

Cryptanalysis of an Early 20th Century Encrypted Journal

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Abstract

Ernest Rinzi (1836-1909), a London-based jeweler, goldsmith and miniaturist, left behind an encrypted journal, which went unsolved until 2017. Dozens of artistically designed illustrations, which interact with text written in tiny letters, make this 175 pages journal one of the most outstanding cryptograms in existence. In 2017 one of the two authors of this paper brought Rinzi's journal to the attention of a wider audience, which led to the other author examining and breaking the encryption. The cipher Rinzi used proved a monoalphabetic substitution cipher (MASC) that replaces letters and numbers. The cryptanalysis work was complicated by the unusual and hard-to-read miniature writing.

1 Introduction

Ernest Rinzi (1836-1909), born as Ernesto Rinzi in Milan, Italy, was a jeweler, goldsmith and miniaturist of Italian decent. He was brought to London by the renowned jeweller Alessandro Castellani around 1859 and became a naturalized British citizen in 1867. Rinzi's oeuvre mainly consists of miniature paintings (mainly portraits) that were used as necklace pendants. He had a wealthy clientele and was very prolific. His works were exhibited at the Royal Academy, the Modern Gallery, the Royal Colonial Institute and other art galleries. Rinzi was a member of the Society of Miniature Painters.

Today, Rinzi's works can be found in art databases like MutualArt, Blouin, or Artnet. His creations are frequently traded at auction houses like Woolley & Wallis, Lofty's, and Bonham's. Nevertheless, there seems to be as good as no literature about Ernest Rinzi. The only owner of a

Rinzi miniature we have found is The Royal Collection Trust (Royal Collection Trust, 2019). We are not aware of a museum or gallery that currently exhibits a Rinzi work.

2 The Encrypted Journal

The Rare Book & Manuscript Library at the University of Illinois at Urbana-Champaign owns a 175 pages hand-written journal Rinzi left behind (Rinzi, 1903). Rinzi created it from 1898 to 1903. He started in the age of 62, which means that this journal belongs to Rinzi's late work (he died in the age of 73). As is easy to see, Ernest Rinzi's manuscript is encrypted. Only small parts of the text have been left in the clear.

The Rare Book & Manuscript Library acquired Rinzi's manuscript a couple of years ago from the Librairie Paul Jammes in Paris. They inquired about additional provenance information but the book dealer did not know much, except that he had obtained the manuscript as part of the remaining stock of a fellow bookseller who had specialized in all things "curious, mysterious and unusual." No other other writings by Rinzi are known to us, let alone encrypted ones.

Rinzi wrote his enciphered journal in a minuscule hand that requires magnification to see clearly. While each journal page (sized 18 cm x 12 cm) is ruled with twenty-one lines, Rinzi managed to fit over a hundred lines of text. Based on these numbers, we estimate that the total amount of characters contained in the manuscript is about 1.5 million, which corresponds to a novel of about 800 pages. Rinzi used a non-standard alphabet consisting of astrological symbols as well as Chinese, Greek and Hebrew letters. It can be assumed that Rinzi assembled this alphabet himself. The first page of the manuscript appears to contain a list of the characters used, but no substitution table.

Among the passages in Rinzi's journal that are

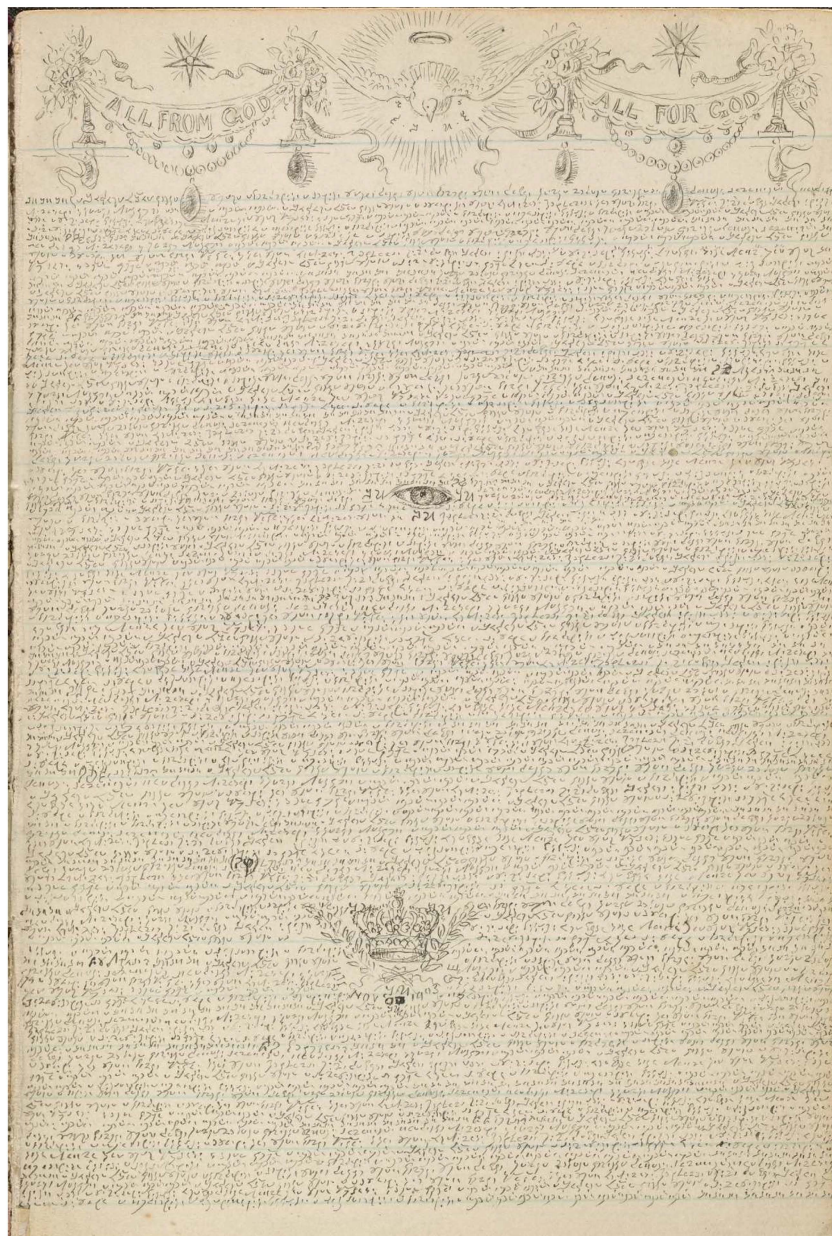


Figure 1: A typical page from Ernest Rinzi's encrypted journal. There are about 100 written lines per page.

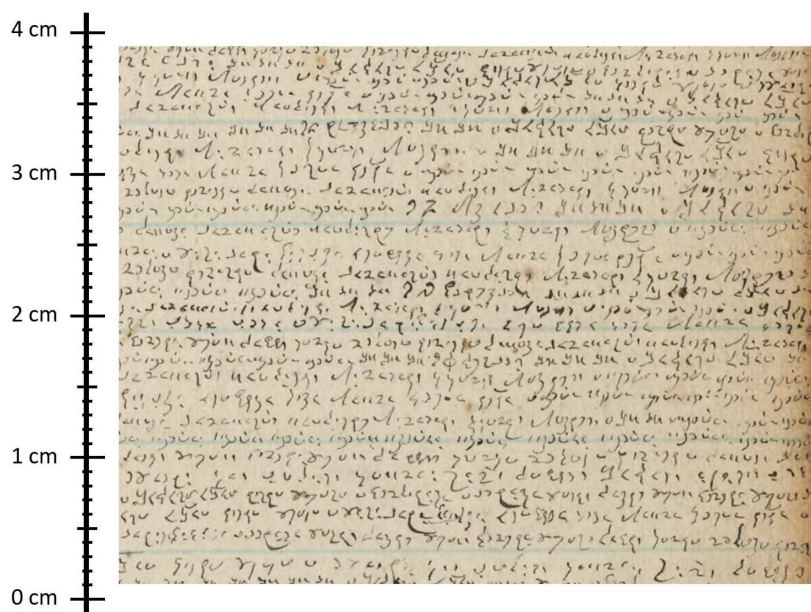


Figure 2: Rinzi's miniature writing is hard to read. There are up to eight lines per centimeter. Rinzi used a non-standard alphabet containing of astrological symbols as well as Chinese, Greek and Hebrew letters.

left in the clear are some names and events, such as the assassination of King Umberto I in 1900, the death of British queen Victoria in 1901, the coronation of British king Edward VII in 1901, and the death of Rinzi's wife Jessie in 1902. Rinzi's writing and drawing shows religious devotion. Most pages are topped with illustrations that feature the Holy Spirit in the form of a dove, angels, or banners, and the motto "All from God, all for God, all to God" (written in English, Italian, or French). While the angels first appear mostly in black and white, they become progressively more colorful throughout the journal. Apart from the "All from God, all for God, all to God" illustrations on many pages, there are other drawings spread throughout the manuscript. Illustrations and text always form a unity – sometimes the pictures are integrated into the text, sometimes it's the other way round.

3 Analysis

As far as we know, Ernest Rinzi's journal is not mentioned in the crypto history literature. The only public source mentioning it originally were two blog posts published by the Rare Book & Manuscript Library in 2017 (Anonymous, 2017) (Anonymous, 2017). David Scheers, a fellow crypto history scholar, made the second author of this paper aware of these posts. This second author subsequently informed other crypto history

scholars via his blog (Schmeh, 2017). The two blog posts described Rinzi's journal as unsolved. A Google search we conducted did not reveal any other sites mentioning it, let alone the solution. Later an employee of the Rare Book & Manuscript Library told us: "We've puzzled over this document for the last couple of years, and come up with all sorts of guesses and fantasies as to what its content might be."

What is especially fascinating about Rinzi's journal, is the combination of art and encryption. The drawings are of high artistic quality. Rinzi's encrypted journal reminded us of a number of other notable encrypted books (which doesn't mean, of course, that a similar encryption method was used):

- *The Voynich Manuscript*: The Voynich Manuscript is the most famous unsolved cryptogram in the world. Like Rinzi's journal, it combines text written in an unknown script with illustrations. However, the artistic quality of the illustrations is considerably lower.
- *The Rohonc Codex*: Similar as the Voynich Manuscript, the Rohonc Codex is written in an unknown script and contains illustrations. A solution was recently published but is not generally accepted to date (Király and Tokai,

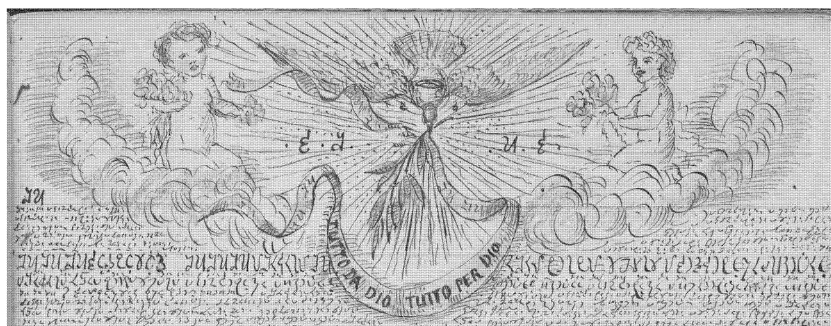


Figure 3: Most pages in Rinzi’s journal are topped with illustrations that feature the Holy Spirit in the form of a dove, angels, banners, and the motto “All from God, all for God, all to God”.

2018).

- *Charles Dellschau’s books*: The manuscripts created by US outsider artist Charles Dellschau contain encrypted text and illustrations, just like Rinzi’s journal (Schmeh, 2017). However, the focus in Dellschau’s books lies on the paintings, while (encrypted) text plays only a minor role. Dellschau’s ciphertexts have been solved.
- *James Hampton’s journal*: US outsider artist James Hampton left behind a journal of over 100 pages written in an unknown script (Schmeh, 2018). This journal mainly consists of text; there are only few drawings. Hampton’s notebook as well as a few other writings in the same script he left behind have never been deciphered.

After having read the blog post about Rinzi’s journal, the first author of this paper started to analyze it. He assumed that the journal was written in Italian, English, or French, as these are the languages that appear in the cleartext passages of the journal. Italian, which was Rinzi’s mother language, appeared to be the most likely choice. Considering the amount of text and the fact that the journal probably was written for himself (and not for an English-speaking audience), it seemed likely that Rinzi wrote in the language he was most fluent in. English appeared to be the second option. Rinzi emigrated to London in the age of 23, and so it seemed plausible that after almost four decades he spoke English well enough to easily write such a huge amount of text. As Rinzi’s biography is not documented very well, it was hard to say whether French was another plausible option. The French passages in the journal are not proof that Rinzi really spoke this language.

The large amount of encrypted text the journal contains made it unlikely that Rinzi had used a complex encryption system. The first author of this paper assumed that a Monoalphabetic Substitution Cipher (MASC) had been applied, which meant that each of the glyphs in the journal corresponded with a certain letter, number, or sign. The number of glyphs in the alphabet Rinzi used is 36. The most obvious explanation was that these glyphs stood for the letters from A to Z and the numbers from 0 to 9.

4 Solution

One method to solve a MASC is to guess plaintext words. When leaving through the journal, the first author of this paper found that the lower part of page 127, which is dedicated to the death of Rinzi’s wife Jessie (figure 5), provided a mixture of encrypted and non-encrypted content. This looked like a good place for guessing words. The lower part of page 127 can easily be located in the journal, as it is this only passage with a black background. Ten lines up from the bottom left of this page there is a three-letter word followed by a seven-letter word in the next line. Both words occur numerous times in the journal. As the text and the illustrations appeared to contain religious content, DIO (Italian for “god”) seemed a good candidate for the three-letter word. The English translation GOD worked, too, while the French equivalent DIEU did not fit. Substituting the letters D, I, and O in the seven-letter word resulted in DI?I?O, while G, O, and D rendered GO?O?D. So, the first author of this work concluded that the Italian variant (D, I and O) made sense and that the seven-letter word was DIVINO (“devine”).

On the same page, just up and to the right beneath the flowers, the first author of this work

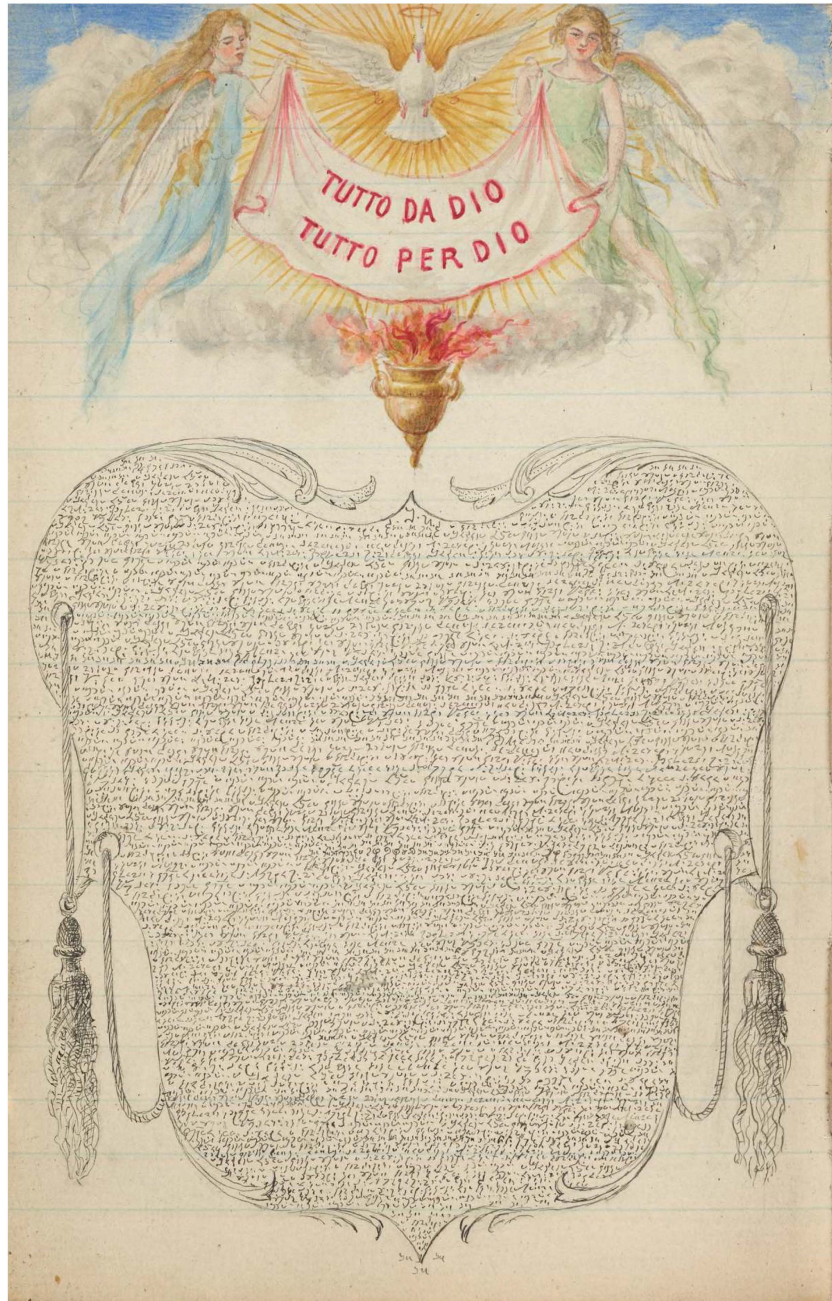


Figure 4: Some of the 175 pages in Rinzi's journal show additional illustrations. They are usually integrated into the text.

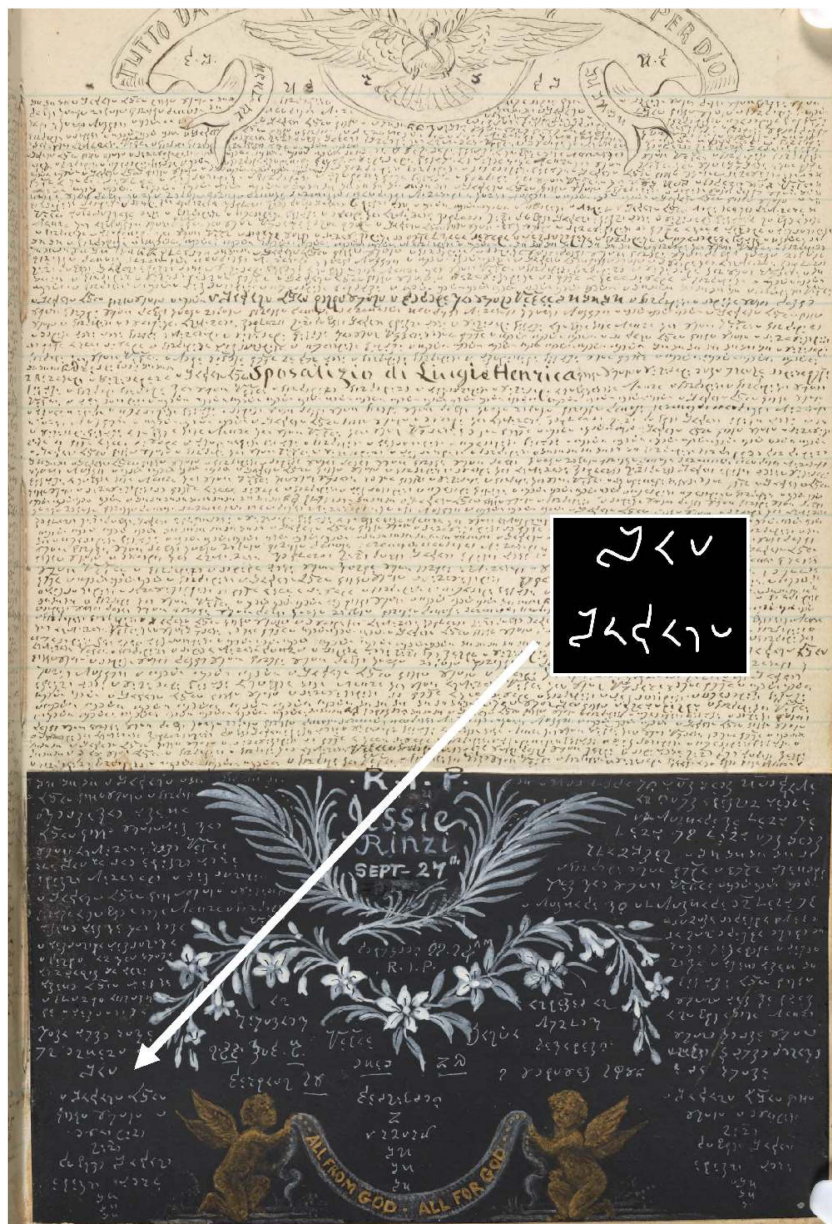


Figure 5: The first author of this work used two words on this page to break into the cipher.

found a two-letter word that, assuming that the Italian hypothesis was correct, became IN. Beneath this, an eight-letter word appeared, where the initial letter occurred twice more in the word. The character used for this letter occurs in many ancient alphabets and is the precursor of our modern M. Assuming that this character actually stood for the M, the expression M?MO?I?M was received. In context of the page it probably meant “in memory of”, which is MEMORIAM in Italian. With nine letters identified, the remaining ones could be guessed, too.

The first author of this work now assumed that the ten symbols not standing for letters were numbers. The numbers under the flowers (? OCTOBER ????) on page 127 most likely indicated the burial date. As Jessie Rinzi died in 1902, the ??? apparently stood for 1902, which rendered the 1st October 1902 as the day when she was buried. The time of death and her age also appear in this section. Substituting the known digits gave the ciphertext representations of 0, 1, 2, and 9.

A fellow crypto history enthusiast provided us the information that Jessie Rinzi was 33 years old at the time of the British census of 31 March 1901. As “September 27th” is written in the clear below “R.I.P.” (at the top of the passage with the black background), we concluded that Jessie died on 27 September 1902, at the age of 35. This is confirmed by the fact that above the second “R.I.P.” (between the willows and the flowers) it reads SATURDAY ??? AM (this is the only English expression we have found in the encrypted text so far) and 27 Sept 1902 was a Saturday. Based on this information a few more digits could be guessed. The lower line of figure 6 shows the substitution table we derived. It seems possible that the digits 5 and 6 have to be switched. So far, we haven’t found a number appearing in the encrypted text that allows for a definite identification of these two digits.

Figure 7 shows a part of the ciphertext that has been decrypted. The first line reads as follows: O DIVINO IDDIO SANTO BUONO O SALVATERIO GRAZEI GRAZI. As far as we can tell based on this short plaintext part, Rinzi’s religious beliefs play an important role in his journal.

5 Conclusion and Outlook

The encrypted journal of Ernest Rinzi is a remarkable document. Especially, the amount of text

(probably about 1.5 million characters), the miniature writing and the illustrations make Rinzi’s journal something very special. The cipher Rinzi used turned out to be a monoalphabetic substitution (MASC) with an alphabet of 36 letters. The first author of this paper broke it based on word guessing. The plaintext language turned out to be Italian. Rinzi’s bad penmanship (probably owed to the small size of the writing) complicated cryptanalysis.

There are a number of open questions about Rinzi’s journal. Especially, we ask ourselves the following:

- *What’s the content of Rinzi’s journal?* So far, only a few sentences of the journal have been decrypted. Decrypting more, let alone the whole journal, will require much more time and effort. Perhaps, somebody interested in Ernest Rinzi’s life will be interested in such a project.
- *Are there other encrypted documents Rinzi left behind?* The journal this article is about was written between 1898 and 1903. Provided that we deal with a diary or a similar document, it is well possible that other journals of this kind exist. In addition, Rinzi might have created other encrypted documents. Perhaps, he even included encrypted text in some of his artworks.
- *Why did Rinzi write this book?* Encryption is usually used to hide information from others. It is therefore an interesting question, from whom Rinzi’s wanted to hide his writing. Did he want to keep his family members from reading his journal? And why did he include all these elaborate illustrations, if he didn’t plan to reveal his journal to others? We have no answers to these questions.
- *Are works created by Rinzi on display in museums?* Though we found many artworks of Ernest Rinzi on the websites of auction houses and art registers, we are still not aware of a Rinzi creation that is on display in a museum or public collection.
- *Can we find out more about Rinzi’s biography?* Finally, it would be interesting to know more about Ernest Rinzi’s biography.

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

Figure 6: This substitution table shows how the cipher works. It is a simple substitution cipher (MASC), but things are complicated by the facts that the writing is tiny and the alphabet contains 36 letters.

⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈
 O DIVINO IDIO SANTO BUONO O SALVATERI O GRAZEI GRAZI
 ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈
 O AERI BONS VERSA BUONA SALUTE BUONA VISTA MOLTO LAVORO SALENTO VIGORE DGA
 ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈
 AILEGNIZA GEOVENSU FELICITA -- OH A MOLTA FORTUNA GRAZEI GRAZI GRAZI
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 DG SULVA ER -- GA
 ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈
 O DELIBERA ERI HA TATTO IR-EI -- EBISI O GUIDA-ERI SEAGRE DG
 ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈
 D-HNR DG DRNESTUS -- ULOS GIOVANNI RINZIUS -- I -- I LARDO GR-ZEI
 ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈ ⋈
 B-NATERID -- B.G. -- TRANS FROM REGULATIONE FOR REGISTRATION

Figure 7: A piece of text from Rinzi's journal that has been decrypted. Decrypting the whole journal would be a laborious project.

These questions have to be answered by historians, art historians, and psychologists. From a cryptographers point of view, the case of Ernest Rinzi's journal is solved.

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