

## Not Lagging Behind Enlightened Europe: The Circulation of Natural Philosophy in Portugal

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**Abstract:** This article is about the circulation of modern science in Europe during the 18<sup>th</sup> century. Specifically, I focus on the works of two Portuguese science popularizers, Jesuit Inácio Monteiro and Oratorian Teodoro de Almeida, and identify some of the actors they recruited to make the new sciences available to the public. Then, I compare their work to that of science popularizers in other European countries, and show that, contrary to prevailing national stereotypes, Portugal was not lagging behind the rest of Enlightened Europe with respect to the dissemination of the new natural philosophy.

**Keywords:** public circulation of knowledge, Portuguese 18<sup>th</sup> century eclecticism, natural philosophy, scientific fact making

### INTRODUCTION

The Marquis of Pombal (1699-1782), prime minister of José I, claimed that the scientific backwardness into which the Portuguese found themselves in the middle of an otherwise Enlightened Europe resulted from a two-century long monopoly on education by the religious Orders. Purportedly, the resistance offered by Jesuits and Oratorians to the new trends in natural philosophy contributed to the perpetuation of an Aristotelian-Peripatetic philosophy of nature and of superstitious thinking in the country. Portuguese historians have already overturned this anticlerical perception of the relations between the new science and religious institutes of education. They show that Jesuits at the College of Arts in Coimbra had been negotiating with João V (and later with José I) to modernize science *curricula* at their schools since 1712, while Oratorians held public sessions on experimental philosophy at their Casa das Necessidades in Lisbon since the early 1730s. They also identify authors such as Manuel de Campos, Jacob

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de Castro Sarmiento, Inácio Monteiro, Bento de Moura Portugal, Isaac Sequeira Samuda, Luís Verney, Teodoro de Almeida, and Ribeiro Sanches, who at that time were producing texts on natural philosophy for the public or new *curricula* to help reform colleges and the University.

In this article, I go a few steps beyond what historians have done so far with the fate of modern science in Portugal during the 18<sup>th</sup> century. I reclassify the genre of the work done by a few Portuguese natural philosophers on behalf of modern science, and I look at the ways in which they established their own credibility by setting themselves up against the science of the Ancients. These steps are necessary. Even though current assessments of the writings of those men were pivotal to contravene national stereotypes about the scientific backwardness of Portugal during the Enlightenment, they have not shown that these works belong to a specific category of scientific “fact-making”, i.e., science popularizing. An analysis of these texts has to identify at least some of the “actors” - i.e., epistemological claims, literary genres, patrons, national pride, educated audiences, public need, relevance for sociability, competition with other countries – that took an active role in this “network of associations”. Here I follow in on the steps of Bruno Latour when he argues that studies in scientific fact-making are essential because they emphasize the “public representation” of science, as well as and the “alliances” which produce, legitimize, and disseminate it<sup>1</sup>.

Second, I follow a direction different from the usual historical reconstruction of what was happening in Portugal. The work by Portuguese eclectics on the popularization of science was not different from the popularizing works in the rest of Europe, and it was not isolated from them either. Yet, to my knowledge, no historian has compared books by Portuguese science popularizers of the 18<sup>th</sup> century with those written by science popularizers in other countries, for instance Germany, Italy, France, and England. My research demonstrates that the works produced by Europeans to make the new science accessible to the public were similar to each other in content,

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<sup>1</sup> Bruno Latour. 1999. *Pandora's Hope: Essays on the Reality of Science Studies*. Cambridge, MA: Harvard University Press. Public representation is an important category, since scientists “who had to travel the world to make (science) mobile, to convince colleagues to lay siege to ministers and boards of directors, now have to take care of their relations with another outside world of civilians: reporters, pundits, and the man and woman in the street”, p.105.

style, rhetorical methods, and mobilization techniques. Not only that, some Portuguese science popularizers were famous in other countries, which speaks to their importance in the context of the dissemination of modern science during the Enlightenment.

I start with a sketch of some of the features of science popularizing books by two eclectic natural philosophers, Jesuit Inácio Monteiro and Oratorian Teodoro de Almeida in order to identify some of the actors that they mobilized to make the case that they were responding to a public need. Then, I compare portions of their work with parts of works by other European science popularizers to show their overlapping features. I finish with a consideration on the motives that have led to the production of such a voluminous body of writing on behalf of science popularizers during the 18<sup>th</sup> century, and the expectations set up by the public with respect to its proper function and mode of dissemination.

#### THE POPULAR SCIENCE OF INÁCIO MONTEIRO AND TEODORO DE ALMEIDA

In 1754, three years before the Jesuits were expelled from Portugal by Pombal, Jesuit Inácio Monteiro (1724-1812) published the first of two «pocket» size volumes of the *Compêndio dos Elementos de Mathematica Necessários para os Estudos das Ciências Naturais e das Artes, para uso dos Estudantes Portugueses, e para servir de Introdução ao Estudo das Mathematicas aos Curiosos destas sciencias* (1754-1756) [*Compendium of the Elements of Mathematics Necessary for the Studies of Natural Sciences and the Arts, to be Used by Portuguese Students, and to serve as an Introduction to the Study of Mathematics to the Curious for those sciences*]<sup>2</sup>. According to him, he had used the «notes» which later became the *Compendium* to lecture on modern Mathematics at the Jesuit College of Arts in 1752 while he was still a student of Theology at the University of Coimbra. Monteiro is adamant that this “brief” introduction to the mathematical basis of modern physics is for students and the public alike (“Prólogo ao Leitor” in *Compêndio*, Tomo I). According to Monteiro, there were in Portugal two cultural gaps that the *Compendium* was going to fill. One gap was a lack of information accessible to the “studious” of the new

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<sup>2</sup> The expression “dois pequenos livros de bolso” to describe Monteiro’s *Compendium* is by Portuguese historian Banha de Andrade, in 1973 article “Inácio Monteiro e a evolução dos estudos nas aulas dos jesuítas de setecentos”, *Revista Portuguesa de Filosofia*, XXIX, 3.

sciences. The *Compendium* hardly needs justification. In fact, “one who is not alien to the Republic of Letters, but who knows the state of the sciences today in other Kingdoms of Europe as well as in our small Lusitania, does not need reasons to persuade oneself that (...) this work would be useful at all times (...) It consists in giving to all people studious of the natural sciences (...) enough instruction in almost all Mathematical matters, in a brief and clear style, one that does not bore the curious, nor needs the explanation of a Master, so that all can perfectly understand it.”<sup>3</sup> Second, the public education afforded by the *Compendium* is unique, because “there are no books necessary for these sciences in Portuguese language; which follows, that the infinite (number of the) curious, who have not studied foreign languages, where these matters are well written, see themselves obligated to be ignorant by necessity” (Rosendo 1998, 324).

Monteiro makes sure to point out in the “Prologue to the Reader” of the *Compendium*, he an eclectic and sides with the Moderns against the Ancients, because the science of the first supersedes that of the second. Contrary to the “idle subtleties of the entities of reason, the possibilities, and the chimeras” of the Peripatetics, which cannot be measured, “True physics” is based on the “study of nature by observation, where calculus and Geometry become the foundation of physical knowledge that makes the body of the Modern Philosophy of Descartes, Gassendi, and Newton”, and Boerhave. The importance of experimentalism is part of Monteiro’s argument in favor of the Moderns as well, and he quickly identifies the actors he uses to assert his belief. The truth of particular principles, he says, is “proven by the experiments of Torricello, Otho Guerike, Boile, Galileo, Paschal, Perrier, and other infinitude of great Physics of these times” (Rosendo 1998, 326-327). He also mobilizes the experimentalist and the instrumentalist components of the new sciences by adding at the end of each Tome multiple pages of folded appendixes with figures of experiments, machines, and scientific instruments such as the air pump and the microscope. As for the fields of science developed in the *Compendium*, they include Statics, Mechanics, Hydrostatic, Hydraulics, Optics, Catoptrics, Perspective, and Spherical Trigonometry (Astronomy) (Ibid., 329).

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<sup>3</sup> Inácio Monteiro, “Prólogo ao Leitor”, in *Compêndio dos Elementos de Matemática*, cited in Ana Isabel da Silva Rosendo. 1999. *Inácio Monteiro e o Ensino da Matemática em Portugal no século XVIII*. Master thesis. Braga: University of Minho, p.163.

A decade after the *Compendium*, Monteiro published another science popularizing book of “lessons in philosophy”, *De Philosophia Libera seu Eclectica Rationalis et Mechanica Sensuum* (1766), in seven volumes. This book is for people of his “Homeland”, for “young students in letters and arts”, and for his Superiors.<sup>4</sup> In the introduction, he makes the point that the remaining confusion on the minds of the Portuguese with respect to the epistemological value, or lack thereof, of the philosophical “Schools” available in Portugal at the time, makes the book essential. The confusion stems from the disagreement of the schools over what is the best natural philosophy. As he points in *Prefácio ao Leitor*, “some defend Aristotle at all costs; others prefer Aristotle and Epicurus (...); many (...) shake off the servile yoke of so many years and they make of Descartes the sole object of their delight (...)”. Still others, who are “worthy of the lineage and the talent of Descartes (...) took away from Newton many of his adepts and, even an entire nation; but there was no lack of people who, like Leibniz, made war to Newton, founding a new school” (Monteiro 1973, 318). While in the book Monteiro asserts he does not believe that any scientific theory can be completely true, he advises that the best is to accept that “what cannot be understood must be left to be resolved” later (Ibid., 320). Besides, he continues, reliable “Testimony” in physics does not come from mere opinion or from the Ancients with their “scholastic method” and “syllogisms” (Ibid., 321). Truth comes after careful calculus, measurement, “seeing, observing, performing experiments...analyzing the physical elements scrupulously, from experiments properly confirmed, by observation, and demonstration” (Ibid., 319). In a *Letter to the Portuguese Youth* [*À Juventude Portuguesa*], which he later added to the first edition of *De Philosophia Libera*, Monteiro offers to readers a synopsis of his lessons. The topics of the lessons include Elementary Geometry and History of Philosophy, General Physics, Mechanics, Hydrostatics, Astrophysics, Geographical Physics, etc. (Ibid., 314-315). He also guarantees in the *Letter* that students and the public alike can understand his explanation of these subjects without effort, and in the course of just three years.

Oratorian Teodoro de Almeida (1772-1804) wrote books on science for the public as well, including *Recreação Filosófica ou Diálogo*

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<sup>4</sup> Monteiro wrote the *Philosophia Libera* in Latin, probably with the intent of having it be adopted by foreign professors at the newly reformed University of Coimbra.

*sobre a Filosofia Natural, para instrução dos curiosos, que não frequentarão as aulas (1751-1800)* [*Philosophical Recreation or a Dialogue on Natural Philosophy, for the instruction of curious people, who did not frequent classes*]. In its “Dedication” to patron José I, Almeida explains that it has become fundamental to help the new sciences move from the private to the public arena. He acknowledges that modern science has already replaced the Ancient in Portugal. Therefore, he says, Modern natural philosophy, is no longer “hidden, solitary, and persecuted...(because) I see it trying again and again experiments, I see it manipulate Machines carefully, I see it consult the Laws of Mechanics, I see it finally form mathematical calculi” (Almeida 1758, 2-3). The problem, however, is that the new natural philosophy is only available to the Portuguese elite. While the educated public has attended traditional schools, to them “are hidden the marvels of nature...I see many ingenious minds, noble and sharp (...) following and venerating the errors that they have carried from birth” (Ibid., 6-7).

Like Monteiro, Almeida claims that the science inherited from the Ancients is for the most part the result of the “blind impetus of a vivid imagination”. The best knowledge comes from our “understanding” as it focuses on discovering “the hidden truth”. This is achieved not just by trusting “the light of reason”, but also by “searching (for it) with repeated strokes of experiments” (Ibid., 3). The public needs science books “in plain language”, not in Latin or in foreign languages, so that “all know what God made for all” (Ibid., 7-8). Almeida also adds to the 1758 edition of *Recreation* that the role of the books’ sessions is to “serve as a guide to those who want to see better the beauty of all creatures...(The book) will discourse on the entire world, because there are no other limits to the curiosity of the Philosopher, except those of the Universe”. This beauty of Nature can only be accessed in “good order, and (with) the natural method” of thinking – as we find in *Prólogo* (Ibid., 4). Similar to Monteiro’s self-assumed eclecticism, Almeida notes, “I will not limit myself to any school, nor will I follow blindly any particular author, but what I more sincerely understand, that is closer to the truth...” (Ibid., 9-10).

The first six volumes out of a total of ten of *Recreation* cover topics in philosophy, gravitation, geometry, the laws of motion and acceleration, centripetal and centrifugal forces, light, colors, reflection and refraction of sound and light, optics, “brutes”, natural history (botany, medicine), and the “machine of the world”. As with

Monteiro's *Compendium*, each volume of *Recreation* ends with three or four appendixes with graphs of scientific instruments, geometric and anatomical drawings, and drawings of men performing experiments in a laboratory setting, on land or at sea. The first and second volumes have graphs of machinery typical of 18<sup>th</sup> century laboratories, i.e., the air pump, levers, scales, lenses, inclined planes, geometrical figures, and experimental scenarios of different types. Almeida also appeals to detailed, clear, and "curious" experiments, which have been "repeated, and researched, by myself, or by the authors whom I cite" (Ibid., 8), i.e., Christian Wolff, Desaguliers, Nollet, Regnault, João Batista, etc. Almeida speaks of the epistemological value of experimentalism for natural knowledge with good reason, since he inherited from his mentor João Baptista the leadership of the public sessions on experimental science at the Oratorian Casa das Necessidades.

On the literary genre of *Recreation*, Almeida writes, "I chose to fashion this work by means of dialogue, because this seemed to me the best to accommodate the intelligence of those to whom I write, and besides it is less fastidious" (Ibid., 13). Most of the dialogues include three characters: Theodosio, who represents eclectic modern philosophy and the views of the "Newtonians", Silvio, who stands for the "Peripatetics", and Eugenio who, "without having been schooled, has a sharp engine, and an ardent desire of being instructed about the modern Philosophies", and in particular to know "what is that Science called Physics" (Ibid., 4-5). The book starts with a colloquial-style "Preliminary Discourse on the History of Philosophy", where Almeida summarizes humanity's scientific achievements from Ancient civilizations to the present. The encounters of the three interlocutors take place at the residence and in the gardens of Eugenio. Eugenio expresses his disappointment from not being able to understand arguments on modern science when he sits in at public conclusions at University, all delivered in Latin. He wants to be taught modern science to be able to understand those arguments, but he also wants to learn to be conversant in the new sciences so that, after he returns from work, he can "have fun with your conversations, and company" (Ibid., 2). Each session in *Recreation* corresponds to one afternoon (the first four volumes alone include a total of twenty), and each session starts with a summary of previous encounters of the interlocutors. Questions by Eugenio follow from each summary. Theodosio responds and, when necessary, demonstrates his modern views with experiments, to the curiosity and admiration of Eugenio. The explanations of Theodosio

are interspersed with questions and criticisms on the part of Silvio, who occasionally lectures on the poverty of modern science, and extols the respectability of peripatetic philosophy with the confidence of a seasoned professor.

Almeida published another science popularizing dialogue, the *Physico-Mathematicas* [*Physico-Mathematical Letters*] (1784-1799), in three volumes. This is a postscript to the first six volumes of *Recreation* (Simões et al. 1999, 22), to clarify assertions Almeida had made in earlier editions, as well as to revise the *Recreation's* sessions in light of new scientific advancements.<sup>5</sup> Volume I (1784) is on the elements of geometry and mechanics, volume II (1784) on mechanics, and volume III (1798) on electricity, magnetism, chemistry, the tides, the Newtonian *vacuum*, and the Lisbon earthquake. The *Letters* also include explanations of the systems of Galileo, Gassendi, Descartes, and Newton.

#### THE METHODOLOGICAL PROFILE OF THE SCIENCE POPULARIZER

The works by Portuguese science popularizers Monteiro and Almeida do not differ radically from each other. They mobilize the same actors to help them make their case for popularizing modern science: literary simplifications of modern science, patrons, epistemology, scientific instrumentation, identity of famous modern natural philosophers or that of other European popularizers, public need, and national pride. They were also markedly eclectic, Newtonian, and proto-experimental.

Examples of how the works of Monteiro and Almeida fit in with the methodological profiles and mobilizing techniques of other European science popularizers are plenty. Here I identify only a few of these works for comparison and influence. Earlier on in the century, there was, in Germany, Christian Wolff, *Anfangsgründe aller Mathematischen Wissenschaften* [*Basic Principles for all the Mathematical Sciences*] (1710). Wolff influenced Monteiro's choice of structure for the *Compendium*, and Monteiro mentions him throughout his entire work as an unsurpassed source of expertise in the new sciences.<sup>6</sup> In Portugal, there was João Batista de Castro, *Philosophia Aristotelica Restituta* (1737), a Gassendist and Cartesian who like

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<sup>5</sup> These editorial changes were not surprising, considering that Newton's science was only completely accepted by natural philosophers at the end of the 18<sup>th</sup> century.

<sup>6</sup> For more, see "As Influências de Christian Wolff sobre a Obra Matemática do Jesuíta Português Padre Inácio Monteiro", in eds. Luís Miguel Carolino and Carlos

Almeida valued experimentalism. Another author who influenced Monteiro was Voltaire, who in his science popularizing *Eléments de la philosophie de Neuton, mis à la portée de tout le monde* (Amsterdam, 1738)[*Elements of the philosophy of Newton, made for everyone*] attempted to simplify Newtonianism and replace Descartes in the popular imagination<sup>7</sup>.

In the 1750s, when Monteiro and Almeida were producing their work, there were also books for the French public by science popularizers such as Antoine Nollet, who Almeida mentions as well. In *Leçons de la physique expérimentale* (1754-1765)[*Lessons of experimental physics*], Nollet presents “an eclectic blend of various scientific theories” (Lynn 2002, 345). He advises that “It is not the physics of Descartes, nor of Newton, nor of Leibniz, that I propose particularly to follow, but without any personal preferences, and without any distinction; it is that which, by the general vogue, and by well attested facts, shall appear to me the best established”<sup>8</sup>. Another French science popularizer, Ferapie-Dufieu, explained that the purpose of his 1758 *Manuel physique, ou manière courte et facile d’expliquer les phénomènes de la nature* (1758)[*Physics manual, or a short and easy way to explain the phenomena of nature*] is to make modern science available to everyone in France. “The taste of physics is so spread out in the world today” he says, “that it seems necessary...to have at least a smattering of it”<sup>9</sup>.

Almeida also shares literary genre and intent with other European science popularizing books, such as the two-volume book in dialogue by Francesco Algarotti, *Il newtonianesimo per le dame ou veri dialoghi sopra la luce e i colori* (1730) [*Newtonianism for ladies, dialogues on light and colors*]. This book was “published without permission and with the forged imprint of Naples”, indexed in 1739, and published in its definitive version in 1752 (Mazzotti 2004, 127). Almeida’s

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Ziller Camenietzki. 2005. *Jesuitas: Ensino e Ciência, Séc. XVI-XVIII*. Lisbon: Caleidoscópio, pp.123-132.

<sup>7</sup> Translators were also important for the dissemination of modern science in Europe, such as Madame du Chatelêt and Jacob de Castro Sarmiento.

<sup>8</sup> Nollet. 1754-1765. *Leçons de physique expérimentale*, XVIII, vol. I. Amsterdam and Leipzig. Cited by Michael Lynn. 2002, “The Fashion for Physics: Public Lectures Courses in Enlightenment France”. *The Historian*, Volume 64, Issue 2, p.345.

<sup>9</sup> See Jean Ferapie-Dufieu, *Manuel Physique, ou manière courte et facile d’expliquer les phénomènes de la nature*, Paris, 1758. Cited in Michael Lynn, *op.cit.*, pp.335-336.

*Recreation* is more extensive in terms of breath of topics, since it offers dozens of afternoons of dialogues covering the whole of modern science, while Algarotti only covers the Newtonian optics in “six dialogues taking place on five consecutive days” (Ibid., 120). Almeida puts in dialogue a Newtonian physician, a Peripatetic professor, and an apprentice, while Algarotti’s is a dialogue of a Newtonian *cavaliere* with a *marchesa* (Ibid., 119), who is curious about light and, faced with alternatives, including Cartesian, ends up converting enthusiastically to Newtonianism. All else is analogous. Both Algarotti and Almeida overview the history of science from Ancient to current times; critique past doctrines in favor of the new; use simple terms to explain complex matters; and use easy experimental situations instead of just *theorica* to make of readers virtual witnesses. Their works were equally popular for decades. Almeida’s *Recreation*, for instance, was considered “one of the most read in the Iberian Peninsula...between c.1750 and c.1800” (Rodrigues 1994, 50). A contemporary of Almeida, Bernardo de Lima, extolled the virtues of this book for the Lisbon journal *Literary Gazette* (1762), a Government journal, and claimed that it “should be considered one of the best works published in Europe to instruct the youth on the study of physics” (cited in Rodrigues, 83).

There were other science popularizers and “best-sellers” later in the 18<sup>th</sup> century. Just to name a few, in Britain, B. Martin, *The Young Gentleman and Lady’s Philosophy, in a Continuing Survey of the Works of Nature and Art. By the Way of Dialogue* (London, 1759, in two volumes); J. Newberry, *The Newtonian System of Philosophy* (1761); and J. Ferguson, *The Young Gentleman and Lady’s Astronomy* (1768) (see Mazzotti, 131). These science popularizers show that the European public kept demanding this type of work throughout the whole century. Monteiro and Almeida, like Algarotti, Wolff, Nollet, and others, responded to this demand at the same pace and they mobilized the same methodological and epistemological actors as their European counterparts.

#### WHO WHERE THE SCIENCE POPULARIZERS AND WHAT THE PUBLIC NEEDED

The 18<sup>th</sup> century was a special century for the proliferation of science popularizers. Their work did not have to wait for the official incorporation of modern science into Universities, a process that was slow and protracted in spite of the acceptance of the new science by

the community of natural philosophers. Quite the contrary, at the beginning of the 1700s, science popularizers started disseminating modern science to the public with speed and efficiency. Furthermore, some professional science popularizers reached the highs of public fame, acclaim, prestige, and wealth. A case in point was Teodoro de Almeida, whose *Recreation* gained him entrance to the Royal Society.

As far as social standing, science popularizers were men and women, and amateurs or natural philosophers with expertise in modern science, and they were in competition with each other<sup>10</sup>. They were secular people, secular clergy, or members of Christian religious orders. Some of them were doing popularizing work in their own countries, at salons, some were doing it from exile in convents, others were writing books expressly as complements to their own lectures in modern experimentalism, while a few travelled in Europe to reach a wider paying audience<sup>11</sup>. Some of them were doing several of these things simultaneously.

The reason for this movement was that the European public had taken a fascination to the new physics, optics astronomy, optics, natural history, anatomy, etc. People wanted to get hold of works that allowed them easy access to those fashionable scientific topics. The public required that those books be in the vernacular, as well as in clear and preferably in non-mathematical language, because people were not conversant in Latin or, even though literate, they had not attended college. If they had attended college, they still could not build bridges between incommensurable scientific worldviews, Ancient and Modern.

Even though the public was eager to learn the basics of the modern natural philosophy, and they wanted this information to come from intellectuals with obvious expertise in the field, they did not want to learn science for its own sake. Instead, they wanted to use the new science to engage in leisurely social conversation; bypass college; not feel “lost” while attending public «conclusions» at universities or the scientific academies; as a source of entertainment; and, in many cases,

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<sup>10</sup> Examples of women science popularizers Madame du Chatelêt, who translated Newton’s work from Latin into French with great acclaim, and the Marquesa de Alorna, who wrote poetry on the new science. Given that the professionalization of the scientist only developed a century later, technically all science experts were amateurs.

<sup>11</sup> There were also those who popularized modern science in public lectures and experimental sessions. Teodoro de Almeida was a case in point.

to use them as complements to lectures and experimental sessions they were paying to attend.

## CONCLUSION

This article shows that Portugal was not lagging behind the rest of Enlightened Europe in the popularization of the new sciences. The works of natural philosophers and science popularizers such as Inácio Monteiro and Teodoro de Almeida were similar to works by popularizers such as Algarotti, Voltaire, and Nollet. More research is needed on the role played by science popularizers on the dissemination of modern science in Portugal, as well as a comparison between works of the Portuguese and those of other European science popularizers. But I hope that this article helps initiate a more symmetrical historiography of the science.

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