

**About bibliographical projects
during the formation of
the mathematical community
in Europe
Portuguese mathematicians
in international bibliography
at the turn of
the XIX-XX centuries**

Almagest

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Abstract

We consider the possibility of using bibliographic as well as reference data for research in the history of mathematics during the formation of the mathematical scientific community in Europe at the second half of the XIX-the first half of the XX centuries. Considering an example of the mathematical scientific community in Portugal, which was still being formed at that time, we explore participation and citing of Portuguese researchers in different bibliographic European projects. We note that bibliographic data can be interpreted in the broader context of the history of Europe as a whole: the link between this local process in the history of mathematical thought and the European historical process can be easily seen in the changing number of publications produced by the mathematical scientific community in Portugal over different time periods. We conclude that the evolution dynamics of international bibliography of the mathematical scientific communities in different countries can be used as a research methodology to understand the social history of mathematics.

Towards the History of the Emergence of the World Mathematical Scientific Community

Much of the existing literature in the history of mathematics is devoted to the process of formation and development of the national mathematical scientific communities as well as to the emergence of the international mathematical scientific community based on these national communities in the second half of the XIX-first quarter of the XX centuries. This literature dates back to the second half of the XX century and new insights are constantly emerging. In recent decades, several researchers have paid their attention to the research on development of the global mathematical scientific community (Goldstein et al. 1996; Grattan-Guinness et al. 2000; Parshall et al. 2002).

The emergence of the global mathematical scientific community was catalysed by the development of the national communities, especially those in Germany and France, which, at the time, were leading communities in the world. These national communities formed the basis for the formation of the global community. For example, in France, the prominent members of the mathematical scientific community were Joseph Fourier, Augustin-Louis Cauchy, Évariste Galois, Charles Hermite, Henri Poincaré, Émile Borel to name a few; while in Germany the major names were, among others, Carl Friedrich Gauss, Karl Weierstrass, Bernhard Riemann, Georg Cantor, Felix Klein, David Hilbert. These researchers dominated the field of mathematics in the XIX century and the first third of the XX century. The development of the communities in Germany and France was followed by the emergence of mathematical scientific communities in other European countries (first of all in Italy, United Kingdom and Russia) and on the North American continent (mainly in the USA).

The rapid development of mathematical science in the last decades of the XIX century in Italy, a country with long-lasting research traditions, gave hope that the two leading mathematical nations would soon be joined by the third – Italy, where the mathematical scientific community included Ulisse Dini, Luigi Bianchi, Giuseppe Peano, and Vito Volterra. Yet, in the first quarter of the XX century the development of Italian mathematics slowed.

At that time, the British mathematics was on the rise leveraging on the country's significant scientific tradition. William Rowan Hamilton, James Joseph Sylvester, and Arthur Cayley were major representatives of the British mathematical scientific community at the time.

At the same time, Russia as well as Scandinavian countries has also joined the club of nations with great mathematical potential. Specifically, Nikolai Lobachevsky, Pafnuty Chebyshev, Andrey Markov, and Aleksandr Lyapunov were among the leaders of mathematical thought in Russia while Niels Henrik Abel (Norway), Erik Ivar Fredholm (Sweden), Gösta Mittag-Leffler (Sweden) defined the mathematical landscape in Scandinavia. The Russian mathematical scientific community, founded by and developed from the seminal works of Leonhard Euler,

was a subject of systematic and rigorous research in the literature on the history of mathematical thought in the second half of the XX century (see, e.g., research by B. Gnedenko (1946), A. Yushkevich (1968), S. Demidov (1996; 2015)).

In XX century, a formidable break-through in the development of the mathematical community was made by Poland, a country with rather modest development of mathematical thought compared to the neighbouring European states. From the 1930s, Poland became one of the major mathematical nations in the world thanks to the work of Stefan Banach, Waław Sierpiński and others. The development of the mathematical community in Poland has been the subject of research of K. Kuratowski (1980), R. Duda (1996), S. Domoradski (2011).

From the end of the XIX the United States of America began to play a noticeable role in the development of mathematical science which led to the US becoming one of the major mathematical science nations in the second half of the XX century. Della D. Fenster, Karen H. Parshall and David E. Rowe provide a detailed account of the formation of the American mathematical science community. In 1988-1989, the American Mathematical Society published *A Century of Mathematics in America* which had 3 volumes and was edited by Richard Askey, Uta Merzbach, and Peter Duren. The work of Thomas Archibald and Louis Charbonneau deals with the development of mathematics in Canada.

Its particular niche in the mathematical science of the XX century was taken by Japan and China, which in the XIX century were characterised by underdeveloped, by in large, medieval scientific traditions, and yet were able to catch up with the leading mathematical nations in less than a century. These processes in Japan and China have been considered by Chikara Sasaki and Joseph Dauben, correspondingly.

Since the second half of the XIX century, the internationalization of mathematics was characterized by an over-border expansion of the international contacts of mathematicians. Finally, a new type of mathematician has emerged – a mathematician which was highly involved in the broader international mathematical community, a mathematician with broad interests as well as vision and insight for issues and problems of this community, a mathematician who contributed to the development of this community. It is noteworthy that countries that were considered at the periphery of modern mathematics, at the same time they also put forward this new type of mathematicians. G.B. Guccia (Italy), A.V. Vasilyev (Russia), Z.G. de Galdeano (Spain), K. Stefanos (Greece), F. Gomes Teixeira (Portugal) were bright representatives of this new type. Much literature in the history of mathematical thought studies this phenomenon. The work of G.B. Guccia was studied by A. Brigaglia and G. Masotto (1982); V.A. Bazhanov and A.P. Yushkevich (1992) considered research of A.V. Vasilyev; the life and work of G. Galdeano was explored by M. Hormigón (1984); the contributions of K. Stefanos was investigated by Ch. Phili (2009); the life and work of F. Gomes Teixeira were investigated by H. Vilhena (1936) and G. Alves (2012), respectively.

International Projects in Bibliographic and Reference Journals

The development of the national scientific communities led to the strengthening of the international contacts at different levels (personal level, the level of academy of science as well as educational institutions, the level of mathematical societies). The first attempt to organize a congress of mathematicians from different countries was undertaken in 1893 in Chicago (timed to the World Exhibition). This idea was further developed 4 years later. The first International Congress of Mathematicians (ICM) was held in Zurich in 1897.

Publication activity has also flourished: the number of international mathematical journals and the number of publications have increases. In 1700, mathematical articles can be found in no more than two dozen journals. By 1900, more than 600 periodic journals were involved in the publication of mathematical articles. Naturally, mathematicians have also issued bibliographic and reference catalogues and journals, which were developed in order to systematise mathematical publication in different countries. In turn, these publications simplified scientific outreach and exchange amongst the representatives of the global scientific community. Currently, these bibliographic data are of great interest to understand the history of the formation of the international mathematical community. This produced major benefits in ensuring the systematic development of mathematics and allowed researchers to decrease the number of repetitions in published results (it is widely known that in the earlier days of mathematical science, several researchers came up with the same ideas multiple times simply due to the lack of access to other researcher's work). In some sense, these developments were much needed to spread and learn new information (a role which is currently played by the Internet).

Here is a brief overview of some of the major international mathematical projects issued by the bibliographic and reference journals at the time:

- *Catalogue of Scientific Papers* (1867-1925) in the United Kingdom;
- *Bullettino di Bibliografia e di Storia delle Scienze Matematiche e Fisiche* (1868-1887) in Italy;
- *Jahrbuch über die Fortschritte der Mathematik* (1868-1942) in Germany;
- *Revue Semestrielle des Publications Mathématiques* (1893-1934) in the Netherlands;
- *Répertoire Bibliographique des Sciences Mathématiques* (1894-1912) in France;
- Mathematical encyclopedias, first in Germany and then in France, which contained numerous bibliographic data.

In contrast to the research journals, bibliographic and reference volumes allowed researchers to navigate the complex landscape of mathematics for a long period of time (from the beginning of the XIX century) allowing mathematicians to access scientific breakthroughs not only in the leading mathematical nations but also far beyond.

The *Catalogue of Scientific Papers* (1867-1925) was published in the United Kingdom by

the Royal Society of London. In 19 volumes of this major publication, the Society provided a detailed index of journals from 1800 to 1900 where one could find articles in mathematics as well as in other sciences. The *Catalogue* is organised in alphabetical order by author's names, following strict historical chronology by author. It contains a grand total of 40,000 references. The chronology of all volumes is summarized in Table 1 below.

Table 1: *Chronological order in the Catalogue of Scientific Papers*

Volume	Dates of articles	Dates of the Catalogue
1-6	1800-1863	1867-1872
7-8	1864-1873	1877-1879
9-11	1874-1883	1891-1896
12	1800-1883	1902
13-19	1884-1900	1914-1925

An additional volume (volume 12) the *Catalogue* indexed "all major documents" which appeared between 1800 and 1883 in periodicals and journals which have not been indexed in the earlier volumes. In 1908-1914 the Society published three Subject Indexes: volume 1 – Pure Mathematics (1908); volume 2 – Mechanics (1909); volume 3, part 1 – Physics: General, Heat, Light, and Sound (1912); volume 3, part 2 – Physics: Electricity and Magnetism (1914).

The *Bullettino di Bibliografia e di Storia delle Scienze Matematiche e Fisiche* (1868-1887) was published in Italy under the leadership of the Italian historian of mathematical thought Prince Baldassarre Boncompagni-Ludovisi (1821-1894). This was one of the first journals which was devoted to the history of sciences. 20 volumes (14,554 pages) of this publication came out between 1868 and 1887.

The *Jahrbuch über die Fortschritte der Mathematik (JFM)* (1868-1942) was published in Germany and edited initially by Carl Orthmann (1839-1885) and Felix Müller (1843-1928), and later on by Albert Wangerin (1844-1933). In the first issue, the goals of the journal were defined as follows: firstly, to offer an instrument for those who cannot follow all publications in various areas of mathematics in order to gain a general understanding about the development of mathematical science and, secondly, to help an active scientist to find references to known facts (Göbel 2008). Starting from the first issue, the journal material was split into 12 categories and 38 subcategories: History and Philosophy, Algebra, Theory of Numbers, Probability, Rows, Differentials and Integrals, Functions, Analytical Geometry, Synthetic Geometry, Mechanics, Mathematical Physics, Geodesy and Astronomy. In the entire history of the journal from 1868 to 1942, 68 issues were published. The first part of the 68th volume (1942) was the last.

In contrast to such journals in other countries, the referees in the *Jahrbuch über die Fortschritte*

der Mathematik were not critics of mathematical thoughts, but “reviewers” – famous and prominent mathematicians of that time (e.g., G. Fichtenholz, D. Hilbert, A. Hurwitz, E. Kamke, F. Klein, E. Landau, S. Lie, G. Minkovsky, M. Mittag-Leffler, V. Smirnov).

The *Revue Semestrielle des Publications Mathématiques* (1893–1934) was published in the Netherlands by the Mathematical Society of Amsterdam and contained a half-annual review of all mathematical publications. Each volume of the publication consisted of 3.000 summary articles in German, English, and French; provided the author index; as well as the list of mathematics journals. In 1932 the *Revue*'s activity declined and the project was closed in 1934.

The *Répertoire Bibliographique des Sciences Mathématiques* (1894-1912) was published by the French Mathematical Society. The initial idea for publishing the *Répertoire* was expressed by Henri Poincaré in 1885 and the first volume came out in 1894. According to Poincaré: “Toute classification est une théorie déguisée, et ce n'est pourtant qu'en classant les faits qu'on pourra se mouvoir dans le dédale sans s'égarer. Ceux qui méconnaîtront cette vérité ne marcheront qu'à tâtons, revenant sans cesse sur leurs pas, refaisant cent fois le même chemin [...]” (Poincaré 1909, 290). Between 1894 and 1912 (27 years) 20 series 1.000 bibliographic indexes each were issued by the *Répertoire*, which were partitioned into 3 main groups: 1. Mathematical Analysis, 2. Geometry, 3. Empirical Mathematics. In 1894-1895 four series came out; in 1896-1905 years 11 series came out; followed by 5 series in 1906-1912. In 1889, the first *Congrès International de Bibliographie des Sciences Mathématiques* (International Mathematical Bibliographic Congress) took place in Paris. This Congress formed a permanent committee which included H. Poincaré, D. André, J. Humbert, M. d'Ocagne, Ch. Henry (France); E. Catalan (Belgium); D.B. de Haan (Netherlands), F. Gomes Teixeira (Portugal), E. Holst (Norway), G. Valentin (Germany), E. Weyr (Austria), G. Guccia (Italy), H. Enestrom (Sweden), I. Gram (Denmark), V. Ljgin (Russia) and K. Stefanos (Greece). Yet, despite the broad international representation, the contribution of member states were not equivalent as some countries failed to contribute their bibliographic data (e.g., United Kingdom and USA participated in other international projects). Furthermore, the international exposure of this initiative was weakened by the fact that the bibliographic contributions from different countries were edited and published in France. As a result, the publication has a significant bias towards publishing and highlighting the work of French mathematicians. Generally, the publication was primarily focusing on French and German mathematical literature and tended to apply a rather subjective approach to contributions from other countries.

Later, in the 1930s-1950s, a new period began in the development of international mathematical bibliography. New bibliographic journals were created: *Zentralblatt für Mathematik* in Germany (since 1931), *Mathematical Reviews* in the USA (since 1940), and *Математика, Реферативный журнал* (Mathematics, Journal of Abstracts) in the USSR (since 1952).

Portuguese Mathematicians in Bibliographic and Reference Journals

It is hard to overestimate the role of reference journals in providing an understanding of the formation of mathematics as a science. Apart from the information in the subject area of mathematics, these journals provide us with understanding of the dynamics of collaboration between mathematicians from different countries; and the level of integration of small and large national mathematical societies into the international tapestry of the global mathematical community. From this standpoint, the exploration of bibliographic data could make a significant contribution into the development of the history of mathematics. Yet, to the best of our knowledge, such bibliographic investigations have not been conducted to date in the literature on the history of mathematical thought. To make our contribution in this area, we collected data from Portugal. At the end of the XIX-beginning of the XX century Portugal was a country rather distant from the leading mathematical nations and yet it made its modest contribution to the development of the international mathematical community (Kharlamova et al. 2016). On the one hand, our focus on Portugal allowed us to consider the bibliographical material which is not vast (compared to that from Germany and France). On the other hand, it allowed us to explore and detect the general tendencies common to the development of mathematics in that time period using Portuguese heritage.

Since 1877 in Portugal Francisco Gomes Teixeira (1851-1933) began publishing the first Portuguese international mathematics journal, entirely devoted only to mathematical sciences – *Jornal de Sciencias Mathematicas e Astronomicas* (1877-1905). In Portugal, at the same period, there were general scientific journals where mathematical articles could appear. The most famous of them are: *Memorias de Academia Real de Sciencias de Lisboa* (from 1797) and later *Jornal de Sciencias Mathematicas, Physicas e Naturaes* (1866-1927) (Saraiva 2008). These scientific journals were widely cited in international mathematical bibliography.

One of the leading Portuguese mathematicians of the time was F.G. Teixeira. His name is associated with the major events in the history of the Portuguese mathematical community. Therefore, we were particularly interested in finding references to his work in the bibliographic resources considered in our investigation (Kharlamova 2013). We were able to obtain a complete reference list to his early work in the *Catalogue of Scientific Papers* mentioned above. Specifically, *Catalogue of Scientific Papers* in 1874-1883 (see volume 10, Royal Society of London, 1891) contains a detailed overview of all research resources by F.G. Teixeira published in different journals in Portugal, France, Italy, and Belgium:

- 1873 – *Aplicação das fracções continuas á determinação das raizes das equações*, *Jornal de Sciencias Mathematicas, Physicas e Naturaes*.
- 1877 – *Sur la décomposition des fractions rationnelles*, *Jornal de Sciencias Mathematicas e Astronomicas*.
- 1877 – *Noticia sobre Saturno*, *Jornal de Sciencias Mathematicas e Astronomicas*.

- 1878 – *Sur le nombre des fonctions arbitraires des intégrales des équations aux dérivées partielles*, Mémoires de la Société des Sciences Physiques et Naturelles de Bordeaux.
- 1878 – *Noções elementares sobre a theoria dos determinantes*, Jornal de Sciencias Mathematicas e Astronomicas.
- 1880 – *Generalisação da serie de Lagrange*, Jornal de Sciencias Mathematicas Physicas e Naturaes.
- 1880 – *Sur les dérivées d'ordre quelconque*, Giornale di Matematiche.
- 1881 – *Sur l'intégration d'une équation aux dérivées partielles du deuxième ordre*, Comptes Rendus de l'Académie des Sciences de Paris.
- 1881 – *Sobre a multiplicação dos determinantes*, Jornal de Sciencias Mathematicas e Astronomicas.
- 1881 – *Sur le développement des fonctions implicites en série*, Journal de Mathématiques Pures et Appliqués, founded by Liouville.
- 1882 – *Sur l'intégration d'une classe d'équations aux dérivées partielles du deuxième ordre*, Bulletin de l'Académie Royale des Sciences de Belgique.
- 1883 – *Sur une formule d'interpolation*, Mémoires de la Société Royale des Sciences de Liège.

The bibliography of Portuguese mathematicians in French publication *Répertoire Bibliographique des Sciences Mathématiques* described above is well-represented. Apart from the citations and references to F.G. Teixeira's work, we were able to find bibliographic data for other Portuguese mathematicians in the *Répertoire*. Specifically, in this French referencing publication we detected 29 references to Teixeira's research: of these 29, 13 were articles in Portuguese journals; 13 in French journals; and 3 in German outlets. In 20 volumes of the *Répertoire* 152 references cite other Portuguese mathematicians.

In the German *Jahrbuch über die Fortschritte der Mathematik (JFM)* Portuguese mathematicians are also well-represented and have detailed bibliography. Apart from the reference to a specific piece of work, the *JFM* contains brief summaries of all contributions and provides a detailed topology relevant to the subject matter (specific area of mathematics). Due to the diligence and significant level of detail in the data, we were able to summarise the German data in the Figure 1 (Kharlamova 2013). On Figure 1, the vertical axis shows the number of Portuguese pieces of research in mathematics for a particular year, and the horizontal axis shows years of *Jahrbuch über die Fortschritte der Mathematik* publication.

Figure 1 clearly shows the evolution and dynamics of the number of works of Portuguese mathematicians which were references in the *Jahrbuch über die Fortschritte der Mathematik* over the years when this German publication existed. Putting these data into the canvas of the broad context of European history in 1876-1942 is an interesting exercise. The last quarter of the XIX century was the time of the widespread national movement to revive the scientific and cultural heritage in Portugal (the period of so-called *Regeneração* in 1880s-1890s). This period is reflected in the increased productivity and creativity in the mathematical bibliography (see Figure 1). In 1910, the change from monarchy to the republic in Portugal led to

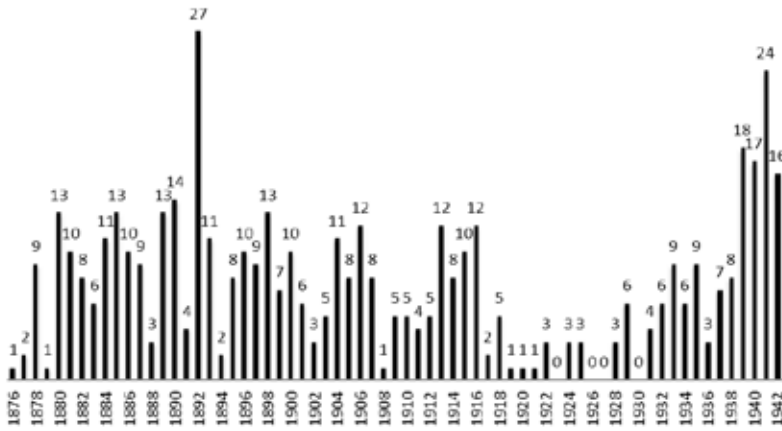


Figure 1: *Portuguese mathematicians in the Jahrbuch über die Fortschritte der Mathematik*

the new outburst of mathematical activity in the country all the way to 1916 (this effect lived through the first 2 years of World War I which began in 1914). In 1916 Portugal declared war to Germany (before 1916 it remained neutral) and entered World War I as an ally of the Entente. As a result, the number of publications by Portuguese mathematicians falls and stays low until the end of 1920s after which point we see a rapid increase until 1942 (last year of the *JFM* publication). The beginning of World War II did not lead to a decline in the number of Portuguese publications according to the *JFM*. Unfortunately, the *Catalogue of Scientific Papers* closed in 1925 and the *Répertoire Bibliographique des Sciences Mathématiques* in 1912. This prevented us from making a detailed comparison of the post-World War I period across different bibliographic publications. Yet, the *JFM* enables us to uncover interesting trends in mathematical science and the interrelations between the scientific community and the society in Portugal at the end of the XIX-beginning of the XX century.

Conclusions

Bibliographic data can be interpreted as a link between a local process in the history of mathematics and the European historical process, which can be easily seen in the changing number of publications produced by the mathematical scientific community in different periods of time. We obtained bibliographic data from a variety of interregional reference projects to explore the development of the mathematical scientific community and the development of the mathematical science using an example of Portugal. Obtained data allows us to understand the development of Portuguese mathematical scientific community in the broad European historical context. While our investigation shows that bibliographic data could be used to understand processes in the history of mathematical thought, our exploration is limited to only one country –Portugal– and it is hard to make far-reaching conclusions from our exercise. A comparative study of the chronology of history and relative changes in the international

bibliography of mathematical scientific communities in different countries can be used as a convenient method of research in the social history of mathematics. Further research in this area should endeavour to explore bibliographic data for both leading mathematical nations and those which were at the periphery of the development of mathematical science at the end of the XIX – beginning of the XX century.

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References

- Alves, M.G. (2012), *Francisco Gomes Teixeira: o homem, o cientista, o pedagogo*. Porto: U. Porto editions.
- Bazhanov, V.A., Yushkevich, A.P. (1992), "A. B. Васильев как ученый и общественный деятель" ("A.V. Vasilyev as a scientist and public figure"), in Vasilyev A.V. (ed.), *Николай Иванович Лобачевский (1792-1856) (Nikolai Ivanovich Lobachevsky (1792-1856))*. Moscow: Nauka, 221-228.
- Brigaglia, A., Masotto, G. (1982), *Il Circolo matematico di Palermo*. Bari: Edizioni Dedalo.
- Demidov, S.S., Tikhomirov, V.M., Tokareva, T.A. (2015), "Московское математическое общество в развитии отечественной математики (к 150-летию основания)" ("The Moscow Mathematical Society in the development of mathematics in Russia (on its 150th anniversary)", *Uspekhi Mat. Nauk* 70(1 [421]): 189-203.
- Demidov, S.S. (1996), "Математический сборник в 1866-1935" ("Matematicheskii Sbornik in 1866-1935"), *Istor.-Mat. Issled.* 1[36] (2): 127-145.
- Domoradzki, S. (2011), "The Growth of Mathematical Culture in the Lvov Area in the Autonomy Period (1870-1920)", *History of Mathematics*, vol. 47. Praha: Matfyzpress, 7-16.
- Duda, R. (1996), "Fundamenta Mathematica and the Warsaw School of Mathematics", in Goldstein, C., Gray, J., Ritter, J. (eds), *L'Europe mathématique – Mathematical Europe*. Paris: Édition de la Maison des sciences de l'homme, 479-498.
- Gnedenko, B.V. (1946), *Очерки по истории математики в России (Essays on the history of mathematics in Russia)*. Moscow-Leningrad: State publishing house of technical and theoretical literature.
- Göbel, S. (2008), "Starting the management of knowledge in mathematics: The «Jahrbuch über die Fortschritte der Mathematik»", in Wegner, B., and Staff Unit Communications (eds), *A Focus on Mathematics*. Karlsruhe: FIZ Karlsruhe, 9-13.
- Goldstein, C., Gray, J., Ritter, J. (eds) (1996), *L'Europe mathématique-Mathematical Europe*. Paris: Édition de la Maison des sciences de l'homme.
- Grattan-Guinness, I. (2000), *Rainbow of Mathematics: A History of the Mathematical Sciences*. s.l.: W.W. Norton & Company.
- Hormigón, M. (1984), "Una aproximación a la biografía científica de García de Galdeano", *El Basilisco* 16: 38-47.
- Kharlamova, V.I., Malonek, H.R., Santos, S. (2016), "O Papel das Revistas Científicas na Internacionalização da Matemática", *Revista Brasileira de História da Matemática* 16(32): 53-67.
- Kharlamova, V.I. (2013), *F.G. Teixeira and the European mathematical community in the XIX-XX centuries*. Ph.D. Dissertation. Aveiro: University of Aveiro.
- Kuratowski, K. (1980), *A Half Century of Polish Mathematics: Remembrances and Reflections*. Oxford: Pergamon Press.
- Parshall, K., Rice, A. (2002), *Mathematics Unbound: The Evolution of an International Mathematical Community, 1800-1945*. London: London Mathematical Society.
- Phili, C. (2009), *Kyprisissos Stefanos and extension on the calculus of linear substitutions*. Thessaloniki: s.n.

- Poincaré, H. (1909), *Le libre examen en matière scientifique*. Liège: Imprimerie La Meuse.
- Saraiva, L.M.R. (2008), "Mathematics in the Memoirs of the Lisbon Academy of Sciences in the 19th century", *Historia Mathematica* 35: 302-326.
- Vilhena, H. (1936), *O Professor Doutor Francisco Gomes Teixeira*. Lisboa: s.n.
- Yushkevich, A.P. (1968), *История математики в России до 1917 года (History of Mathematics in Russia to 1917)*. Moscow: Nauka.

