# The Correspondences of Luigi Cremona and Placido Tardy in the Libraries of Genoa

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**Abstract**

We describe the historical framework and the main issues (biographical, scientific, political, etc.) of the correspondences of Placido Tardy and Luigi Cremona in the libraries of Genoa, which constitute an important contribution to the reconstruction of the History of Mathematics in the Italian "Risorgimento". In particular, we mainly deal with the Cremona-Tardy, Betti-Tardy and Cremona-Guccia correspondences. Tardy's letters are preserved at the Genoa University Library and Cremona's letters at the Mazzini Institute of Genoa.

## 1 Introduction

The aim of this paper is to analyse the correspondences of Placido Tardy[1] and Luigi Cremona[2] that are included in the archives of the libraries of Genoa. Tardy's

[1]Placido Tardy (Messina 1816–Florence 1914) left Sicily in 1848 for political reasons. From 1851, he was professor of Analytic Geometry and calculus at the Navy School in Genoa, and from 1859, he was professor of Calculus at the University of Genoa. He was Rector of the University of Genoa from 1865 to 1868 and from 1878 to 1888. Even though he was not a mathematician of the first magnitude, he played a key role in the first stages of formation of the Italian School of Mathematics around 1860, as evidenced by the correspondence he held with leading mathematicians of the time.

[2]Luigi Cremona (Pavia 1816–Rome 1903) was one of the leading mathematicians of the Risorgimento. He graduated in engineering in 1853 at Pavia, and in 1860, he became professor of Higher Geometry at the University of Bologna. In 1867, he went to teach at the Polytechnic

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correspondences are in the Genoa University Library, while the correspondences of Cremona considered here are in the Mazzini Institute in Genoa. We remark, for the sake of completeness, that the main part of Cremona's scientific correspondences, above all, the letters between Cremona and European mathematicians, are preserved in the archive of the Mathematics Department of the "La Sapienza" University of Rome.[3] In the following, we will describe and study these archives. In particular, from an examination of the correspondence, we have identified some issues that are more significant than others for the History of Risorgimento Mathematics. We will analyse these subjects through Cremona's letters and Tardy's letters with their contemporary mathematicians. The two protagonists of the correspondences have been placed among the main figures in the history of the Italian Risorgimento, and especially the founders of a "unitary" school of mathematics.

## 2 The Libraries of Genoa

We focus our attention on an analysis of some of the correspondences between the mathematicians Luigi Cremona and Placido Tardy, which are housed in two libraries in Genoa: the *University Library* and the *Mazzini Institute*.

In the *University Library* of Genoa, one can find the *Cassetta Loria*.[4] The *Cassetta Loria* contains all of the correspondence donated in 1925 by Professor Gino Loria, from whom it takes its name. It is characterized by the correspondence [784 units] of prestigious Italian and foreign mathematicians with Placido Tardy. This correspondence can help us to understand the connections between the development of Italian mathematics in the second half of the nineteenth century and the main political issues of Italian history.

Tardy's correspondence was first described by Loria, who stressed its importance and remarked that: "*A rapid examination of it induced me to notice some [letters] with such considerable historical and scientific value that I felt it would be opportune to publish them, without ignoring the fact that a more detailed examination of it [the correspondence] could lead to the discovery of others [letters] of no less importance*"[5] (Loria 1915, 516).

of Milan. In 1873, Minister Scialoja called him to Rome to head the School for Engineers, where he taught Graphic Statics until 1877, when he was given the chair of Higher Mathematics at the University. In 1879, he was named a Senator of the Kingdom.

[3]Cf. Millán Gasca (1992), Menghini (1994), Menghini (1996), Nurzia (1999).

[4]A cataloging of the documents contained in it was undertaken by Oriana Cartaregia, Ariella Pennacchi and Maria Teresa Sanguineti (2000–2001) and it can be found at the link http://www.bibliotecauniversitaria.ge.it/it/cataloghi/f_a_s/loria.htm.

[5]Un rapido esame da me fattone m'indusse a notarne alcune dotate di tanto considerevole valore storico e scientifico che reputo opportuno il renderle di pubblica ragione, senza escludere che un più minuto esame di esse possa portare alla scoperta di altre di non minore importanza.

The letters to Tardy mentioned by Loria, published as an appendix to a commemoration of Tardy,[6] are the following: a letter from Angelo Genocchi of December 25, 1866, in which a new pair of *Amicable numbers is described*, two letters from Enrico Betti, dated October 6 and 16, 1863, respectively, in which conversations with Bernhard Riemann are reported, two letters from Ludwig Schläfli of August 17, 1864, and October 4, 1865, respectively, in which appreciations are expressed for papers that Tardy had written.

Another study of this correspondence was made by Umberto Bottazzini[7] in 1980. In particular, he remarked that: "*Such an investigation has revealed the existence of very interesting materials, especially for the history of Italian mathematics in the second half of the* $19^{th}$ *century and for the scientific biographies of such men as Betti, Genocchi, Brioschi, Cremona, Bellavitis, Tortolini, and Beltrami*" (Bottazzini 1980, 84).

Bottazzini, in his study, identified some relevant topics covered in the correspondence,[8] many of which will be analyzed in Sect. 3.

At the *Mazzini Institute*, surprisingly, one can find *Legato Itala Cremona Cozzolino*, which contains a portion of Cremona's correspondence. The reason why part of Cremona's correspondence is housed at the *Mazzini Institute* is that the testamentary executor of Maria Mazzini, Giuseppe Mazzini's mother, was Napoleone Ferrari, the uncle of Cremona's wife, Elisa Ferrari, who was one of Mazzini's aides. After the death of Napoleone, the documents passed to Cremona's family.[9] The *Legato Itala Cremona Cozzolino* was given to the library of the *Mazzini Institute* by Cremona's daughter, Itala, probably in 1939. This legacy, which contains over 6000 documents, mainly consisting of Cremona's correspondence with scientific and institutional Italian interlocutors, can help us to understand the main political initiatives involved in the development of scientific culture in Italy and the considerable advances that were made in the national organization of science in this period, thanks to the intervention of Cremona.

A description of the Archive of the *Mazzini Institute* was made by Aldo Brigaglia and Simonetta Di Sieno, who were the first to identify this archive: "*We have found further documents relating to Cremona in the library of the Mazzini Institute in Genoa which make us certain that the majority of letters to Cremona are now at the disposal of historians of mathematics*" (Brigaglia and Di Sieno 2011, 98).

In particular, in the description of the research project concerning the *Mazzini Institute*, they observed that: "*A great part of the correspondence of the most important mathematicians of the first* 30 *years after the unification of Italy has been saved. These letters form an impressive corpus that reveals how a small group of young mathematicians were led to create, almost from nothing, a first-class mathematical community in just* 20 *years (circa 1858–1878), such as to make*

[6] Cf. Loria (1915, 516).

[7] Cf. Bottazzini (1980).

[8] Cf. Bottazzini (1980).

[9] For more on the history of the legacy, see Brigaglia and Di Sieno (2011).

*Darboux state in 1870: 'I think that if things continue to go on in this way, Italians will surpass us in a short time.' Through these letters, we can follow day by day the human, scientific and political happenings of this community. The line of their researches, their contacts with the European mathematicians, their hopes and goals can all be studied in detail*" (Brigaglia and Di Sieno 2011, 104).

In conclusion, the description of the archives of the *University Library* of Genoa and the *Mazzini Institute* shows the importance of studying the correspondences contained therein for the history of Italian mathematics.

## 2.1 The Correspondences Analyzed

Some correspondences conserved in these archives have already been edited in their entirety. The correspondences of Placido Tardy that have already been published, housed at the *University Library* of Genoa,[10] are the following:

- The Beltrami-Tardy[11] correspondence;
- The Bellavitis-Tardy[12] correspondence;
- The Betti-Tardy[13] correspondence;
- The Cremona-Tardy[14] correspondence;

additionally, the Brioschi-Tardy correspondence[15] is currently being printed.

The correspondences of Luigi Cremona that have been published, in addition to the one between Cremona and Tardy, housed at the *Mazzini Institute*,[16] are the following:

- The Battaglini-Cremona[17] correspondence;
- The Brioschi-Cremona[18] correspondence;
- The Chelini-Cremona[19] correspondence;
- The Cremona-Guccia[20] correspondence;

[10] This means the portions of correspondence that concern letters from mathematicians to Tardy.
[11] Cf. Giacardi and Tazzioli (2012).
[12] Cf. Canepa and Fenaroli (2009).
[13] Cf. Cerroni and Martini (2009).
[14] Cf. Cerroni and Fenaroli (2007).
[15] Maria Teresa Borgato analyzed this correspondence.
[16] This means the portions of correspondence that concern letters from mathematicians to Cremona.
[17] Cf. Palladino and Mercurio (2011).
[18] Cf. Palladino et al. (2009).
[19] Cf. Enea and Gatto (2009).
[20] Cf. Cerroni (2013).

additionally, the Masonic[21] correspondences between Cremona and Giosuè Carducci and Francesco Magni are currently being printed.

We will focus our analysis mainly on the following correspondences:

The Betti-Tardy correspondence: the letters from Betti to Tardy are in *Cassetta Loria* at the *University Library* of Genoa. There are 79 letters, covering the period 1850–1891. The letters from Tardy to Betti are in the Library of the *Scuola Normale Superiore* of Pisa. There are 49 letters, covering the period 1850–1889.

The Cremona-Tardy correspondence: the letters from Cremona to Tardy are in *Cassetta Loria* at the *University Library* of Genoa. There are 74 letters, covering the period 1860-post-1888. The letters from Tardy to Cremona are at the *Mazzini Institute*. There are 50 letters, covering the period 1860–1884.

The Cremona-Guccia correspondence: the letters from Guccia to Cremona are at the *Mazzini Institute*. There are 44 letters, covering the period 1878–1900. The letters from Cremona to Guccia are in the Archive of the *Circolo Matematico* of Palermo. There are 14 letters, covering the period 1878–1900.

We will also be dealing with the Beltrami-Tardy, Brioschi-Tardy[22] and Genocchi-Tardy[23] correspondences.

## 3 Principal Subjects of the Correspondences

From an examination of the correspondence, we have identified certain issues that are more significant than others. They are the following:

- The planning and foundation of the *Annali di Matematica pura e applicata*;
- The foundation and development of the *Circolo Matematico di Palermo*;
- The discussion among the Italian mathematicians over Non-Euclidean geometry;
- The references to the researches of Bernhard Riemann;
- The references to Giuseppe Garibaldi and the wars of independence;
- The references to the politics and organization of the university.

The issue concerning the planning and foundation of the *Annali di Matematica pura e applicata*[24] is mainly present in the letters of Enrico Betti, Luigi Cremona, Francesco Brioschi and Angelo Genocchi.

The previous journal, *Annali di Scienze Matematiche e Fisiche*, also known as *Annali di Tortolini*,[25] was published in Rome starting in 1850. Betti, Brioschi and

[21] Brigaglia and Di Sieno studied these correspondences.

[22] Cf. Lacaita and Silvestri (2000).

[23] Cf. Garibaldi (1991).

[24] For insights into the history of the *Annali di Matematica pura e applicata*, see, also Bottazzini (1994).

[25] They were called this because they were drafted by Barnaba Tortolini (1808–1874).

Genocchi joined the editorial staff in 1858 and the journal was refounded as the *Annali di Matematica pura e applicata*. The project was to create a prestigious journal in which Italian and other European mathematicians could publish, to contribute to the rebirth of Italian mathematical studies.

> [...] I feel pleased that the project of the new journal is to your liking, and that you will also contribute to its success. The purpose of this journal is twofold, both to acquaint people abroad with what we do in Italy and introduce (by means of writings and bibliographic articles, as well as translation) the main memoirs published in foreign journals, in the proceedings of Academies and even in new books, to those lovers of mathematics who do not live in scientific centres [...].[26] [Brioschi to Tardy, December 23 1857]

> [...] We have almost arranged with Brioschi to be in Genoa over the Easter holidays, where Genocchi will perhaps also come. We also want to speak with you about our Journal; and to establish all that is necessary for it to follow the best course. [...][27]
> [Betti to Tardy, February 26 1858][28]

It was at the meeting at Tardy's home that the trip to the Universities of France and Germany was to be planned, the purpose of the trip being to increase their knowledge of European research and broaden their relationships with European mathematicians. The journey was subsequently undertaken by Betti, Brioschi and Felice Casorati on September 20, 1858.[29]

The publication of the *Annali di Matematica pura e applicata* ceased in 1865. Brioschi and Cremona, in 1867, decided to resume publication and transfer its headquarters to Milan. They sought the cooperation of their colleagues in accomplishing this.

> [...]Here, they are thinking about stopping publication of the Annali di Tortolini, and to found a Journal, analogous to the Crelle, in instalments, to be paid for separately with no time limits. I have written to Betti and Genocchi about it on behalf of Brioschi. Betti has already replied affirmatively, and as soon as I have the answer from Genocchi

[26] [...] Sento con piacere che il progetto del nuovo giornale è di vostro gradimento, e che contribuirete anche voi pel meglio di esso. Lo scopo di questo giornale è duplice, e di far conoscere al di fuori quanto si sa fare in Italia e di render note (col mezzo di scritti e di articoli bibliografici ed anche di traduzioni) a quei cultori delle matematiche i quali non abitano in centri scientifici le principali memorie pubblicate sui giornali stranieri e negli atti delle Accademie ed anche i nuovi libri [...].

[27] [...] Abbiamo quasi fissato con Brioschi di trovarsi a Genova nelle vacanze di Pasqua, dove forse verrà anche Genocchi. Vogliamo parlare un poco anche insieme con Te del nostro Giornale; e stabilire bene tutto ciò che è necessario per il migliore andamento dello stesso [...].

[28] The letter is in Cerroni and Martini (2009).

[29] See Bottazzini (1994).

as well, I will write to Tortolini. But we need the support of friends, have I secured yours?[...][30] [Cremona to Tardy, 10 January 1867][31]

[...] I very warmly recommend to you the Annali just transferred to Milan, both for the collaboration and for the association. I take the liberty of sending you some copies of this circular, asking you to send it to the indicated names, which I have largely found in the note of the Associates given me by Tortolini; but I don't know their addresses[...][32] [Cremona to Tardy, 10 February 1867][33]

[...] The new Annali di Matematica, to be printed in Milan, seem to me to be seriously delayed. What is our Cremona doing?[...][34] [Genocchi to Tardy, May 28 1867]

The issue concerning the foundation and development of the *Circolo Matematico di Palermo* is present in the correspondence between Luigi Cremona and Giovanni Battista Guccia.

In 1884, Guccia, through personal contributions of resources and labour, founded the *Circolo Matematico di Palermo*,[35] whose journal *Rendiconti del Circolo Matematico di Palermo* became, a few decades later, one of the foremost international journals of mathematics. Guccia was a student of Cremona, and turned to him for advice and support from the Ministry of Education.

[...] The day before yesterday at the institute, Mr. Darboux congratulated me on the foundation of the Circolo of Palermo;[...] And speaking of the Circolo, I believe I have worked well. Everyone, without exception, has taken an interest in the Library of the mathematical society in Palermo and gifts rain down from all parts. Now we will see how you do in Rome!![36] [Guccia to Cremona, October 22 1884][37]

[...] It was then that I had the idea of a Circolo Matematico that would bring together, in a comfortable room equipped with reading and study areas (no fewer than 16 maths periodicals), all people, young and old, from nearby and far away, who had dealings with

[30][...] Qui si pensa di far cessare gli Annali del Tortolini, e fondare qui un giornale, analogo al Crelle, che sia per fascicoli da pagarsi separatamente e senza vincolo di tempo. Ne ho scritto a Betti ed a Genocchi per incarico di Brioschi. Betti ha già risposto assentendo, appena avrò risposta anche da Genocchi scriverò a Tortolini. Ma ci abbisogna l'appoggio degli amici, il vostro ce l'ho assicurato?[...]

[31]The letter is in Cerroni and Fenaroli (2007).

[32][...] Vi raccomando caldissimamente gli Annali trasferiti a Milano, sia per la collaborazione sia per l'associazione. Mi prendo la libertà di mandarvi sotto copia alcune copie di sta circolare, colla preghiera di farla ricapitare ai nomi segnativi, i quali in massima parte ho trovato nella nota degli Associati datami da Tortolini; ma non ne conosco gli indirizzi precisi [...].

[33]The letter is in Cerroni and Fenaroli (2007).

[34][...] I nuovi Annali di Matematica, da stamparsi a Milano, mi sembrano molto in ritardo. Che fa il nostro Cremona? [...]

[35]For more on the history of *Circolo Matematico di Palermo*, see Brigaglia and Masotto (1982).

[36][...] L'altro ieri all'Istituto il Sig. Darboux si mosse al mio incontro per congratularsi a proposito della fondazione del Circolo di Palermo; [...] Ed a proposito del Circolo credo di aver lavorato bene. Tutti, nessuno eccetto, si sono interessati alla Biblioteca della società matematica di Palermo ed i doni piovono da tutte le parti. Vediamo ora cosa sa' fare lei a Roma!!

[37]The letter is in Cerroni (2013).

math.[...] Therefore, the formation of a good library is one of the main objectives of the institution that I am creating. [...] This is the point upon which I take the liberty of appealing to you most urgently.[38] [Guccia to Cremona, April 13 1884][39]

The *Circolo Matematico di Palermo*, starting from a few years after its birth, was enriched by members who were not residents of Palermo; in 1905, it was elevated to the rank of an international society.

[...] The noble initiative of the young mathematicians of Palermo has given Italy an institution that has already earned the recognition of foreign scholars, and I heartily hope that it will prosper and be to the benefit of science in Italy.[...][40]
[Cremona to Guccia, December 31 1887][41]

[...] I had with me for several days Mr. Mittag-Leffler and family. You can imagine the great advantage I derived for the Circolo !!! [...] The work is increasing every hour, the enterprise is colossal,[...] but success is greater and greater! If the Executive Council [...] lives up to the importance of its mandate and is able, when necessary and without disrespect to anyone, to stand firm; if this is possible in Italy, then, but only then, can we be proud of having created a beautiful institution in our country that will honour us abroad[...][42]
[Guccia to Cremona, May 6 1888][43]

[...] At the Congress [of Heidelberg], I met everybody. [...] and all, without distinction, received me very well, which I attribute to the new Italian institution founded by myself with your support, the Circolo Matematico, which, to my great surprise, was already known and appreciated in Germany, more perhaps than it is in France. You can imagine what a great pleasure this was for me! Spontaneously, some German mathematicians came to ask me if they could join our Society. Many told me about the subjects of study that they would

[38][...] Fu allora che mi venne l'idea di un Circolo Matematico che riunisse in un locale comodo e fornito di un buon gabinetto di lettura e di studio (non meno di 16 pubblicazioni periodiche di matematica) tutte le persone, vecchi e giovani, che da vicino e da lontano avessero avuto commercio colle matematiche.[...] È dunque la formazione di una buona biblioteca, uno dei principali obiettivi della istituzione da me creata.[...] Ecco il punto su cui mi permetto di rivolgerle il più caldo appello.

[39]The letter is in Cerroni (2013).

[40][...] La nobile iniziativa de' giovani matematici di Palermo ha dotato l'Italia di una istituzione che già ha meritato il plauso di dotti stranieri, ed alla quale io di cuore auguro che prosperi e che riesca a vantaggio delle scienze in Italia.[...]

[41]The letter is in Cerroni (2013).

[42][...] Ho avuto con me parecchi giorni il Sig. Mittag-Leffler e famiglia. Può immaginare quanto profitto abbia ricavato pel Circolo!!! [...] Il lavoro è ognora crescente, l'intrapresa è colossale, [...] Il successo si afferma sempre più! Se il Consiglio Direttivo [...] s'inspirerà all'importanza del suo mandato e saprà tener fermo, ove accorra, senza riguardi di persone, pur usando delle forme di squisita cortesia; se ciò sarà possibile in Italia, allora, ma soltanto allora, potremo vantarci di aver creata nel nostro paese una bella istituzione che ci farà onore all'estero.[...]

[43]The letter is in Cerroni (2013).

desire to publish in the Rendiconti, among which was George Cantor (Set theory).[...][44]
[Cremona to Guccia, October 2 1889][45]

The issue concerning the Italian mathematicians' discussion on non-Euclidean geometry[46] is mainly present in the letters of Eugenio Beltrami, Giusto Bellavitis, Cremona and Genocchi.

In 1866, 10 years after the death of Nikolaj Ivanovich Lobachevsky, Guillaume Jules Hoüel published a French translation of Lobachevsky's geometry[47] together with some of the correspondence on non-Euclidean geometry by Johann Carl Friedrich Gauss. In 1868, Beltrami presented a concrete model of Lobachevsky's geometry.[48]

[...] Have you read a booklet by Lobachevsky about parallel lines? It was translated into French by Hoüel and printed in the Mémoirs de la Société des Sciences Physiques et Naturalles de Bordeaux (1866), along with some letters from Schumacher to Gauss. It is nothing less than a deconstruction of the famous postulate by Euclid through proof that all geometry can be based on the assumption that that famous postulate is false, and it comes down to entrusting to experience (through astronomical observations) the choice between the Euclidean doctrine and its antithesis. [...] I confess that I do not really accept these new ideas: I do not understand how experience should be a judge of a geometric theory [...] Meanwhile, the work of Lobachevsky and the solemn approval of Gauss seem more appropriate to an increase rather than a diminishing of the importance of attempts at direct demonstration of that postulate. If you have the chance to deal with it, please do and tell me your opinion. [...] So the new doctrine does not find any hitch in geometric applications, but could it not find any, for example, in rational Mechanics, a science that is also based on simple notions of common sense?[49] [Genocchi to Tardy, May 28 1867]

[44][...] Al Congresso [di Heidelberg] conobbi tutti. [...] e tutti, senza distinzione, mi usarono grande accoglienza, che io debbo attribuire alla nuova istituzione italiana da me fondata col suo appoggio, il Circolo Matematico, il quale con mia grande sorpresa, era già conosciuto ed apprezzato in Germania, più di quanto, forse non lo è in Francia, che è quanto dire. Può immaginare se ciò mi ha fatto piacere! Alcuni matematici tedeschi spontaneamente son venuti a chiedermi di far parte della nostra Società. Molti mi hanno sviluppato gli argomenti di lavori che desidererebbero veder pubblicati dai nostri Rendiconti, fra cui George Cantor (teoria degli insiemi)[...]

[45]The letter is in Cerroni (2013).

[46]For further information, see Giacardi (1991).

[47]Cf. Lobachevsky (1866).

[48]Cf. Beltrami (1868).

[49][...] Avete letto un opuscolo di Lobaschevsky intorno alle parallele? fu tradotto in francese da Hoüel e stampato nelle Memorie della Società di scienze fisiche e naturali di Bordeaux (1866) e seguito da alcune lettere di Schumacher a Gauss. Si tratta niente meno che di abbattere il famoso postulato di Euclide provando che tutta la geometria può benissimo stabilirsi sull'ipotesi che quel postulato sia falso, e si finisce col rimettere alla esperienza (alle osservazioni astronomiche) la scelta fra la dottrina euclidea e la contraria. [...] Io confesso che difficilmente accetterei queste nuove idee: non capisco che l'esperienza debba esser giudice d'una teorica geometrica [...] Intanto il lavoro del Lobachevsky e l'approvazione solenne di Gauss mi sembrano atti piuttosto ad accrescere che a togliere l'importanza dei tentativi diretti alla dimostrazione di quel postulato. Se avete agio di occuparvene fatelo e ditemi il vostro avviso. [...] Così nelle applicazioni geometriche

At that time, Beltrami was presenting his model of non-Euclidean geometry to which Genocchi was openly opposed.

> [...] I do not know if you have given any attention to the system of ideas that is now spreading under the name of non-Euclidean geometry, and what judgment you have made. I know that Professor Chelini is decidedly adverse, and that Bellavitis calls it loony geometry: while Cremona believes it questionable and Battaglini approves it without hesitation. I analyzed it a little and I sent to Cremona a confidential exposé of my views, but although these actually lead to an exact interpretation of non-Euclidean theorems, I yet have serious doubt, which comes from the fact that this interpretation seems to have no link with the system of ideas toward which Gauss leaned in giving his consent to the new geometry: or at least none of the laconic phrases contained in his letters to Schumacher leaves legitimate reason to support it. Now, I'm waiting to know what Cremona thinks. [...] I believe that the rigorous and acute Genocchi is unfavorable to non-Euclidean geometry.[50]
>
> [Beltrami to Tardy, November 14 1867][51]

In 1870, Cremona spoke definitively in favor of non-Euclidean geometry:

> [...] The $4^{th}$ issue of the $3^{rd}$ volume will soon be published; it will contain, among other things, the important memoir by Riemann on the fundamental hypotheses of geometry, translated by Hoüel. So, in France, they have published the translation of Beltrami's memoirs on the same subject. Analogous ideas have been mentioned by Neumann in a recent discourse on the principles of Galileo and Newton. So, soon only Bellavitis and the foolish old men of the Academy of France will have the triple privilege of opposing the correct ideas of Gauss, of Lobachevsky, of Riemann, etc.[...][52]
>
> [Cremona to Tardy, April 26 1870][53]

la nuova dottrina non trova alcun intoppo: ma non potrebbe trovarne per esempio nella Meccanica razionale, scienza fondata anche essa sopra semplici nozioni di senso comune?

[50][...] Non so se ella abbia accordato alcuna attenzione a quel sistema di idee che ora si va divulgando col nome di geometria non euclidea, e quale giudizio ne faccia. So che il prof. Chelini gli è decisamente avverso, e che il Bellavitis lo chiama geometria da manicomio: mentre il Cremona lo crede discutibile ed il Battaglini lo abbraccia senza reticenze. Io me ne sono un po' occupato ed ho indirizzato al Cremona una esposizione confidenziale delle mie vedute: ma benché queste conducano effettivamente ad una esatta interpretazione dei teoremi non-euclidei, pure mi rimane un grave dubbio il quale proviene da ciò che questa interpretazione non sembra avere alcun nesso col sistema d'idee al quale si appoggiava Gauss nel dare il suo assenso alla nuova geometria: o per lo meno nessuna delle laconiche frasi contenute nelle sue lettere a Schumacher lascia legittima ragione di supporto. Ora sto aspettando di sapere che ne dice il Cremona. [...] Credo che anche il rigoroso ed acuto Genocchi sia poco favorevole alla geometria non-euclidea.

[51]The letter is in Giacardi and Tazzioli (2012).

[52][...] Presto uscirà il 4° fascicolo del tomo 3°, esso conterrà, fra l'altre cose, l'importantissima memoria di Riemann sulle ipotesi fondamentali della geometria, tradotta da Hoüel. Così in Francia hanno pubblicato tradotte le memorie di Beltrami su argomennti analoghi. Idee pure analoghe sono accennate da Neumann in un suo recente discorso sui principi di Galileo e di Newton. Così fra poco, resterà al solo Bellavitis ed ai vecchi rimbambiti dell'Accademia di Francia, il triplo privilegio di combattere le sane idee di Gauss, di Lobachevsky, di Riemann, ecc. [...]

[53]The letter is in Cerroni and Fenaroli (2007).

The references to the researches of Bernhard Riemann are mainly present in the letters of Betti, Cremona, Genocchi and Tardy.

In the spring of 1858, as we have remarked, Betti, Brioschi and Casorati made their famous trip to Europe.[54] The meeting with Riemann was decisive for Betti's research; his memoirs became his new object of study, and when Betti took the Chair of Higher Analysis, at the end of 1859, the theory of elliptic functions became the topic of his lectures.

> [...] I have translated the memoir by Riemann, but I did not make comments. Now, I am engaged in studying the theory of elliptic functions, for lectures. [...][55]
> [Betti to Tardy, September 30 1859][56]

> [...] In the next issue, 10 sections of the translation of Riemann's memoir will be published, and in the issue after that, the subsequent ones, and then a Monograph, which I am expounding upon in my lessons, above the elliptic functions, that will also be a comment on Riemann's memoir.[...][57]
> [Betti to Tardy, January 3 1860][58]

> [...] I had started a paper on Riemann's researches. It is a beautiful subject. I have a slightly different starting point that makes the exposition easier and clearer.[...]"[59]
> [Betti to Tardy, February 19 1862][60]

In October of 1863, Riemann began his stay in Pisa, for health reasons. During that time, Riemann interacted with Italian mathematicians, as evidenced by the famous letters[61] by Betti describing the conversations with "the eminent mathematician":

> [...] I spoke again with Riemann about the Connection of Spaces, and I got an exact idea. [...] Riemann also spoke with me about his ideas in mathematical physics, but it is necessary that we talk about it. I'm very sorry that you are not yet here and I remember with great pleasure the very few days when, after talking with Riemann, we spent time talking together about what we had understood to help each other to get an exact idea.[...] And we

[54] For further information about the contacts with the European mathematicians, see Neuenschwander (1978/1979), Neuenschwander (1983) and Neuenschwander (1998).

[55] [...] Ho tradotta la memoria di Riemann, ma non ho fatto commenti. Ora Io sono impegnato a studiare nella teoria delle funzioni ellittiche, per le lezioni.[...]

[56] The letter is in Cerroni and Martini (2009).

[57] [...] Nel prossimo numero saranno pubblicati 10 paragrafi della traduzione della Memoria di Riemann, nell'altro numero i seguenti, e poi una Monografia, che sto esponendo nelle mie lezioni, sopra le funzioni ellittiche, che servirà anche in gran parte di commento alla Memoria di Riemann. [...]

[58] The letter is in Cerroni and Martini (2009).

[59] [...] Aveva cominciato un lavoro sopra le cose di Riemann. È un bel soggetto. Prendo un punto di partenza un poco differente che rende più facile e più chiara l'esposizione[...]

[60] The letter is in Cerroni and Martini (2009).

[61] See Sect. 2.

were so lucky that he came to see us. We must not miss the chance and take advantage of this opportunity.[...][62] [Betti to Tardy, October 6 1863][63]

[...] much more than I hope that you will write to me here again and that you will communicate to me something of your very interesting conversations with the incomparable Riemann. My stay in Florence left me with sweet memories, both for the hours spent with you and for the precious knowledge that I got from Riemann, and I envy you greatly, as you are lucky enough to have him all to yourself for the whole winter in Pisa. If only I could come too and enjoy the presence of such a great geometer in Italy! [...][64]
[Tardy to Betti, October 14 1863][65]

[...] Riemann demonstrated with much ease that one can reduce any space to being simply connected, by means of straight sections and surface sections, simply connected. [...][66]
[Betti to Tardy, October 16 1863][67]

Cremona and Tardy were both involved in the study and geometric interpretation of Riemann's theory, through the reading of the works published at that time on the subject, namely *Vorlesungen über Riemann's Theorie der Abel'schen Integrale*[68] (1865) by Carl Neumann and especially *Theorie der Abelschen Functionen*[69] (1866) by Alfred Clebsch and Paul Gordan.

[...] I too received the work of Neumann, and I am enchanted by it. I didn't have time to get too far into it, but the exposition in the part that I did study seems to me admirable for its clarity and accuracy. Oh, if only everyone wrote like that! You told me to wait for a work by Clebsch on the same subject. Will it be a separate book, or some memoir that will be

[62] [...] Ho parlato nuovamente con Riemann della connessione degli spazi, e me ne sono fatta una idea esatta. [...] Riemann mi ha parlato anche delle sue idee in fisica matematica, ma bisogna che ne parliamo ancora. Mi dispiace molto che tu non sia ancora qui e rammento con desiderio i pochissimi giorni nei quali dopo aver parlato con Riemann andavamo insieme parlando di quello che avevamo inteso aiutandoci a farcene un'idea esatta.[...] e noi abbiamo avuta la fortuna che è venuto a trovarci egli stesso. Bisogna approfittarne e non lasciar fuggire l'occasione.[...]

[63] The letter is in Cerroni and Martini (2009) and in Loria (1915).

[64] [...] molto più che spero che tu mi scriva un'altra volta quassù e mi comunichi qualche cosa delle tue interessantissime conversazioni con l'impareggiabile Riemann. Il mio soggiorno a Firenze mi ha lasciato dolcissima ricordanza, e per le ore passate con te e per la preziosa conoscenza che ho fatta di Riemann, e t'invidio grandemente la fortuna di averlo tuo per tutto l'inverno a Pisa. Potessi venire anch'io e godere del soggiorno di un si' grande geometra in Italia!![...]

[65] The letter is in Cerroni and Martini (2009).

[66] [...] Riemann dimostra con molta facilità che si può ridurre uno spazio qualunque ad essere semplicemente connesso, mediante sezioni lineari e sezioni superficiali semplicemente connesse. [...]

[67] The letter is in Cerroni and Martini (2009) and in Loria (1915).

[68] Cf. Neumann (1865).

[69] Cf. Clebsch and Gordan (1866).

published in the Crelle journal? After reading the Treatise by Neumann, I will try to read the writings of Riemann himself. [...][70] [Tardy to Cremona, January 3 1866][71]

[...] I am reading the work of Clebsch, but it is not as clear and easy as that of Neumann. When will Casorati publish his lectures that you told me about?[...][72] [Tardy to Cremona, January 9 1867][73]

[...] I have been in Pavia for days. I often see Casorati, because he makes frequent trips to Milan. He is printing his work on the general theory of functions: it will be a large book and, I think, very well done and very important. The printing will not be complete for another six months. I hope you will not want to compare the book by Clebsch with that of Neumann. The latter has a most basic formulation, but this is the work of a much higher genius: it is a wonderful book, at least it produces this effect on me. [...][74] [Cremona to Tardy, January 10 1867][75]

[...] It also seems difficult to me to read Clebsch's book, and indeed, having found some difficulties with the first pages, I stopped, putting off to quieter days the continued study of this work.[...][76] [Genocchi to Tardy, June 4 1867]

From these letters emerges the esteem that Cremona had for Clebsch, with whom he was in correspondence at that time,[77] as well as the difficulty, shared by Tardy and Genocchi, in reading the book by Clebsch and Gordan. In addition, they were all waiting for the publication of the book "*Teorica delle funzioni di variabili complesse*,"[78] which came out in 1868. In it, Casorati reported on the lectures held in Pavia during an extraordinary course of Higher Analysis of Riemann's theory.

[70] [...] ò ricevuto anch'io l'opera di Neumann, e ne sono incantato. Non ò avuto il tempo di andare molto innanzi, ma nella parte che ò fin qui studiata l'esposizione mi sembra mirabile per chiarezza e precisione. Oh se tutti scrivessero così! Voi mi dicevate aspettare un lavoro di Clebsch sullo stesso argomento. Sarà un libro a parte, o qualche memoria che uscirà nel giornale di Crelle? Dopo la lettura del trattato di Neumann mi proverò a leggere gli scritti di Riemann stesso.[...]

[71] The letter is in Cerroni and Fenaroli (2007).

[72] [...] Sto leggendo l'opera di Clebsch, ma non è così chiara e facile come quella di Neumann. Casorati quando pubblicherà quelle sue lezioni di cui mi parlaste?[...]

[73] The letter is in Cerroni and Fenaroli (2007).

[74] [...] Sono stato da giorni a Pavia. Vedo spesso Casorati perché egli fa corse frequenti a Milano. Egli sta stampando il suo lavoro sulla teoria generale delle funzioni: sarà un grosso volume, e, ritengo, fatto bene e molto importante. La stampa non sarà compiuta prima di sei mesi ancora. Spero che non vorrete paragonare il libro di Clebsch con quello di Neumann. Questo ha una formula più elementare, ma quello è il lavoro di un ingegno decisamente superiore: è un libro meraviglioso, almeno a me fa questo effetto. [...]

[75] The letter is in Cerroni and Fenaroli (2007).

[76] [...] Anche a me pare difficile a leggere il libro di Clebsch, anzi avendo trovato qualche intoppo dalle prime pagine mi arrestai rimettendo a giorni di maggior agio a quiete lo studio continuato di quest'opera.[...]

[77] Cf. Menghini (1996).

[78] Casorati (1868).

In 1869, Brioschi, Casorati and Cremona held their famous lectures on the theory of elliptic and Abelian functions, for the purpose of understanding the "*Riemannian mysteries*":

> [...] The three of them will hold a Complementary Course of Mathematics, and they will expound upon the researches of Clebsch on the Abelian functions. Cremona will do the geometric part, Casorati the part that refers to the theory of the functions of the complex variable, and the remaining part will be done by Brioschi. Brioschi is enthusiastic about Clebsch's book: I too admire the power of analysis of this beautiful talent, but it doesn't arouse in me the enthusiasm that I get from the study of the researches of the kind of deep thinker that Riemann was, and I hope this year that I will have young students able to follow me in the exposition that I intend to give them of his theory of the Abelian functions. [...][79]
>
> [Betti to Tardy, October 31 1868][80]

> [...] The book that most engrosses me is Clebsch's, in which, if I am not mistaken, I was able to simplify and complete some important points: and I will perhaps have an opportunity to publish a few copies on the subject. Also, Casorati will soon print a paper on periodicity, having succeeded in simplifying much of the $4^{th}$ Section of Clebsch. I attend Casorati's lectures, and so I am beginning to be able to see a little inside the Riemannian mysteries. It is really true that there is strength in numbers: alone, I would never have succeeded in making these studies, of which I now also see their true importance for geometry. [...][81]
>
> [Cremona to Tardy, February 20 1869][82]

References to the wars of independence and Garibaldi are present mainly in the letters of Cremona and Tardy. As is well known, Betti, Brioschi, Cremona and Tardy were involved in the Italian Risorgimento, to varying degrees, starting in 1848.

Betti took part in the famous battle of Curtatone with the Tuscan battalion commanded by Fabrizio Mossotti; Brioschi played an active part in the five days of Milan; Tardy, after the first riots in Reggio Calabria in 1847, had to leave Sicily to repair to Tuscany, where he met and became friends with Betti; Cremona participated for over a year in the heroic defence of Venice. These patriotic feelings never left them.

[79] [...] Faranno un Corso Complementare di Matematica in tre, ed esporranno i lavori di Clebsch sulle funzioni abeliane. Cremona farà la parte geometrica. Casorati quella parte che si riferisce alla teoria delle funzioni di una variabile complessa e il resto Brioschi. Brioschi è entusiasmato del libro di Clebsch: anch'io ammiro la potenza dell'analisi di questo bell'ingegno, ma non mi desta l'entusiasmo che mi da lo studio dei lavori di quel pensatore profondo che era Riemann e io questo anno spero che avrò giovani capaci di seguirmi nella esposizione che ho intenzione di far loro della sua teoria delle funzioni abeliane. [...]

[80] The letter is in Cerroni and Martini (2009).

[81] [...] Il libro che più mi occupa è quello di Clebsch dove m'è riuscito, se non m'inganno, di semplificare e completare alcuni punti importanti: e forse avrò occasione di pubblicare qualche copia in proposito. Anche Casorati stamperà presto un articolo sulla periodicità, essendogli venuto fatto di semplificare moltissimo il 4° Abschnitt del Clebsch. Assisto alle lezioni di Casorati, e così comincio a vedere un po' entro ai misteri riemaniani. È proprio vero che l'unione fa la forza: da me solo non sarei mai riuscito a fare questi studi, dei quali ora vedo tutta l'importanza anche per la geometria.[...]

[82] The letter is in Cerroni and Fenaroli (2007).

Cremona wrote to Tardy, during the first meeting of the Italian Parliament on February 18, 1861, as follows:

> [...] You will have the fortune to attend, in a few days, the opening of the first Italian Parliament, where Vittorio Emanuele will be proclaimed the first king of united Italy! What a Solemn moment! [...]"[83] [Cremona to Tardy, February 18 1861][84]

The correspondence shows that Cremona and Tardy lived through the tragic and exciting events of the third war of independence and the subsequent actions by Garibaldi with great trepidation.[85] In particular, there emerges a pattern of alternating hopes and painful disillusionment:

> [...] How is it possible to study with the mind so worried about the political and financial conditions of our country? I already feel old, because at other times, I would have been full of enthusiasm, and today, I look at the future with dismay, and I don't have trust in the intelligence of our men of state. God help us, and save Italy! [...][86]
> [Tardy to Cremona, May 1 1866][87]

> [...] The war is ready to break out: all Italians are in agreement and are pleased the government is pushing ahead armaments with great energy.[...][88]
> [Cremona to Tardy, May 23 1866][89]

> [...] Dear Cremona, write me and give me courage. I do not despair yet, but this first defeat makes my heart bleed.[...][90] [Tardy to Cremona, June 26 1866][91]

All of which led to a conclusive painful outburst:

[83] [...] Voi avrete la fortuna d'assistere fra pochi giorni all'apertura del primo Parlamento italiano, ove si proclamerà Vittorio Emanuele primo re dell'Italia una! Qual momento Solenne! [...]

[84] The letter is in Cerroni and Fenaroli (2007).

[85] During the Third War of Independence, Italy suffered the tough losses of Lissa and Custoza, but obtained the liberation of Venice and of the Veneto. The following year, the Roman expedition of Garibaldi suffered a disastrous defeat by French troops at Mentana.

[86] [...] Ma come si fa a studiare con l'animo così agitato per le condizioni politiche e finanziare del nostro paese? Io mi sento già vecchio, perché in altri tempi sarei stato pieno d'entusiasmo, ed oggi guardo l'avvenire con sgomento, e non ò fiducia nell'intelligenza de' nostri uomini de' stato. Iddio ci aiuti, e salvi l'Italia! [...]

[87] The letter is in Cerroni and Fenaroli (2007).

[88] [...] La guerra sta per iscoppiare: tutti gli italiani sono concordi e lieti: il governo spinge gli armamenti con somma energia [...]

[89] The letter is in Cerroni and Fenaroli (2007).

[90] [...] Scrivetemi e fatemi coraggio, caro Cremona. Non dispero ancora, ma questa prima sconfitta mi fa sanguinare il cuore.[...]

[91] The letter is in Cerroni and Fenaroli (2007).

> [. . . ] I will not speak about politics: the madness of Garibaldi and the dishonesty of Rattazzi have brought us to the brink of the abyss. In order not to get dizzy, you should not think about it, since it is not in our hands to remedy it.[. . . ][92]
>
> [Cremona to Tardy, November 9 1867][93]

The references to politics and to the organization of the university are present mainly in the letters of Betti, Brioschi, Cremona and Tardy.

Already before the unification of Italy, Betti, Brioschi, and Tardy, as well as Cremona, who was not even a university professor, played a collective leading role in education policy,[94] but their role in Italian politics, especially, of course, in the field of Education, grew after the proclamation in 1861 of the Kingdom of Italy.[95]

From the correspondence, it emerges, for example, that Cremona, after transferring to the University of Rome and becoming the director of the School of Engineering in 1873, was so completely absorbed by the institutional activities[96] that he tried to escape from these tasks so as to return to research and that he suffered tremendous pressure to stay:

> [. . . ] Obviously, if you went away, the consequences would be very serious from every point of view. I do not know what would remain of the School of Application. I do not know what would remain of the Academy. It would be such a terrible mess that if you think about the consequences for even a moment, any desire to leave should disappear altogether. If scientists do not want to be in Rome, if they do not bear any inconvenience that may occur in regard to the needs of the country, they declare, by their conduct, that they are of

[92] [. . . ] Di politica non vi parlo: la follia di Garibaldi e la malafede di Rattazzi ci hanno tratti sull'orlo dell'abisso. Per non avere le vertigini, non bisogna pensarci, dacché non è in nostra mano metterci rimedio.[. . . ]

[93] The letter is in Cerroni and Fenaroli (2007).

[94] In 1859, Brioschi was a member of the Committee for the preparation of the "*Casati*" law (the "Legislative Royal Degree, November 13, 1859, n. 3725" of the Kingdom of Sardinia, which came into force in 1860 and was later extended, with the unification, to all of Italy. The law, which took its name from the Minister of Education, Gabrio Casati, organically reformed the entire educational system.); in 1860, Cremona was deeply involved in the review of school mathematics programmes. Thus, in fact, Genocchi, who was involved in this operation, wrote to him: "[the ministerial programmes] *are yours, neither more nor less*."

[95] Brioschi, among other things, was a Deputy (from 1861), the rector of the Polytechnic of Milan from its foundation in 1863, and a Senator (from 1865). He was then the vice president of the Higher Council of Education. Betti was a Deputy (from 1862), the Director of the "Scuola Normale Superiore" of Pisa in 1865, the Secretary-General of Education (i.e. the undersecretary) from 1874 to 1876, a Senator (from 1884), and the vice president of the Higher Council of Education. Cremona was director of the School of Engineering of Rome in 1873, a Senator from 1879 and the vice president of the Senate in 1897–1898, as well as Minister of Education for 1 month in 1898.

[96] To learn more about the political activities of Luigi Cremona, see Brigaglia and Di Sieno (2009) and Brigaglia and Di Sieno (2010).

> the idea... horribile dictu ... that we have to give Rome back to the Pope. So, I make the warmest appeal to your patriotism, and even your love of science.[...][97]
>
> [Sella to Cremona, October 4 1877]

The correspondence is particularly useful in allowing for the reconstruction of the ephemeral but significant life of the commission established by the Minister Terenzio Mamiani to renew and supplement the Casati law. The commission was established before the proclamation of the Kingdom of Italy (July 18, 1860), in order to "write up a unitary school code to apply to the new kingdom."

Of course, after the events of May to September 1860, in view of the proclamation of the Kingdom of Italy, the Minister, on January 12, 1861, ordered an extension "so as to represent the whole of Italy."[98] Tardy was consulted by the Minister regarding this extension and, on January 16, he gave notice of it to Betti:

> [...] I am writing you two lines to tell you that I have proposed to Mamiani that he appoint you to a commission of which I will also be part for the compilation of a law on public education. I don't know if you have had official notice of it yet, neither do I know when the commission will meet.[...][99]
>
> [Tardy to Betti, January 16 1861][100]

Cremona wrote to Tardy, with high expectations, a few days after the inauguration of the Committee, on February 8, as follows:

> [...] I am pleased that the new Commission for constituting the law on Public education includes Betti and you. Nobody prays more than I do that this future law will be established with haste, the conditions of this university are so miserable![...][101]
>
> [Tardy to Cremona, February 8 1861][102]

[97] [...] Evidentemente se voi ve ne andate, le conseguenze sarebbero gravissime sotto ogni punto di vista. Non so ciò che rimarrebbe della Scuola di applicazione. Non so ciò che rimarrebbe dell'Accademia. Sarebbe uno scompiglio così grave che se pensate anche solo un momento alle conseguenze ogni voglia di andarvene debba scomparire del tutto. Se gli uomini di scienza non vogliono stare a Roma, se non sopportano qualche inconveniente, che vi possa essere in vista delle necessità della patria, essi dichiarano con la loro condotta, che sono d'avviso ... horribile dictu... che si deve ridare Roma al papa. Io faccio quindi il più caldo appello al vostro patriottismo, ed anche al vostro amore per la scienza. [...]

[98] Cf. Ciampi (1983) and also Polenghi (1993).

[99] [...] Ti scrivo due righe per dirti che ò proposto a Mamiani di nominarti in una commissione della quale faccio parte anch'io per la compilazione di una legge sulla pubblica istruzione. Non so se tu ne abbia ancora avuto avviso ufficiale, né so quando la commissione si riunirà.[...]

[100] The letter is in Cerroni and Martini (2009).

[101] [...] Sono lieto che la nuova Commissione per formare la legge della pubblica Istruzione comprenda voi e Betti. Nessuno più di me affretta coi voti questa futura legge, tanto sono miserabili le condizioni di questa università![...]

[102] The letter is in Cerroni and Fenaroli (2007).

The Commission met regularly starting on February 5 and began collecting opinions from universities throughout Italy, on the basis of directives from the Minister. The members of the committee were, besides Betti and Tardy, Quintino Sella and Francesco De Sanctis (who, a few months later, would replace Mamiani).[103] The outcome of the committee's work was almost nil. As reported by Tardy:

> [...] Several times, I made a resolution to write to you, but in Turin, I was busy, and then I waited for our famous commission to achieve something to acquaint you with. [...] The comments you made then on the teaching of mathematics were absolutely right. [...] But all these arguments remained without any result, and I do not think that the new minister wants to make a general law on public education, because then its discussion in Parliament would go on indefinitely.[...][104] [Tardy to Cremona, June 11 1861][105]

And as Mamiani himself said : "The poor law, certainly not yet well-defined and accomplished, is a dead embryo, apparently."[106]

## 4 Conclusions

We have seen that through the correspondences analysed here, it is possible to describe the historical framework and the main interests and political positions of Placido Tardy, and also to enhance existing information on the political role of Luigi Cremona. Furthermore, we can study the human, scientific and political events of the mathematical community. In particular, their line of research, their contacts with other European mathematicians, and their hopes and goals can all be analysed in detail. Hence, these correspondences constitute an important contribution to the reconstruction of the History of Risorgimento Mathematics.

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[103] Cf. Romizi (1902).

[104] [...] Più volte aveva fatto il proponimento di scrivervi ma in Torino era occupatissimo, e poi aspettava che in quella nostra famosa commissione si fosse concluso qualche cosa per rendervene conto.[...] Le osservazioni che allora mi facevate sull'insegnamento matematico erano giustissime. [...] Ma tutti questi discorsi sono rimasti senza risultato, e non credo che il nuovo ministro pensi a fare una legge generale per l'istruzione pubblica, perché poi la discussione di essa in Parlamento ci porterebbe alle calende greche.[...]

[105] The letter is in Cerroni and Fenaroli (2007).

[106] Romizi (1902, 62).

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