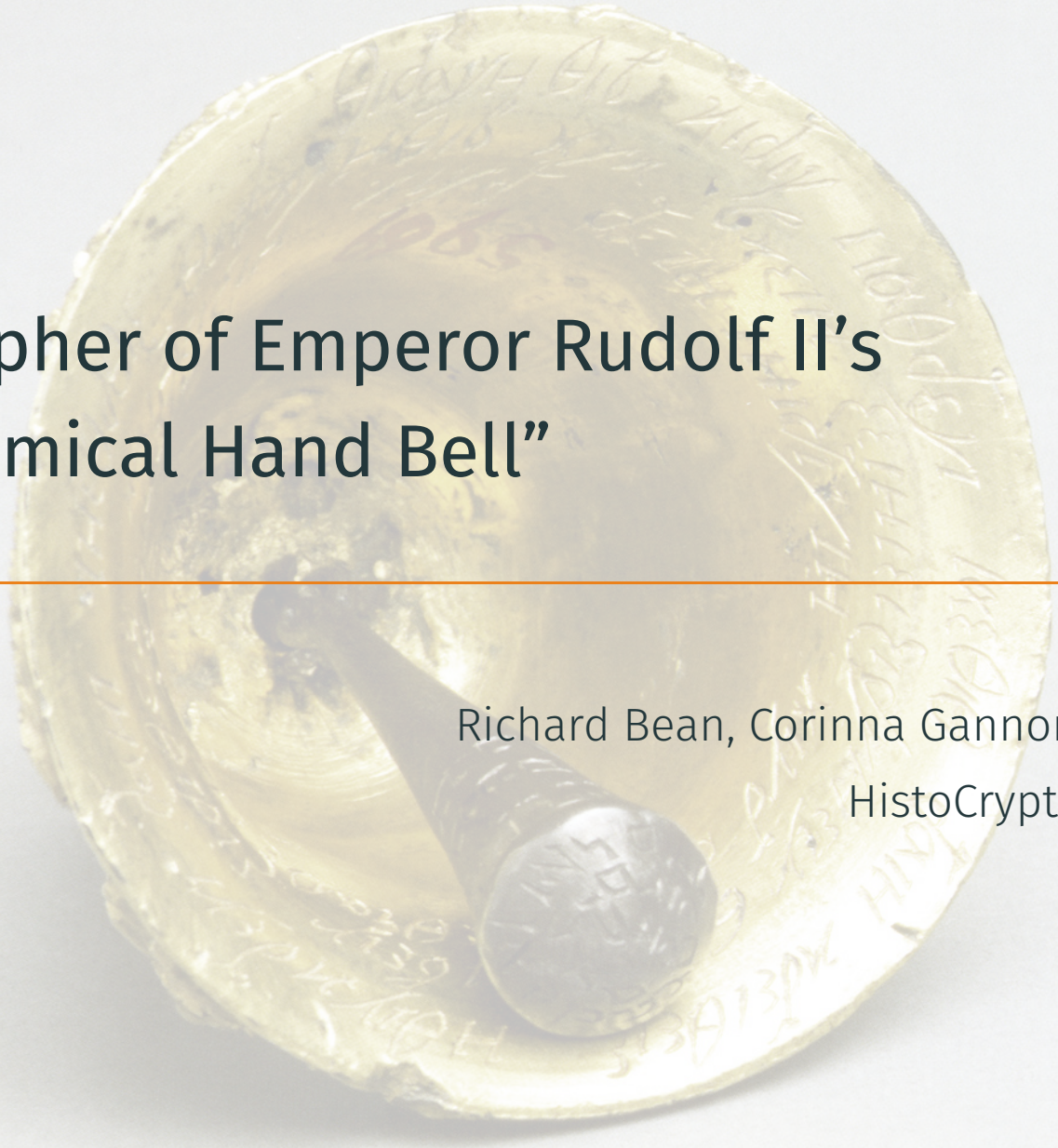

The cipher of Emperor Rudolf II's "Alchemical Hand Bell"

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HistoCrypt2023 in Munich

Rudolf II's alchemical hand bell

Hans de Bull, "Alchemical Hand Bell" of Emperor Rudolf II, ca. 1600
h. 7,8 cm; d. 6,3 cm, Vienna, Kunsthistorisches Museum, inv. no. Kunstkammer, 5969.
https://www.khm.at/objektdb/detail/91976/.
Source of images: Gannon 2019.

Rudolf II's alchemical hand bell

Context

- cast around 1600 by Prague goldsmith Hans de Bull
- *Kunstkammer* piece for Emperor Rudolf II (1552–1612)
- originally part of a pair
- alloy of the seven planetary metals (*Electrum*, concept by Paracelsus), see Gannon 2024
- spirit summoning bell
- cultural and historical background have been researched extensively Bukovinská and Purš 2010; Tilton 2015; Gannon 2019; Gannon 2023b; Gannon 2023a; Gannon 2024
- …a cryptological riddle remains to be solved.

...and its cipher

The ciphertext

> θιδαγH θιβ κιδιγ ιιαθδεγι ιαεθιθ δαιH κδειθειζ Hθιγκδεγι δαHι ιHεθδθιζ θιδαγ Hθιβ κγκ βκειH ζειHιει ζιδγHειγ θιβ ιγαιβειγ ζιδιθειH καιθειζιH κιγδ δειH ιHιδιγιH κιγδ δειH Hεθιαθζειγ ζεθιHθιH

Frequency table

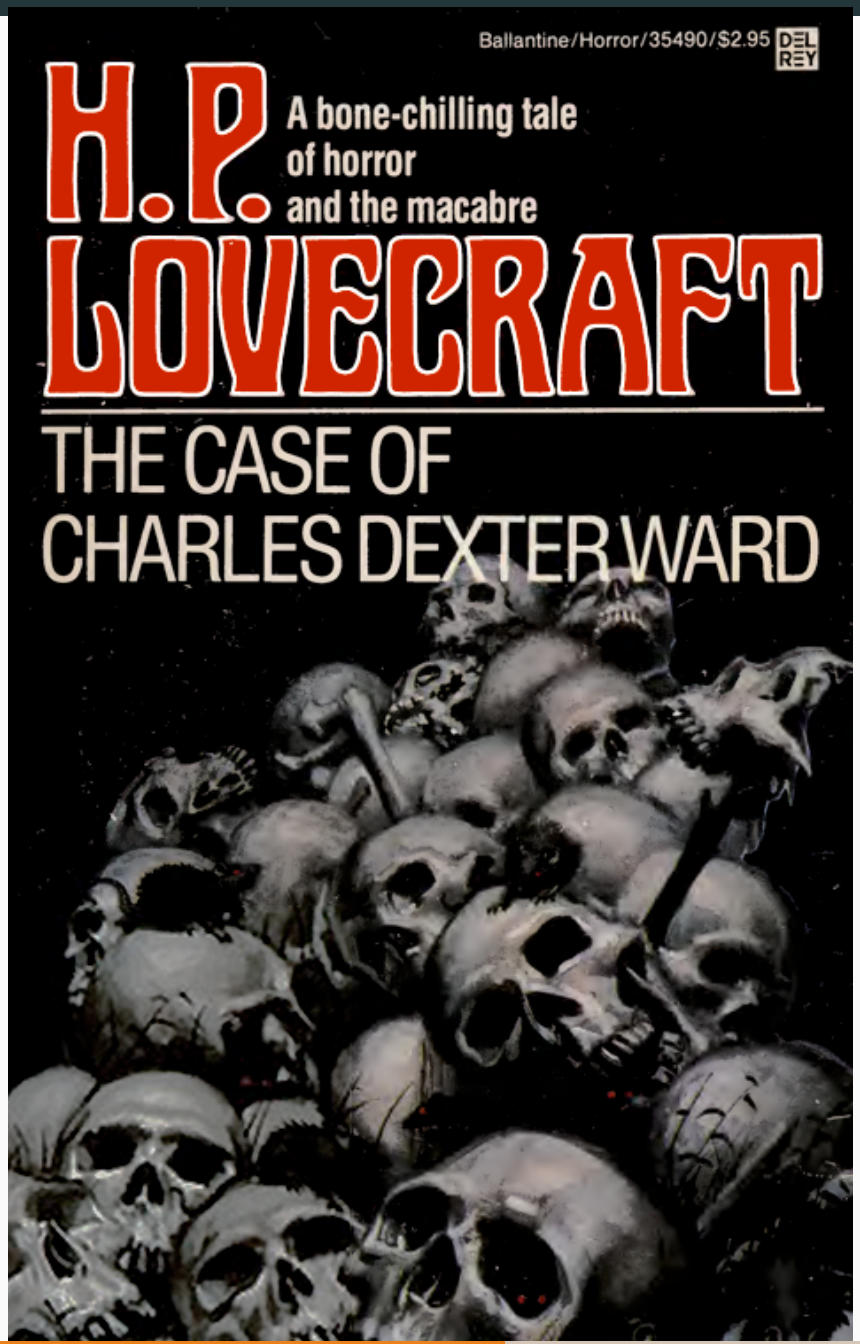
A transliteration of this into numerals would be:

> 783026 781 98382 88073428 804787 3086 93487485 678293428 3068 86473785 78302 6781 929 19486 5486848 58326482 781 82081482 58387486 908748586 9823 3486 86838286 9823 3486 6478075482 54786786

The frequency count is as follows:

Greek Letter	Digit	Count
A α	0	9
B β	1	5
Γ γ	2	15
Δ δ	3	16
E ε	4	18
Z ζ	5	8
H η	6	18
Θ θ	7	18
I ι	8	47
K κ	9	9

Best leave it unsolved really



The Case of Charles Dexter Ward

"...do not calle up That which you can not put downe; either from dead Saltes or out of ye Spheres beyond."

Assumptions

Assuming there is actual meaningful content here, and there is no significant transposition.

That is, we only need to decide on the direction of the words (forward or backward).

Decide on

- plaintext language
- cipher type

Look at similar contemporaneous ciphers.

Basic observations

The letters are all from the first ten letters of the Greek alphabet.

α β γ δ ε ζ η θ ι κ

There are 163 letters, 27 words with an average word length of 6.0.

There are several repeated “words” - 781, 9823 and 3486. Also, we see 3086 and 3068; and words with the same prefix - 78302 and 783026. Other shorter repeated prefixes are 583 and 678.

Omitting spaces, two 10 letter repeats: 7830267819 and ”86 9823 3486”.

There are also many digraphic repeats. The obvious two diagnoses are

- a digraphic cipher
- polyphonic cipher.

Monographic and digraphic IC

Index of coincidence = 0.142

Digraphic index of coincidence = 0.0269

Random ciphers with 10 digits would have IC ~0.1 and DIC ~0.01

18 of the 27 words have even length.

Plaintext language classification

Thought to be Latin (60%), Greek (30%) or German (10%) based on languages seen in similar objects and used at Rudolf's court.

Perhaps looking at word lengths could help - for example mean, minimum and maximum of word lengths in texts from these languages.

How many contiguous 27 word texts have word lengths in this range?

Diagnosis

This may or may not be a “known” named cipher.

We can look at statistics of known digraphic and polyphonic ciphers (e.g. ACA ciphers) to see what might be the best match.

However, these statistics are built off English “standard” plaintext, for plaintext of certain lengths.

(cf “Cryptodiagnosis of Kryptos K4” Bean 2020)

ACA ciphers

A table of BION with mean and standard deivation statistics. (Handbell cipher: IC 142, DIC 269)

ACA Cipher Type	IC	DIC
Grandpré	128/3	179/15
Monome-dinome	124/7	249/36
Tridigital	122/8	195/29
Nihilist substitution	144/11	218/33

Table 2: Monographic and digraphic index of coincidence statistics for selected ACA ciphers. **IC** = Index of coincidence (mean/sd) times 1,000; **DIC** = Digraphic index of coincidence (mean/sd) times 10,000.

Grandpré from 1905; monome-dinome from Spanish Civil War (c1936); Nihilist from 19th century Russia; tridigital 1959. Pollux and Morbit based on Morse (from 1840s).

NCID and BION tool output

Two classifiers trained on ACA ciphers using English plaintext.

- Monome-dinome
- Tridigital
- Bazeries
- Checkerboard
- Key-phrase

Key phrase cipher

Key phrase

The only one which is not anachronistic is the “key phrase” cipher.

However, Kahn suggests the use of the cipher was limited to one time period, around 1832 (Duchess of Berry).

“Allowing repetitions is bad: it leads to polyphones, e.g., the ’key-phrase’ cipher.” – F. L. Bauer

Polyphonic ciphers

"Cryptographically, polyphonic enciphering steps, in which several plaintext words are assigned to one and the same cryptotext word, make decryption a guesswork and are rare." – F. L. Bauer

Longer polyphonic ciphers examined in Lasry, Megyesi and Kopal (2021) "Deciphering papal ciphers". Simulated annealing used.

Simple method

Take a ten letter word with no characters repeated, and create the mixed alphabet with a matrix.

```
0 1 2 3 4 5 6 7 8 9
A R T I C H O K E S
B D F G J L M N P Q
U V W X Y Z
```

Unicity distance and attitudes

> For extremely short cryptograms cryptanalytic solution is actually impossible: there are several completely different meaningful plain texts which, when enciphered by completely different keys, result in the same cipher text.
> [Unicity distance U] for a given cipher system is the length of text such that cryptograms shorter than U typically do not have unique solutions and those longer than U typically do have unique cryptanalytical solutions. – Reeds, Cryptologia 1977

> One key to solving an unknown cipher is a positive attitude: if you believe you have a good chance of breaking it, you may well be correct. If you believe you will not be able to crack it, you are almost certainly correct. – Gillogly, “Decoding the IRA”

Conclusion and ideas

We still lack understanding of some of the many different alchemical practices of secrecy.

Is this a “real cipher” or some other form of symbolism which was meaningful to its creators, yet whose meaning we do not yet understand?

We may calculate unicity distance of the ciphers discussed here in the suggested three plaintext languages.

Is solution possible at this ciphertext length i.e. 163 letters?

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