LITERATURE REVIEW

The “empirical turn” in the historiography of the Iberian and Atlantic science in the early modern world: from cosmography and navigation to ethnography, natural history, and medicine

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ABSTRACT
This essay-review carries out a bibliographic review of the most representative publications in the field of the history of Iberian science and the Atlantic world of the last decade, with special emphasis on cosmography, navigation and cartography, but also in the field of medicine, pharmacopoeia, natural history, and ethnography. To do so, I start examining six of the most recent books published in English, Spanish and Portuguese, without forgetting to refer to some books published in the last two decades that have somehow marked the course of the new history of the Ibero-Atlantic science. As an interpretive contribution, it is suggested that one of the points of convergence of all these studies is what we could call an empirical turn in knowledge, that is, that the diverse scientific cultures that emerged in the Ibero-Atlantic world were eminently practical cultures, and that these cultures were a constituent part of modern Europe and science.

A “viragem empírica” na historiografia da ciência ibérica e atlântica do mundo moderno: da cosmografia e a navegação à etnografia, a história natural e a medicina

RESUMO
Este artigo leva a cabo uma revisão bibliográfica das publicações mais representativas no campo da história da ciência Ibérica e do mundo atlântico na última década, com especial ênfase na cosmografia, navegação e cartografia, mas também no campo da medicina, farmacopéia, história natural e etnografia. Para fazer isso, eu tomo como ponto de partida o exame de seis livros recentes publicados em Inglês, Espanhol e Português sem deixar de me referir a alguns livros publicados nas últimas duas décadas e que de alguma forma marcaram a trajetória da nova história da ciência ibero-atlântica. Como contribuição interpretativa é sugerido que um dos pontos de confluência de todos esses estudos é o que podemos chamar uma viragem empírica no conhecimento, isto é, que as diversas culturas científicas surgidas no mundo ibero-atlântico eram culturas eminentemente práticas,

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El “giro empírico” en la historiografía de la ciencia ibérica y atlántica del mundo moderno: de la cosmografía y la navegación a la etnografía, la historia natural y la medicina

RESUMEN
Este ensayo-reseña lleva a cabo una revisión bibliográfica de las publicaciones más representativas en el ámbito de la historia de la ciencia ibérica y del mundo atlántico de la última década, con especial énfasis en la cosmografía, la navegación y la cartografía, pero también en el campo de la medicina, la farmacopea, la historia natural y la etnografía. Para ello, parto del examen de seis de los libros más recientes publicados en inglés, español y portugués sin dejar por ello de remitirme a algunos libros publicados en las últimas dos décadas y que de alguna manera han marcado el rumbo de la nueva historia de la ciencia ibero-atlántica. Como aporte interpretativo se sugiere que uno de los puntos de confluencia de todos estos estudios es lo que podríamos denominar un giro empírico en el conocimiento, esto es, que las diversas culturas científicas surgidas en el mundo ibero-atlántico fueron culturas eminentemente prácticas, y que esas culturas también formaban parte constitutiva de la Europa y de la ciencia modernas.

1. Iberian science in the history of science

In the last two decades, we have witnessed a rebirth of the Iberian studies of science, or what can simply be called “Iberian science.” Why? What are the reasons that have led to a proliferation of works on scientific and technological developments in the context of the Iberian monarchies and their colonial empires? And what is even more important, what do these studies teach us and what impact do they have on the history of early modern science, if any? The most obvious answer to the first group of questions is one that refers to the disciplinary transformations that occurred in the field of history and philosophy of science, from the sixties onwards. What we call the historicist and sociological turns not only taught us the limits of an intellectual and internalist history of science based on an a-historical and unchanging rationality, but also opened the door to the consideration of social, economic, institutional, and cultural aspects traditionally excluded from the field of knowledge. The new history of science was a history of practices with new subjects (women, artisans, instrument makers, healers, etc.) and with new epistemological communities (indigenous, illiterate navigators, missionaries, etc.) that worked in new spaces of knowledge interacting with a broad material culture. These transformations seem to have allowed not only exploring new ways of producing knowledge, but also the revision of old topics, with new eyes. In short, we could say that the various transformations that science studies underwent during the second half of the twentieth-century created the necessary conditions for the birth and rebirth of various topics, including Iberian science.
However, there may be other more specific reasons, such as historiographical ones. One of them is the fact that the history of science has progressively ceased to be a Eurocentric story, that is, the dominant narratives about the achievements of the Scientific Revolution have been strongly questioned (see David N. Livingstone, *Putting Science in its Place*, 2003; and Kapil Raj, *Relocating Modern Science*, 2006). The geographical reductionism and the chronological displacement of the Great Narrative has prevented other non-Anglo-Saxon or Central European interlocutors and traditions from participating in the debate about scientific modernity. Furthermore, and probably as a consequence of that decentralization of early modern science, historians – especially in the Iberian world – seem to have definitively emancipated themselves from the prejudices and historiographical constrictions put into circulation by Protestant and Enlightened narratives, while countering the perceived Iberian superstition, backwardness, irrationality, and intolerance, as well as its barbarism, ferocity, secrecy, and imperialist control. To this end, explicit desires have emerged to overcome such obstacles by going, for example, “beyond the Black Legend,” (see Navarro and Eamon 2007). Additionally, and without the need to return to the ghosts of the past, some collective works placed the relationship between science and empire in a new dimension: the Atlantic world. This is the case of Delbourge and Dew (2008), Bleichmar et al. (2009), and Bleichmar and Mancall (2013). The Black Legend seems to have come to an end. Three special issues of the journals *Early Science and Medicine* (2016), *History of Science* (2017), and *Centaurus* (2018) have recently revisited the subject to confirm its death certificate, or at least to rethink and to redirect some of the main questions.

Aside from the disciplinary transformations and historiographic problems, it is even possible to refer to a less intellectual reason, and to more pragmatic and functional ones. It is a matter of internationalization and, therefore, visibility of the field because of the North American institutional and university reality. Beyond Portuguese, Spanish, and Latin American authors of recognized prestige – such as Henrique Leitão (Portugal), Palmira Fontes da Costa (Portugal), Marcos Cueto (Peru), Júnia Ferreira Furtado (Brazil), Mauricio Nieto (Colombia), Juan José Saldaña (Mexico), Mauricio Sánchez Menchero (Mexico), Juan Pimentel (Spain), José Pardo-Tomás (Spain), María Luz López Terrada (Spain), and Jesús Bustamante (Spain) among others – who work in Portuguese, Spanish, and Latin American universities or research centers, in the last two decades the Iberian studies of science have been associated with names of Hispanic origin – such as Jorge Cañizares-Esguerra, Antonio Barrera-Osorio, María Portuondo, Ricardo Padrón, Daniela Bleichmar, Nicolás Wey Gómez, Pablo F. Gómez, and Vera Candiani, to name just a few – who work in North American universities. There are notable exceptions, such as William Eamon, Ralph Bauer, John Slater, Paula de Vos, and more recently Arndt Brendecke and Hugh Cagle, since none of them is of Hispanic origin. In any case, the social reality of the USA and the intellectual hegemony of the Anglo-Saxon academic world on the international scene have created and legitimated an ideal space for new generations of researchers to carry out historical studies on aspects related to their linguistic-cultural identity. Thus, considering all these factors, Jorge Cañizares-Esguerra gave the starting shot at the beginning of the new millennium with a new question in the form of a book – *How to Write the History of the New World* (2001). This difficult question seemed to presage a new era in the Ibero-Atlantic studies of science, and it has. Historians have responded to this interrogation in very different and interesting ways.
The interrelation of all these features has given rise to remarkable works that have encouraged the area. These works have not only provided new empirical evidence from an intense archival research, but have also introduced new analytical categories that are illuminating modernity in general and the history of Iberian science in particular. The research topics of historians encompass now a wide and rich variety of concerns, among which are explanations about the conformation of global empires sustained by complex long-distance maritime networks; the emergence of empirical practices and new groups of practitioners associated with the Atlantic world; the elaboration of new mechanisms of production, management, and circulation of knowledge for colonial control and domination; hybridization and epistemic interaction between forms of indigenous knowledge and metropolitan imperial projects; or the re-evaluation of the notions of testimony, authority, and credibility in light of this new context. This kind of questions guides the analysis of old areas of practical knowledge such as navigation, cosmography, cartography, shipbuilding, pharmacopoeia, medicine, natural history, and ethnology. In the following, some of the most recent works in this field will be examined, as well as some of the most influential publications of the last decade.

Far from carrying out an exhaustive bibliographical and historiographic review of the history of early modern science in the Ibero-American world, I have selected a specific literature on some precise aspects of the history of Ibero-Atlantic science. I am perfectly aware that there is a wide and growing literature in this field and that this decision requires leaving aside certain lines of research that are equally important, and therefore are subject of another essay. A notable example is the work that Latin American authors are carrying out, mostly in Spanish, from the perspective of local medical knowledge and indigenous therapeutic practices, without excluding the fields of astronomy, mathematics and even technology – agriculture, architecture (temples and construction materials), mining, engineering and hydraulic works (mills, dams, and canals), military technology and nautical technology. A relevant debate in this respect that deserves more attention is the role that non-European indigenous communities (Americans, Africans and from the Southeast Asian region) occupied in the emergence of early modern science.

These works are being especially prolific in countries like Mexico, where a group of historians has been contributing for years to our understanding of native knowledge and its interaction with other traditions, both of the Hispanic and pre-Hispanic periods. Again, an attempt to carry out an exhaustive examination of this bibliography would take us too long. It is, however, necessary to mention some of the

1For a history of science in Latin America from a social perspective see Saldaña (1996). This book was subsequently translated into English with the title Science in Latin America: A History. Originally in English, the two oldest texts of Thomas P. Glick, “Science and Independence in Latin America” (1991) and “History of Science in Latin America” (1992), can be consulted. In Spanish, see also Azuela and Rodríguez-Sala (2013). Also, it is worth highlighting three periodicals among some others, the Brazilian journal História, Ciências, Saúde – Manguinhos (that publishes articles mostly in Portuguese), the Mexican Quipu, Revista Latinoamericana de Historia de las Ciencias y la Tecnología (that publishes articles mostly in Spanish), and more sporadically the Colombian Historia Crítica (that publishes articles mostly in Spanish). In a more international context, prestigious authors such as Marcos Cueto and Jorge Cañizares-Esguerra are doing an important historiographic work in English in their attempt to include Latin American science within the broader perspective of non-Western scientific traditions. This work has the advantage of overcoming the limitations of the language, thus allowing the study of the history of Latin American science to reach a wider audience. See for example the resources on Latin America made available by The History of Science Society, https://hssonline.org/resources/teaching/teaching_nonwestern/teaching_nonwestern_latin/.

2Some approximations to these topics are found in the purely dissemination plane as for example Tamayo (2010).
most representative names and works. For the Aztec and Mayan, the most explored cultures, we must mention among others the work of Alfredo López Austin on Mesoamerican indigenous cosmovisions and Carlos Viesca Treviño on Náhuatl medicine. Also the astroarchaeological studies on pre-Hispanic Mesoamerican traditions have given fantastic results, as highlighted by the most recent works of Jesús Galindo Trejo. For the Hispanic era, the panorama is wider and heterogeneous, but there is no doubt that the fields of natural history and medicine have been the most studied. Some recent collective publications make it clear, as for example Köppen and Sánchez Menchero (2013); Pardo-Tomás and Sánchez Menchero (2014); and Morales Sarabia, Pardo-Tomás and Sánchez Menchero (2017).

Since the first years of the twenty-first century, some authors have drawn attention to two closely related aspects that, according to them, have especially affected studies on Iberian science. Firstly, marginalization, how the dominant narratives on modern science subjected the rest of the world, whether for geographical, ideological or purely intellectual reasons. In Nature, Empire, and Nation: Explorations of the History of Science in the Iberian World (2006), Jorge Cañizares-Esguerra argued that the fact that the Anglo-American academic tendencies remained blind to the Iberian origins of modernity has to do, in part, with the manuscript culture of the Spanish empire, which fostered a tradition of state secrecy and kept interesting works hidden in the archives, unavailable to other Europeans or to collective historical memory. Furthermore, Cañizares-Esguerra attributed the traditional marginality of Spain and Portugal to two main reasons. On the one hand, the kind of science promoted by the Spanish and Portuguese states – cartography, navigation or natural history – was considered peripheral within the framework of the Scientific Revolution. On the other hand, the narratives of modernity inaugurated first by Protestantism and later by the Enlightenment were deeply hostile to Catholic Iberia. The triumph of reason and the experience of the European Enlightenment over dogma and faith directly relegated the contributions of Spain and Portugal to the margins. This phenomenon is even more dramatic in the case of Latin America.

Secondly, it is necessary to consider the tendency of these same narratives to impose, sometimes unconsciously, their own analytical categories to different historical realities. The fact that certain categories are valid when explaining the emergence of a new natural philosophy of an experimental nature in the seventeenth century does not mean that they are universal categories applicable to any local context. If it were so, a question as apparently innocent as “who could be considered modern?” could be entirely misleading. If being modern meant looking through a telescope or performing an experiment repeatedly and systematically in an artificial environment, then the answer seems undeniable. Instead, if being modern was also going around the world, using an astrolabe or modifying the food life of Europeans, then modern was not just a small group of experimental mathematicians. Was not Magellan one of these moderns? Was not his trip around the world – which is currently commemorating five hundred years – a journey of science? Does experimentation, mastery, and control of nature through science and technology, exploration of the natural world, trade, control of new territories and their people or religious conversion, derive from the values of modern science?

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3 On this issue see Cañizares-Esguerra (2017).
2. Cosmography and navigation

Some recent works have responded directly or indirectly to these issues. A notable example is Arndt Brendecke’s book, *The Empirical Empire: Spanish Colonial Rule and the Politics of Knowledge* (2016) originally published in German in 2009, and then in Spanish in 2012. Brendecke carries out a very rigorous, well documented and conceptually very solid historical study. His approach to the understanding of the Spanish empire from political and legal thought is very enriching for the history of early modern science. In what could be interpreted as an attempt to respond to the famous question of the enlightened Frenchman Nicolas Masson de Morvilliers in the entry “Espagne” of the *Encyclopédie méthodique* (1782) “What is due to Spain?”, Brendecke wonders what modern empirical knowledge owes to the Spanish empire – the political notion of empire and empirical knowledge, two typically European forms of domination of the sixteenth and seventeenth centuries. His main thesis revolves around the idea that the cognitive processes that supported the European maritime expansion represent the basis of the empirical culture of modernity. For this, instead of following the idealist Baconian program of building a new experimental philosophy based on the control and mastery of nature through science and technology, Brendecke historically reconstructs that process of domination from the relationship established between colonial domination at a distance and the use of knowledge. In other words, Brendecke analyses the mechanisms that were behind the body of knowledge generated by the new political-legal culture of colonial expansion – new laws, knowledge by questionnaire, etc. He is interested in the systematic recording of empirical knowledge, as well as in the methods and means created for that purpose. Brendecke introduces the notion of “epistemic setting,” an analytical category based on written culture that allows him to explore the information system put into circulation by the monarchical administration to obtain credible knowledge of far-flung places and realities. It is an information system based on written communication and knowledge, a non-hedonistic knowledge, but a knowledge for control purposes. Implicitly, Brendecke attributes to early modern science a strongly empirical character, a character that began to be forged in the sixteenth century.

With this new and original claim to the role that empirical culture and practical knowledge occupied in the early modern world, Brendecke seems to follow the path initiated, first, by Antonio Barrera-Osorio’s pioneering work, and then followed by authors such as Alison D. Sandman, and even Eric H. Ash. The latter sets forth in his *Power, Knowledge, and Expertise in Elizabethan England* (2004) the role that technical experts played within the English Crown during the second half of the sixteenth century. In his *Experiencing Nature* (2006) Barrera-Osorio revealed how the maritime, imperialistic, bureaucratic, and commercial culture of the Atlantic world gave rise to the institutionalization of a new empiricism, new empirical practices related to ocean navigation, the realization of maps, and the collection of information about the natural American world – minerals, tropical products, medicinal plants, etc. This new empirical culture was based, according to Barrera-Osorio, on individual inquiries into the study of nature and the exploration of new territory. That same individual process of observing, experimenting, and representing had for Barrera-Osorio two significant consequences in the early modern world. On the one hand, imperialist desires to discipline and institutionalize experience displaced the hegemony that natural Aristotelian philosophy and classical narratives had about
the study of nature. On the other hand, those same desires and the vicissitudes of the
Atlantic world accelerated the mechanisms of transformation and exploitation of nature
several decades before Francis Bacon marked the empiricist course of the Royal Society
and the Newtonian drifts of the Scientific Revolution.

Given the new empirical universe that seemed to open up the Atlantic world, Alison
Sandman (2001) analyzed in the same institutional-type environment – the Casa de la
Contratación in Seville – an old dichotomy, practical knowledge versus theoretical
knowledge, but this time broken into two groups of new practitioners, pilots and cos-
mographers, representatives of the empiric and proponents of the theory. From the
Spanish case (basically during the reign of Charles V), Sandman tries to answer the
question about the usefulness of science, that is, how the State could use science
for its interests and vice versa, what role science played in the construction of
modern forms of State. For this, Sandman rigorously describes how a group of cosmo-
graphers understood and appropriated the idea of utility to control the practical world
of navigation, modifying the practices of pilots during their travels and favoring theor-
etical knowledge, knowledge that only they possessed. According to the cosmogra-
phers, only the rules of universal knowledge such as astronomy would allow for the
correct location of geographical coordinates and the most accurate cartographic rep-
resentations. Sandman illustrates how diplomatic-political tensions regarding territorial
sovereignty, such as the dispute over the Moluccas or debates about safe navigation,
were decisive in convincing the king of the usefulness of science and, consequently, of
the need to create institutions sponsored by the State in order to apply theoretical
knowledge to practical ends.

Like Sandman and Barrera-Osorio, other subsequent studies have highlighted the role
of cosmography and navigation in the context of the Spanish empire. One of them is The
Tropics of Empire (2008) by Nicolás Wey Gómez. In this book, Wey Gómez returns to a
classic topic, the voyages of Columbus, but with a radically original and unexpected
interpretation. The author spins 360° the historiographical debates about the Columbian
venture and its desires to reach the east sailing towards the West. Wey Gómez reconstructs
the practical and ideological roots of Columbus’ travels and his worldview not in East–West
terms, but in North–South terms. The novelty of this work lies in formulating the question
in a different way, why didn’t Columbus sail only to the West, but instead sailed also and
especially to the South? According to Wey Gómez, this look at the Columbian company
is more enlightening from a cosmographical point of view and from the expansionist
perspective that followed. In short, Wey Gómez’s book seeks arguments in classical anti-
quity and in the medieval period, as well as in Americanist historiography and in the
biography of the famous navigator, to suggest that Columbus was an “ancient” who
made modern accomplishments. Also in 2008, a book came out which exceeds the
chronological limits of this essay, but that deserves a special mention, Measuring the
New World: Enlightenment Science and South America, by Neil Saifer. The virtue of this
book is that it manages to Americanize one of the great topics of the history of
science and, without doubt, the great European debate of the eighteenth century,
the geodesic polemic between Cartesians and Newtonians on the shape of the Earth.
Part of that controversy would be solved on South American soil and that new
context would affect, according to Saifer’s thesis, the 1735 expedition to the Viceroyalty
of Peru, led by La Condamine.
Another of these works is *Secret Science* (2009) by Maria Portuondo, which in this case also returns to an old problem, the secret nature of some of the Spanish monarchy’s greatest scientific projects relating to the New World, especially under the reign of Philip II. According to the author, this secrecy has made early modern Spanish science invisible. Portuondo starts, like Sandman, from the assumption that scientific activities were never independent of the administrative needs of the Spanish empire and, therefore, agreeing with Sandman, maintains that this relationship occurred in a utilitarian context. Personal aspirations that did not serve the requirements of the monarchy were either subordinated to the interest of the State or, otherwise, were abandoned. Portuondo’s book features the work of some of the most important cosmographers of the sixteenth century – such as Alonso de Santa Cruz, Juan López de Velasco, Juan Bautista Gesio, and Andrés García de Céspedes – and the “cosmographic styles” developed in three new spaces: the Casa de la Contratación, the Council of the Indies, and the Royal Court. Portuondo shows how, in the field of cosmography, the utilitarian demands of the empire had little or nothing to do with speculative natural philosophy, but with the creation of inventories of the real, visible and tangible world. Aristotelian natural philosophy had little place in a system of patronage solely concerned with the benefits of practical outcomes. Far from a causal analysis of the phenomena observed, the cosmographers directed their efforts towards the identification and organization of useful knowledge for the benefit of the empire and not towards the revelation of the secrets of nature. In the same way, these cosmographers did not need to align themselves *stricto sensu*, according to Portuondo, with a new Baconian natural philosophy to explain the new American reality.

Portuondo’s book is presented as the perfect thematic and chronological complement of Sandman’s work, offering a renewed image of the Spanish cosmography of the sixteenth century. Before them, other classics’ works, such as those of María Isabel Vicente Maroto and Mariano Esteban Piñeiro (1991), Ursula Lamb (1995), and William Randles (2000), marked the way. Both Sandman and Portuondo, and to a lesser extent Barrera-Osorio and Wey Gómez, logically flirt with the history of cartography, but without entering it. Some relatively recent works that could be included in this extensive essay-review have dealt more with this aspect. Among them we can mention Barbara Mundy (1996), Ricardo Padrón (2004), Alessandra Russo (2005), Antonio Sánchez (2013) and José M. García Redondo (2018), among others. Although from different perspectives and geographies, they all give voice to maps, nautical charts and, in general, to the different forms of cartographic representation in the context of the European maritime expansion and the New World. Under the influence of the historians of cartography John Brian Harley and David Woodward, and his rereading of the new nature of the maps, Mundy carried out an up-to-date canonical study about the pinturas (maps) of the Relaciones Geográficas de Indias in his *The Mapping of New Spain: Indigenous Cartography and the Maps of the Relaciones Geográficas*. Mundy’s book overcame the limitations imposed by interpreting the maps of the Relaciones in terms of natives and Europeans, and opened a new line of research on the Mesoamerican indigenous reality that is ever evolving. That work has to some extent been continued by Russo in his *El realismo circular* – and more recently (although from a more political and artistic perspective) by Angélica J. Afanador-Pujol in her *The Relación de Michoacán (1539–1541) and the Politics of Representation in Colonial Mexico* (2015). In this book Russo interprets the pinturas of the
Relaciones as the interaction between a rich and extensive cosmographic corpus represented by what she calls mesoamerican stones-maps, European topographic representations, and medieval maps of the Christian tradition; the circular notion that New-Hispanics had of space; and their realistic method of representing the environment. In other words, Russo considers the maps of the Relaciones as products of a realistic and circular vision of different forms of representation adapted by New Mexicans. A new book by Mundy – The Death of Aztec Tenochtitlan, the Life of Mexico City (2015) – highlights the role that the Nahua culture played in the architectural and technological image of Mexico City, ancient Tenochtitlan.

From a literature perspective, Padrón traces in The Spacious Word an intellectual history of Spanish exploration and conquest via the relationship between science, literature and power; or to put it more precisely, between the geography of the New World, the narrative representations of space, and a conquering empire. The metageographies or the literary interpretations of the New World with a cartographic dimension of Martín Fernández de Enciso, Hemán Cortés, Francisco López de Gómara, Gonzalo Fernández de Oviedo, Bartolomé de las Casas, and Alonso de Ercilla y Zúñiga, among others, invented a new geography in the imagination of the readers. In other words, they allowed the discoverers to imagine a new place through an inherited understanding based on the old idea of the medieval space. According to Padrón, this cartography coming in the form of texts, be they voyages itineraries, epic poems or chronicles, forged the idea of a conquering empire. More recently, Sánchez has attempted in his La Espada, la Cruz and el Padrón (2013) to reconstruct the history of the Royal Pattern Chart of the Casa de la Contratación (from approximately 1508–1606), with particular focus on three historical problems: one of a diplomatic nature – Spanish-Portuguese tensions – another technical – the Padrón Real as a hybrid artifact that gives an overview of the meeting of different but complementary cartographic traditions (portulan, Portuguese and Ptolemaic) – and another imperialist – the Padrón as a product of a Habsburg vision of the world. For his part, García Redondo returns to this in his recently published Cartografía e Imperio. El Padrón Real y la representación del Nuevo Mundo (2018). But this time, the Royal Pattern Chart is understood as being not only a single master nautical chart, but as a “compound system,” a hybrid machinery for the collection and presentation of nautical knowledge, as both written and visual, at the service of Spanish navigations. Thus, the courses and nautical descriptions are considered as a fundamental part of the Padrón system. Furthermore, addressing the concept of representations, a projection of great immensity can be traced abstractly from the lines drawn on the map: a cartographic meta-structure, independent of the Ptolemaic coordinate lines that expanded and ordered the world during the Era of the Discoveries.

In 2013, Las máquinas del imperio y el reino de Dios, by Mauricio Nieto, was published in Spanish. It is a new look at the Iberian-Atlantic world. Nieto introduced a new element in the debate, the religious aspect, providing a providential value for our understanding of the sixteenth-century Atlantic world. The work of Nieto can be interpreted as a response to the need that Iberian studies of science have for theoretical reflection of a sociological nature, which encourages the expansion of the field. Contrary to what the subtitle of the work indicates, it is not only a reflection on science, technology and religion, but also an exploration of the relations between knowledge and empire and, above all, a study on the origins of modernity. In other words, Nieto delineates
the reasons that led to “the consolidation of a Christian empire of global pretensions and the formation of a new world order centred on Western Europe.” With acidic and insightful prose, Nieto understands European maritime exploration in general, and the Spanish Catholic imperial state in particular, as a global scientific and technological project, in the service of both the monarch and Divine Providence. In that sense, he refuses to refer to the conquest in terms of discovery, encounter or invention and does so in postmodern terms of “understanding the New World,” namely, explaining how certain scientific practices turned the unfamiliar into the every day. Hence, the impossibility of separating the story of the history of the sciences from the one that tells the political history of modern Europe. According to Nieto, technological practices were constitutive parts of imperial power and not mere tools. Only in this way should the machines of the empire be understood, as artifacts that developed their functions in the hybrid kingdom of God. Nieto analyses these machines in light of the actor-network sociological theory used by John Law in his interpretation of the Portuguese empire, that is, as part of remote control systems and not as means to an end.

_Las máquinas del imperio_ is a book on the establishment of norms that would regulate the organization of information and experience, on the implementation of stable codes of observation, and on the standardization of data and measurements. However, it is also a book about pilots, cartographers, cosmographers, naturalists, travelers, merchants, and princes; and decidedly about regulations, sails, ships, maps, navigation treatises, astrolabes, plants, and animals. Furthermore, it is about the questioning of the ancients, the articulation of complex networks of information circulation, Iberian strategies for the domestication of the American natural world, and the processes of understanding of the New World, not only construed as mechanisms of appropriation of nature, but in particular as instruments for translation and appropriation of native knowledge. It also contains extremely atypical ingredients, such as considering how Portugal fits in the shaping of this story; interesting reflections on navigation treatises, ships, and nautical instruments; the role of indigenous traditions; a meticulous description of the crew that undertook a voyage to the Indies; and more especially, a compelling explanation about life on board. The place from where Nieto writes – Los Andes, Colombia, Bogota – confers on his narrative a different and unique vision.

### 3. The Atlanticization and globalization of Iberian science: medical cultures and natural history

If something is evident in this history, it is the progressive process of Atlanticization of Iberian science. That is, the appeal that the new history of the Atlantic world developed by authors like Bernard Bailyn (2005; and 2009, in collaboration with Patricia L. Renault), Jorge Cañizares-Esguerra and Erik Seeman (2006), Jack P. Greene and Philip D. Morgan (2009), and Thomas Benjamin (2009), among others, has brought to the history of Ibero-Atlantic science. As outlined so far, this influence has been noted in recent works on cosmography, cartography, and navigation, but also on natural history, botany, pharmacopoeia, medicine, alchemy and, in general, the various scientific practices conformed in the cultural laboratory of the Atlantic world. Studies on early modern natural history, especially those devoted to the visual culture of science, have been one of the most prolific areas of recent years. Some of the first attempts to build a new Atlantic history
of colonial nature were the works of Londa Schiebinger, *Plants and Empire: Colonial Bioprospecting in the Atlantic World* (2004). In collaboration with Claudia Swan, she then published a collective volume, *Colonial Botany: Science, Commerce, and Politics in the Early Modern World* (2005). In this book, the reader will find two chapters dedicated to Spanish colonial botany, one by Jorge Cañizares-Esguerra on the ecological sensibilities of Humboldt, and another by Antonio Lafuente and Nuria Valverde on the influence of Linean botany on the biopolitical policies of the Spanish empire. In this area, we must highlight the work of authors with long careers such as José Pardo-Tomás and Juan Pimentel, but also a new generation of historians like José Ramón Marcada – author of an award-winning book, *Arte y ciencia en el Barroco español: historia natural, coleccionismo y cultura visual* (2014) – Emma Sallent Del Colombo, and Iris Montero Sobrevilla, among others. One of the most original and celebrated works has been *El rinoceronte y el megaterio. Un ensayo de morfología histórica* (2010) by Juan Pimentel, recently translated into English with the title *The Rhinoceros and the Megatherium: An Essay in Natural History*. As its title indicates, Pimentel’s book intertwines the life story of two natural objects that surpass the limits of the Atlantic world. Pimentel tells the story of Ganda, the exotic rhinoceros, and its long and tragic journey from India to Portugal in the early years of the sixteenth century, to the delight of King Manuel I of Portugal. Dürer would go on to reimagine that same rhinoceros in his iconic woodcut of 1515, as so too did Francisco de Arruda – who probably saw it in Lisbon – who sculpted the animal in the Torre de Belém (Belém Tower). The history of the rhinoceros maintains some parallels with another later history, that of the megatherium, which traveled from Argentina to Madrid at the end of the eighteenth century. The great ground sloth would attract the attention of the French naturalist Georges Cuvier, who analyzed it in his studies of anatomy and paleontology. Pimentel turns two apparently unrelated stories into an excellent account regarding the veracity of the images and our imagination in creating a reliable understanding of distant natural worlds.

Although they exceed the thematic scope of this literature review, it is worth noting that medical studies in this context have brought about an interest and impetus in this area. Some recent books stand out. Among them are the collective volume edited by John Slater, Maríaluz López-Terrada, and José Pardo-Tomás, *Medical Cultures of the Early Modern Spanish Empire* (2014); *The Andean Wonder Drug: Cinchona Bark and Imperial Science in the Spanish Atlantic, 1630–1800* (2016) by Matthew Crawford; and *The Experiential Caribbean: Creating Knowledge and Healing in the Early Modern Atlantic World* (2017) by Pablo F. Gómez. In short, the first of them brings into dialogue the diverse medical cultures of modern Spain with the local medical cultures reached by the arteries of the empire. The second reconstructs the difficulties encountered by the Spanish Crown when it came to imposing its political and commercial control over the production of cinchona bark in Quito, which was the basis of quinine, an antimalarial. The third deals with the healing practices developed by the Caribbean communities of black Atlantic healers, a type of empirical knowledge based on direct sensory experience that was genuinely autonomous and independent of any modern and European medical corpus or dogma. Other recent works halfway between natural history and medical culture deserve a mention, such as *The Globalization of Knowledge in the Iberian Colonial World* (2016) edited by Helge Wendt and *Secret Cures of Slaves: People, Plants, and Medicine in the Eighteenth-Century Atlantic World* (2017) by Londa Schiebinger. All of them deserve a thorough and in-depth read more than just a mere mention. The same goes for
studies on alchemy, an area where authors such as Ralph Bauer and Paula de Vos predict a promising future.

This Ibero-Atlantic history far from reaching its end seems to be taking promising interpretative paths. The last collective book edited by Jorge Cañizares-Esguerra, *Entangled Empires: The Anglo-Iberian Atlantic, 1500–1830* (2018) is evidence of this reality. Instead of establishing obsolete comparisons in terms of priority and imitation among the empires of the Atlantic world, this volume deals with the epistemological and even economic interconnections between all of them, not as differentiating elements, but as constitutive features of the European empires. In other words, the construction processes of the Portuguese, Spanish, and British empires should not be understood as separate agents, but as political entities that were configured around one another throughout the modern period because they shared geographic, political, and intellectual categories responding to European imperialist ideals. More specifically, *Entangled Empires* reveals, via several case studies, the links between the imperial projects of the Iberian world and England. The most outstanding feature of this new perspective is that it attends to the common elements between different European empires as a manifestation of a greater phenomenon, that is, looking at what unites them more than what separates them. This global and multidisciplinary approach can be, with new protagonists and new crossings, the beginning of future works of the same style.

A first attempt at this, also taking a global perspective, may be another recent collective work, *Connecting Worlds: Production and Circulation of Knowledge in the First Global Age* (2018), edited by Amélia Polónia, Fabiano Bracht, and Gisele C. Conceição. This book, which arose from a meeting held in Porto (Portugal) in May 2016, aims to establish connections between different worlds, different interpretive frameworks and, in general, between different historical sub disciplines, namely, global history, colonial history, and the history of science. The various contributions of this volume focus on local production of “knowledge” – instead of science per se – and the global circulation of knowledge in the cross-border world which takes place between the fifteenth and the eighteenth centuries, in effect the first period of globalization. In one way or another, all of them insist on the work of intermediaries and bearers of such knowledge, but also on the means and mechanisms that allowed collaboration and reciprocal communication between the architects of modernity, oftentimes via unsuspected agents.

Up to this point, this bibliographical review about the Atlantic and Iberian studies of science has focused more on the Spanish case and on its interaction with indigenous cultures. Few in number are the historians – with the exception of Pimentel, Nieto, Sánchez, and the last collective book edited by Cañizares-Esguerra (2018) – who have considered the contributions of the Portuguese case. However, it would be unfair to claim a place for these studies within the broad framework of early modern science while leaving out Portuguese historiography, especially the most recent one, which is also responsible for the rebirth of Iberian science. In the same way, an exclusively Iberocentric and imperialist vision discarding the Latin American reality would also fall into naïve and unproductive reductionism. The history of Portuguese science practiced in Portugal has been showing signs of good health for several years. With regard to the early modern period, standing out among them are the works of Henrique Leitão, Palmira Fontes da Costa, Laurinda Abreu, and Luís Miguel Carolino, to mention only some of the most internationally recognized authors. Apart from the classic works of Luís de Albuquerque and,
even, of Reijer Hooykaas, the new Portuguese historiography has been concerned with making a modern and critical edition of scientific sources. Among them the *Obras de Pedro Nunes* (the works of Pedro Nunes) stands out, published in six volumes between 2002 and 2012, or the mathematical works of Francisco de Melo. Besides the editing of texts, Henrique Leitão has published important works in Portuguese, such as *A Ciência na “Aula da Esfera” no Colégio de Santo Antão, 1590–1759* (2007), *Os Descobrimentos Portugueses e a Ciência Europeia* (2009), and *360° Ciência Descoberta* (2013), all in continuous dialogue with the most recent historiographic trends. Of all of them, I should highlight the last one, which is much more than the catalogue of a successful and award-winning exhibition held in 2013 in the Calouste Gulbenkian Foundation of Lisbon. With a clear and direct style, Leitão describes the characteristics of a new science, a science that responds to the needs of modern transformations and a new world that goes beyond the limits of the Mediterranean. The change of scale, as Leitão calls it, and the technical and methodological responses of Portuguese and Spaniards to a new situation seem to place the Iberian world in a different position than what classical historiography is used to seeing with respect to the birth of European scientific modernity.

Although Leitão has been mainly concerned with mathematics applied to astronomy, cosmography, and navigation, other recent studies have explored the field of medicine and the natural history of the Portuguese Empire in the East, especially from the figure of Garcia de Orta. Two relevant works, *Os desafios d. Garcia de Orta* by Teresa Nobre de Carvalho and *Medicine, Trade and Empire: Garcia de Orta’s Colloquies on the Simples and Drugs of India (1563) in Context* under the direction of Palmira Fontes da Costa, were published in 2015. Carvalho’s book, written in Portuguese, is the result of a doctoral thesis, which carefully analyses the entry into Europe of the Asian natural world through Orta’s *Colóquios dos Simples e Drogas da Índia*. Carvalho considers Orta, the *Colóquios*, and its rich network of informants a pivotal element for the configuration in Europe of a new medical and botanical knowledge about oriental traditions, in general, and about local practices of India, in particular. Thus, in the hands of Carvalho, the indefatigable work of accumulation and circulation of information that Orta carried out for decades, not only illustrates the cultural dialogue between Europe and the East in the second half of the sixteenth century, but also allows, as the author suggests, a comparative dialogue on Asian nature and the American natural world. On the other hand, the collective work steered by Fontes da Costa is also the result of another academic study, this time a conference that took place in 2013 to mark the 450th anniversary of the publication of Orta’s *Colóquios*. The lectures were entitled “O Mundo num Livro” (“The world in a book”). *Medicine, Trade and Empire* analyses Orta’s *Colóquios* in its context, or better, in its contexts, that is, in the medical context of circulation of herbs and healing plants, in the commercial context of oriental spices, and in the imperial context of the Portuguese colonial power. The Orta’s *Colóquios* are interpreted as the link between these three contexts – scientific, economic, and political – and vice versa, these three contexts coexist in the work of Orta. The twelve chapters that make up this volume have been written by some of the greatest specialists in natural history and in the history of medicine from this period. Although all of them examine the legacy of Orta from different angles, there is an internal coherence that revolves around three main thematic axes: Orta (the man), the *Colóquios* (the work), and the Portuguese empire (the historical-political context). In the first case, the authors focus
on the Jewish question, the formative period of Orta in Spain, his time spent as a doctor in Portugal, his trips to India, as well as his medical and naturalistic vocation that materialize in Goa, the capital of the Portuguese Empire in the East, where Orta would live for almost three decades. In the second case, the different dimensions of the *Colóquios* are highlighted, underlining the style with which new knowledge is expounded, the reception and circulation of the work, and the significance of its contents for the Western world. In the third case, the relationship between Portuguese colonial expansion and the increase of medical knowledge in Europe is emphasized.

The studies on the Portuguese colonial empire are not limited to the books of Portuguese authors produced in Portugal. There is a growing interest in the Anglo-Saxon world in this topic, especially in the field of medicine and pharmacopoeia, two interrelated fields that exceed the limits of this essay, but which ought to be mentioned. These include the most recent works by Timothy Walker and Benjamin Breen, as well as Hugh Cagle’s recent monograph, *Assembling the Tropics: Science and Medicine in Portugal’s Empire, 1450–1700* (2018). In this book, Cagle emphasizes an often forgotten aspect, the importance which the global scale of the Portuguese empire and its simultaneous activity in Africa, Asia, and America had on the formation of a tropical science. In other words, from a global geographic perspective, the first attempts to understand medical and natural knowledge in the tropics were conducted in Portuguese before Spanish.

4. Other lines of inquiry: ethnography

Finally, we should mention the field of ethnography and comparative ethnology, whose birth presupposes one of the most quintessentially modern domains. There are few obsessions more modern than the description of people from other regions of the globe, as well as the description of their customs, beliefs, and ways of life. Much has been written since the classic study of Anthony Pagden, *The Fall of Natural Man: The American Indian and the Origins of Comparative Ethnology* (1981). And many have been the sources that have been reedited or even edited for the first time in recent years, especially those related to early modern religious missions. Among the historians who have contributed most to the development of this area is Joan-Pau Rubiés, who since the last years of the last century has carried out a tireless work in both the field of ethnology and ethnography, looking towards the West and the East alike. Always taking travel, travelers and travel literature as a source of knowledge, Rubiés has published very influential works in this area (see Rubiés 2000; 2007). On the Portuguese side, I should highlight the works of Luís Filipe Barreto on intercultural encounters between Europe and the East, with special emphasis on China – *Macau: Poder e Saber. Séculos XVI e XVII* (2006). Also, I should highlight two books published in 2014: *Intercultural Encounter and the Jesuit Mission in South Asia (16th–18th Centuries)*, a book edited by Anand Amaladass and Ines G. Županov; and *Catholic Orientalism: Portuguese Empire, Indian Knowledge, 16th–18th Centuries*, written by Angela Barreto Xavier and Inez G. Županov. While neither of these two books are strictly ethnographic or ethnological books, the truth is that both contain parts that belong to this field. In this sense, it is worth noting the eloquence with which

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4I thank William Eamon and José Pardo-Tomás for their suggestions on this area, as well as Joan-Pau Rubiés.
Barreto Xavier and Županov present the exhaustive knowledge that existed in Europe about India and the people of India thanks to the first Catholic Orientalists, many of them were Portuguese.

Obviously, the works outlined here do not refer the large number of publications in the form of articles in specialized journals that undoubtedly have helped to promote the field. This rich panorama of Portuguese, Spanish, and Latin American studies of science has only grown in recent years in different directions, many of them sophisticated and unexplored. Partly to blame for this situation is the interest that these issues have awakened and continue to awaken among new generations of talented historians. In addition to those authors already mentioned throughout this essay, other stand-out works are by Tayra Lanuza and Thomas Haadad in the field of astronomy and astrology, by Gabriel Rocha and Melissa N. Morris in the area of environmental history and agriculture, by Mariana Françozo and Angélica Morales Sarabia in the field of natural history, and Edward Collins in the field of navigation, among many others.

The work of this broad cast of historians of modernity highlights how much we had lost in our attempt to reduce the history of early modern science to certain geographical areas, to certain scientific traditions, and to the ideas and theories of certain geniuses. In other words, the books outlined here teach us how restrictive it is for an historian of early modern science to work within an obsessively Eurocentric view. If we have learned anything, it is that the question about modern science is not exclusive to the narratives of the Scientific Revolution. Many of the most interesting episodes of modern science occurred at the intersection of different oceans, continents, local cultures, and communities of practitioners. And what is even more interesting, these episodes not only allow us to build a richer and more heterogeneous history of science, but also help us to better understand the processes of constitution of modern science and of old Europe.

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