Assuming there are three glyphs χ ,

| Glyph | Count |
|------------------|--------|
| | 11,008 |
| <u>ಹ</u> | 4,501 |
| c ¶ c | 950 |
| cffc | 906 |
| ct c | 216 |
| ctc | 74 |
| c | 143 |
| ರಂ | 9 |
| <i>C</i> 9 | 7 |

Table 2: Glyph frequencies in Takahashi's transliteration for several σ combinations.

 $\sqrt{3}$, and $\sqrt{3}$, it is of course difficult to determine when there actually is a $\sqrt{3}$ or a $\sqrt{3}$.

| Glyph | Count |
|-------|-------|
| `\ | 590 |
| \\ | 195 |
| 111 | 10 |
| J | 148 |
| ν9 | 1,752 |
| (1) | 4,076 |
| 1119 | 154 |
| 11119 | 2 |

Table 3: Glyph frequencies in Takahashi's transliteration for several \(\circ\) combinations.

This being said, I tentatively stipulate a set of 22 glyphs. Table 4 gives frequencies for those glyphs. They are counted as follows:

- The glyphs a, δ , c, δ , τ , φ , δ , o, \uparrow , \uparrow , \uparrow , \uparrow , \uparrow , and φ are simply counted as before. Hence, frequencies are identical with Table 1.
- The glyph \mathcal{L} is counted every time \mathcal{L} and \mathfrak{c} appear consecutively.
- The glyph c = c is counted every time c = c and c = c appear consecutively, as well as in cases where there is #, #, #, or # between them.
- The glyph # is counted every time # or # appears.
- The glyph If is counted every time If, If, or If appears.
- The glyph f is counted every time f or f appears.
- The glyph f is counted every time f or f appears.
- The glyph $\sqrt{3}$ is counted every time $\sqrt{3}$ appear consecutively without there being a preceding second $\sqrt{3}$.
- The glyph $\$ is counted every time $\$, $\$, and $\$ appear consecutively.
- The glyph ι is counted every time it is not part of $\iota \Im$ or $\iota \iota \Im$ as well as in instances of τ .

| Glyph | Count | Percent |
|----------|------------|---------|
| 0 | 25,468 | 15.636 |
| С | 20,070 | 12.322 |
| 9 | 17,655 | 10.839 |
| α | 14,281 | 8.768 |
| ದ | $13,\!154$ | 8.076 |
| රී | 12,973 | 7.965 |
| r | 10,934 | 6.713 |
| ۶ ک | $10,\!518$ | 6.458 |
| 5 | $7,\!456$ | 4.578 |
| 11 | 6,944 | 4.263 |
| 1 | $5,\!423$ | 3.329 |
| ત્ત | 4,501 | 2.763 |
| 611 | 4,232 | 2.598 |
| S | 2,886 | 1.772 |
| 6, | 1,752 | 1.076 |
| f | 1,630 | 1.001 |
| \ | 1,240 | 0.761 |
| В | 1,116 | 0.685 |
| ያ ተ | 505 | 0.310 |
| ද් | 96 | 0.059 |
| T | 35 | 0.021 |
| ٨ | 9 | < 0.001 |
| | 162,878 | |
| | | |

Table 4: Glyph frequencies in Takahashi's transliteration

2.2 Entropy

Next, we take a look at the manuscript's entropy. To this end, we utilize the conceptualization of entropy by Shannon (1948). As shown in (1), the entropy H of a

$$H(X) = -\sum_{i=1}^{n} P(x_i) \log P(x_i)$$
(1)

3 Transcription

Folio 1, Recto

```
Paccos offax ar affarry door doro offeres of 1602 doorso
     Cos Feath Feath 250 Feathall of 60 Feath of Co
     OS UNIBSOS SSOND OF OBLIVE BOD ON DELO PO OPLIVE FILED
    Callo 90 GIIA GIIAS 910209 Sooto pooto GIIO
    8017-9 ccca? ctally ctall 6015
    980701259
    920 Fo.2 (1.08) office of the coeffice of the coeffice of the coefficient of the coeffici
    8011 202 ctog 2089
[T2, 10]
    psooff So Gras
[P3, 11]
    Sagabosta obos Proffe osts Sago Prosats Probe Y
    UNDER 629122 Crosoco Collo 20216 Cresto 6021 021/10
    tog effecy fosarry effect effects arrived the ogsarry s
     Said only cros osand crosand cros offand sad after fos
    8a110 detheog too coop dog coop coop lot cag
    to cros todal lity licy sof crosall to lices
900 flower ochlard the $9898 offer 8aroffer
    Stepths Grasses grants established san etters
     8cca? &cotta 110 olla 117 ccco Pcco tollog ctros 8aoctla
    coll coop crop sand office
[T3, 21]
    GIII 2010
    os os es essent es essenta essentantes essentantes estas
    Feath 2022 Fab Unia Past Sab Rash Unas 2020 Cross
    coso farro coarro offog sarro far ctoog sarro ctoogsar
     gorceg ollag ollg sarry olloreg lollarry otorog llasorg sag
     Soco dos locas etto ollaro loco loco sas allo
    To Tox Toll Tollo Tollo
```

Folio 1, Verso

[P1, 1]

Mcco crabarro or orthogo crao ctar ab

[P1, 2]

office, crao or occ, beco shobs oblobar crobs

[P1, 3]

bo ether ether ether des blichers ether hotheroby bas

[P1, 4]

box crolles bar? bab corres crollobs

[P2, 5]
Totlog coop dan? ctroag da? creg thody othern in the coop graph of the coop can be called the coop of the coop of the coop of the coop dog can be called the coop of the coop dog can be called the can be called the called th

Folio 2, Recto

[L1, 8] offoa\qc* [L2, 9] ***av

Folio 2, Verso

[P1, 1]

Noon No aco Paro? offan No o dan o aco? dan? Ltg

[P1, 2]

Nao Nag Lo Log toffan goece? toffg aco? dan N

[P1, 3]

offan aco? gag acog acodg acodan acotheg dan N

[P1, 4]

Lo acogo aco? acodan N

Folio 3, Recto

[P2, 11]

**Teccos & cos Cos & cos &

[P3, 15]

The coaron took of or or oper of the of offer of offer of offer of offer o

Folio 3, Verso

[P2, 7]

Theor offeray cror etern 2

[P2, 8]

offero fleor cror eethor offa

[P2, 9]

offercar offer ethosoary cror ethop

offercar offer ethosoary cror offa

[P2, 10]

ocror sann tolletor sann cror offa

from the cross offer theory cross offa

(P2, 11)

cto choeffer etho fleor cross offa

(P2, 12)

oct cross offer fleor fleor fleas

(P2, 13)

ctar chiann tollers offs ethas cells

[P2, 14]

sand chean offers

Folio 4, Recto

```
[P1, 1]

Nosagang atas accor of accor total solve and story office solve and story attemption and story attemption and story according and solve a
```

Folio 4, Verso

[P2, 7]

Thoras accor and dollars afters
[P2, 8]

ogacd and afters and offer afters

possible to the standard according according to the second according according to the second according accordin

Folio 5, Recto

[P1, 1]

Microso Teros erlos oarro ogro eroso slico so
[P1, 2]

oeros olios tollarro do etlos etles eros olia*or otlos
[P1, 3]

toarro otlar ero sarro otles eros otles otles otles so
[P1, 4]

Folio 5, Verso

[P1, 1]

floccor cor office of those core crossin office of sand

for or office office

Folio 6, Recto

```
[P1, 1]

Toar of chox cross core core collection offices offic
```

Folio 6, Verso

```
[P1, 1]

Noa? 9 2a? accila? toa? co? attag 2 aca? aa? offag

[P1, 2]

occ2 aco? actteg toclaa? aca2 obarro lace aco? acar.

[P1, 3]

toar? attg acox ooacoattg aclasog attg offox ?gaco2

[P1, 4]

g dettg gfacog 2o2 g babg bag bag offox gflobg

Bar? da acobar bar offor offg boxbor
```

[P2, 6] 1 cost coeffice coeffice 9cto2 9ctog 8a112 ctrog 80g 9000 000 01000 tolog occo 809 cto7 cto8 S 10 (cc. 20)

tollarod gazar lasg

[P2, 11]

gor arr offar after 89

[P2, 12] officeo2 ctg tollar cfftg 908a110 cttg 2 cto7 occ2 o7 tollof cros effeos floragoso coeffeg S oS crg Savo o? oceg cttar cttar cttar cttag 9 ccarro ctrag ctrosas 39 officer officer and affect 000000 Per 20] gocco? coo? octtag

Folio 7, Recto

[P1, 1]
Toodarry the deg tool deeg caroog
[P1, 2]
Souce flood door door door flood deeg caroog
[P1, 3]
occeed accodarry deeg flood to tage
[P1, 4]
toffee ac gover darry gary flood odarry
[P1, 5]
oarry offerry

[P2, 6]

Mctogoctco toffocco collogog officer acoally

Betog affice acog officer day took acoffee

officer decede acoff toffae took flee acoff day

toffee ogacoll acog affee acomp fleed

[P2, 9]

toffee ogacoll acog affee acomp fleed

Catall acof dayl acoffee

Folio 7, Verso

[P1, 1]
Toggico cico fictoso totas officos so sann fictososo
[P1, 2]
crocro ctro sann tollo cretico sann ctros ctro ctros
[P1, 3]
tollos sollos critico licto lo so creco os crecos so
[P1, 4]
croffeced occar crocro sand cho licto cros secces sos
[P1, 5]
scrosann tolloso

Folio 8, Recto

```
[P1, 1]
Those crop offices croff offices cross to offices crops
                         Ticillo de l'accaso de oblace de dans as
   حده کوم کوم کوم دره کومالی کره الحدم حده کوم الحدم الحدم کوم کومالیک الحدم کرم کومالیک کرمالیک کرمالی
     10162 007 007 2003 8009 2003 001 001 808
                           Office of the only office of the constant of t
                           Took offerers for togget for the court of the formal for the formal formal for the formal formal for the formal for the formal formal for the formal formal formal for the formal for the formal formal formal formal formal formal formal formal for the formal formal
crotto Mcroad croos 8a17
                           8000 8a118
                         Theort to their party ofters steers tox-sarry too?
                           8avv cocost flocosa os cocostro ostro cos saves
 ctor accosann sann so offeros acolf at the offernion of the transfer of the contract of the c
 tocoobarry confollobo conformation [T2, 13]
                           olollcross
   [P3, 14]
                           etto etter dos cotos dos coros líces soso cosas
 Screg effect crop etc. flower crop effect crop effect
     . .
gozeg PoroPorg ceSeg Porg Screavid cthaverar ctheg 8ar
[P3, 17]
 crop being follow ere and exadeff or a crand [P3, 18]
                           olla? Acarra con Poor Ca rain carrage
                           Zar? cocard officer sar took larry took larry sarlag
 \underset{[T3,\,21]}{\circ \hat{\forall}} \text{ crolleccy cheg offag crag}
                           Scrop Sars
```

Folio 8, Verso

```
[P1, 1]

cffcos Soocthe Sox Lox offox crox officeann offosann Sanno
[P1, 2]

Letter Sar cror Leann Lor croping offann offosann sanno
Leann Los cross Sar cror cross Cox cranno cffcar cross crox sax cross cffcar cross sar

[P1, 6]

Sanno cffcar cffcar croffann sar
[P1, 6]

Sanno cffcar cross crox cffcar croffann rop
[P1, 7]

Lo ffcox sar crox crox cffcar croffann rop
[P1, 8]

offcox fcx crox crox crox cffcanno
Crox orax cross crox cffcanno
Crox orax croffann rop

Crox orax croffcan crox cffcar

Crox orax cross cffcar

Crox orax croffcan crox cffcanno
Crox orax croffcanno
Crox orax croffcan crox cffcanno
Crox orax croffcan cffcanno
Crox orax croffcan cffcanno
Crox orax croffcan cffcanno
Crox orax croffcanno
Cro
```

[P2, 12]

Therefore the content of t

Folio 9, Recto

[P1, 1]

Tookso cross officer orcing 2 deg obann 2arg dor office officer conficer cross officer officers officer officers officers officers officers officers officers officers officers read the conficers officers officers

[P2, 6]
Thoomand officially officially officially official officia

Folio 9, Verso

```
[P1, 1]
Tocco? otoroso oto cor sann totogtero totog cog etcog sann
[P1, 2]
Secor toann ellann ettor ecog ecor etcog so otly tollann so
[P1, 3]
glicy ecor gliann sann etcog otlann olly occes sann
[P1, 4]
glicy teng liann ettor otlog otly togso
```

Folio 10, Recto

[P1, 1]

The coefficts of offices and colors for the second control of the second colors of t

[P2, 6]
gcc20? cffcg cco? cffca\\dagger\dagg

Folio 10, Verso

[P1, 1]

Tand dand coo forces tothe dand offer offer dand offer offer and following the dand offer offer and the following offer of and following offer of and dand offer offer and dand offer offer offer of dand offer offer of offer of dand offer offer of offer off

[P2, 4]

totagtage con sand totage cottes of of sand

[P2, 5]

co office sand totage totage con sand totage

con office sand totage

con office sand totage

con office con con totage

Folio 11, Recto

[P1, 1]

1 thicog 2 croag ctog ctog ctog ctog through choosing

[P1, 2]

2 octhoosy toso? 9 thicy sann offers offerolly through sann

[P1, 3]

totag crog ctog so? 9 those crotag sann crand sann ses

serog crog through so sann

Folio 11, Verso

Folio 12

Folio 12 is missing from the manuscript.

Folio 13, Recto

[P2, 5]

choroso de fleto l'acox staro totaro ottaro de cheox so l'acoroso de cheox so l'acoroso de con tara ottaro ottaro de cheox so l'acoroso de con totaro de controlo de cont

Folio 13, Verso

```
[P1, 1]
| Noar? cettorry offices office offices
| P1, 2]
| office to fore cettory offices offices offices cettory
| offices to food cess offices offices
| P1, 4]
| oge cess offices oarry offices to offices
| P1, 4]
| oge cess offices oarry offices to offices
| P1, 5]
| tollo darry
```

Folio 14, Recto

Folio 14, Verso

Folio 15, Recto

[P1, 1]

The cor decy therasy to entrope they sand

[P1, 2]

offeror tolleror osy ollor to loss

tolland tollery these sand erose etter

[P1, 4]

Cercand erosand eros especificand easily

tollery resolutions

tollery resolutions

tollery resolutions

tollery resolutions

tollery resolutions

tollery

sand ettery

tollery

tol

Folio 15, Verso

[P1, 1]
To Por orchy connot offer or so [P1, 2]
**cor or oro or annothing than offer or so [P1, 3]
cftor sand tollor offer offer offand
[P1, 4]
sond collo con tollo tollor offer or offer or cor offer or cftor offer or cftor offer or cftor offer or cor offer or cftor offer or cor offer or cftor or offer or cor or offer or or or or offer or or or or offer or or or or offer or sand
[P1, 8]
offer or cor or or only off cor sand
[P1, 9]
offer or cor cor cor cor cor offand
[P1, 10]
Cor cor cftond cftor tolland
[P1, 11]
Corond cftor cor cor sand find
[P1, 12]
sand cftor cor cor cor

Folio 16, Recto

[P2, 5]

There of the continuous force of the figure of th

[P3, 10]

To Po P 8agg8ag of Tog force of Took of Took of Sagg8ag of Took of Sagge of Took of Took of Sagge of Took of Took of Sagge of Took of Too

Folio 16, Verso

```
[P1, 1]

Terranno offeror enterog entercy 2 teroetly

[P1, 2]

offeror of for enough to forcettor chord

[P1, 3]

offerog so error totto error forcett

secon enteroso ettos enoting sag

[P1, 5]

offerog enoting error error offerog san

[P1, 6]

Zor entor otto enteror error santon
```

[P2, 7]
To cotte of the policy of the offer o

Folio 17, Recto

```
[P1, 1]

Thooso saray osarcon otoso otos crot others soso oxsetting
[P1, 2]

gsarr crolly others tosar ethoso sor others, tosetting osc
[P1, 3]

cros or cro tosan other cror others,

[P2, 4]

There, crox tosan tother tor oxarry others,

[P2, 5]

gerelles ethic cror chor ethor ethoso sarr ethics tosa
[P2, 6]

There to there crosses methos see others,

[P3, 7]

[P3, 7]

[P3, 8]

Secres special ecrop ethics

[P3, 9]

Cog crettes o sar crotters,

[P3, 10]

are crear secres sarry nor ender of sarry of examples

sarry crear secres sarry nor ender of ethoso

[P3, 11]

others ethics often one sarry of examples

sarry ecrop ecrop ecrop early

sarry crear secres sarry nor ender of ethoso

sarry crear secres sarry nor ender end
```

Folio 17, Verso

occes less ctodas olos obarro ollas 0,000 lloco? Pocos oftos osocios ollocos gcros cros 80scrccg Hcros 8a7 cHzg $_{[P1,\,6]}$ 8 G//210 90 G//210 90 90130 6112 So Fosso S110 Cost post Fos †oliccy licrat og 89 crog8a112 29 general feros erostanos os [P1, 10] ogto7 olco7 ola7 olog 80117a8 †ollaco †ollovi? attacog acog 00 ct09 loarry crefteg of ct07 9 1/co? cros cros ctos ctos cros cto? ctos oro ? officeox crosarry officer ffcro?9 . 90007 cthg accellg acco othor othogo [P1, 16] offercos cros offcos effcos offercosos toand Saf to sox to fearn cottoo Sus fo for cos gos ao follo 8ail ccco toail cttod ccox ccox 9/cc9 offcc9 cco7 ccox co 98a110 Jus Fossits of Eccept Fosos Fosos †016cc 8a7 ccc9 16cc07 cccc09 cffccc9 cffcg 80sllo 9as Fosllo posllo

Folio 18, Recto

```
[P1, 1]

**T87a\789 8a708ct* 90a7 916cox 8a7 0 8 cectes octeo? 8ax

[P1, 2]

otteox tolecox cestes olecax 8a\1) 89 ceox 8\1\0

**Tolecor ceor cettes oreces tolecox 89 9thear 8

[P1, 4]

cor etteor oleor ottoox ola\0
```

```
[P2, 5]

Theore took effective effective engage engages of the solution of the second effective of the solution of the second effective of the solution of the second effective of the second of the second effective ending the second of the second of the second effective ef
```

Folio 18, Verso

```
[P1, 1]

**Thogo coop office office of office offi
```

Folio 19, Recto

Folio 19, Verso

Folio 20, Recto

[P1, 1]

Notice of the control of th

[P2, 5]

Throoffing molloanny off mechy offers docanny?

[P2, 6]

mocco offero? follog mechy sanny may monny sanny

[P2, 7]

omogetos sanny molleog mog sog etog offanny

[P2, 8]

Comosany moc ? mecoso

[P3, 9]

Toodeco dody tottong tottong toothy orothogogo

[P3, 10]

ootoall oroof dody toodall orothogogo orothy dog too

[P3, 11]

dool tottondy offers tottong domall orogody

[P3, 12]

doll oroody offers offers they tottong dall dark

[P3, 13]

ootall oroof oroof orony they

Folio 20, Verso

[P1, 1]

tarrow and office of totocco office to to to together office of the control of the cont

[P2, 5]

The of to grow of to the tog to the of the of the growth of the

Folio 21, Recto

[P1, 1]
Theor occoeffics of gency offeres to the code offer of gency of the code of the co

[P2, 4]

Toology dann offern offern forces for the force of the force

[P3, 8]

Tocolicing offor choose octions officeooc officeoococ officeo

Folio 21, Verso

[P1, 1]

Those of a color to total a color of the solution of and the solution occords to the solution and the solution occords to the solution occords the solution occords the solution occords the solution occords and solution occords and color occords and solutions occords occording the solution occords and occording occords occording the solution occords occording occords and solutions occording occords occording occordinates occording occordinates occording occording occording occordinates occording occording occording occording occording occording occordinates occo

Folio 22, Recto

[P1, 1]

To go oxity through those offers offer offers and offers a oction of the control of the control offers and offer

[P3, 7]

Marcox dog saccor allo asogg offarro of offag

[P3, 8]

Sacor offg sarro affects follo acottaro acottag

P3, 9]

Osarro sarro attag affector orarro

Folio 22, Verso

```
[P2, 6]

Thoo has a flacor offand

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Folio 23, Recto

[P2. 4]

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[P3, 6]

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[P3, 8]

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[P3, 9]

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[P3, 10]

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[P3, 11]

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Folio 23, Verso

Folio 24, Recto

[P1, 1]

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[P1, 12]
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Folio 24, Verso

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Folio 25, Recto

[PI, 1]

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