

Portuguese Imperial Science,
1450–1800

A Historiographical Review

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Even a cursory perusal of a map immediately shows the most salient and remarkable fact of the Portuguese maritime expansion of the fifteenth and sixteenth centuries: its staggering magnitude. Starting in the first decades of the fifteenth century with a territorial expansion to North Africa, in the next decades Portuguese seamen rapidly advanced all through the Atlantic, along the western coast of Africa and then the coast of Brazil. In the first decades of the sixteenth century, this expansion intensified and spread from the east coast of Africa and the Indian Ocean, to Southeast Asia and the seas of China. By the mid-sixteenth century, Portuguese trading posts were scattered all through the Atlantic coasts, from the eastern coast of Africa to the Indian subcontinent, and as far as Japan. Ships were regularly sailing from Lisbon along routes to places as diverse as the Azores islands, Brazil, or Goa. A reasonably effective military control of the seas where the trading routes operated had been achieved, a network of administrative control was being implanted, and missionary work was beginning in earnest.¹

The vastness of the Portuguese empire posed enormous logistical problems. Besides the establishment of settlements along the coast, the fate of the trading routes depended also on gaining control of the seas. The problems involved and the solutions attempted are much too complex to be dealt with here, but it is important to keep two fundamental aspects in mind.

First, the Portuguese established trading posts and engaged in diplomatic relations or warfare with civilizations and cultures of the most

diverse types. Differently from the Spanish empire, which, despite its dimension was mostly concentrated in South America and the Philippines, the Portuguese empire was above all characterized by its enormous geographical dispersion. The Portuguese came into contact with such wide-ranging cultures as the indigenous tribes of Brazil and Africa, the Arab merchants of North Africa and the Indian Ocean, the various kingdoms of India, myriad peoples in Southeast Asia, and the highly developed civilizations of China and Japan. Needless to say, it would be futile to try to find a common pattern or strategy of dialogue when so much diversity is at play.

Secondly, the Portuguese overseas enterprise was always affected by an acute demographic problem. By the mid-sixteenth century, the population of Portugal was roughly 1 million to 1.5 million inhabitants. Whatever the issue one focuses on—be it administrative, military, commercial, or religious—the imbalance between the task to be performed and available human resources is always enormous.

These two facts—the gigantic geographical dispersal of Portuguese presence around the world and the extreme scarcity of human resources—make the designation of “empire” a complex one to use when applied to Portugal’s huge network of settlements, scarcely populated and loosely controlled by a central administration, a fact that historians have reminded us of frequently. Yet the surprising longevity of Portuguese presence around the globe signals the existence of durable, if informal, modes of relation with local populations and the sagacity of some strategies adopted.

The Portuguese empire was mostly a sea empire and navigation was crucial to maintain and foster it. (For a further examination of this question, see Almeida’s contribution in Chapter 4.) The long-term success of the maritime expansion required the creation of state-supported institutions dedicated to the training of nautical personnel, certification of instruments and charts, and regulation of all procedures related to nautical activities. But the Portuguese empire was also, in the apt designation of Russell-Wood, “a world on the move,” permanently traversed by merchants, travelers, soldiers, missionaries, and all sorts of voyagers who in many informal ways collected and exchanged information about nature.

Throughout the centuries, the Portuguese empire experienced great changes, and although even a summary description of these events is impossible to make, the principal lines of this evolution must be recalled. Needless to say, the chronological changes of the Portuguese empire will have direct implications on scientific activities. Up to the early seventeenth century, the Portuguese expansionist movement proceeded almost unhin-

dered by other European competition. Disputes with Spain being mostly settled due to the celebrated Treaty of Tordesillas, the Portuguese were challenged above all by non-European powers. At the turn of the century this pattern began to change, mostly due to the arrival of the British and the Dutch in East Asia. The contraction of the Portuguese Asian empire led to strategic focusing in other regions, namely Brazil. All through the eighteenth century and until the first decades of the nineteenth century, when it became independent, Brazil was of vital importance to Portugal. A significant colonial presence in Africa is a phenomenon of the later nineteenth and twentieth centuries.

The history of the Portuguese maritime expansion is the most important topic in Portuguese historiography. The study of the creation, building, and ultimate fate of the Portuguese empire is the theme most investigated by Portuguese historians.² Scholarly production in these topics greatly exceeds any other aspect of Portuguese history. Yet, despite the massive erudite production on these topics, there is nothing that can aptly be called a study of Portuguese imperial science. This state of affairs, which is due, most of all, to the fragile nature of studies in the history of science in Portugal, has only slowly been changing in the past few years, but it has not yet been consolidated into an autonomous historical discipline.³ Historians interested in the study of Portuguese imperial science must therefore collect their information from the myriad of studies that have inspected partial aspects of this story. In other words, one can only hope that sometime in the near future, from the variety of approaches to history of the Portuguese empire, a picture of Portuguese imperial science will emerge.

SCIENCE, TECHNOLOGY, AND THE MARITIME EXPANSION

For more than one century, the designation “Portuguese imperial science” simply meant “Portuguese nautical science.” Either pressed by external demands or pursuing the discovery of a specific Portuguese contribution to science, historians have turned to the period of maritime expansion and concentrated on the technical and scientific innovations that gave Portuguese sailors advantage over their European (and non-European) competitors. Thus, historians have analyzed many different topics that include navigation techniques (manuals, teaching, and instruments), ship-building techniques, gunnery, cartography, literature of voyages and geographical descriptions, and more. The field is thus very broad and has frequently been shaped by the desire to ascertain

Portuguese priority or novelty in scientific and technical matters. Needless to say, it has been deeply influenced by the vagaries of the politics of each time.

This historiographic trend can be discerned from the early nineteenth century and has been maintained until today, making it one of the most constant and durable topics of investigation in Portugal.⁴ In fact, for a country that has been slow to engage in studies of the history of science, the history of Portuguese nautical science is a happy exception. Although earlier attempts existed, the origins of this historiographic tradition may be associated with works that were published in the mid-twentieth century, such as Vicomte of Santarém's (1791–1856) foundational three-volume work, *Essai sur l'histoire de la cosmographie et de la cartographie pendant le Moyen Age et sur les progrès de la géographie après les grandes découvertes* (Essay on the History of Cosmography and Cartography during the Middle Ages and on the Progress of Geography after the Great Discoveries; 1849–1852). A few decades later, Luciano Cordeiro (1844–1900) inaugurated the study of Portuguese navigation techniques with his work, *De como navegavam os portugueses no começo do século XVI* (How the Portuguese Navigated at the Dawn of the Sixteenth Century; 1883). These works were soon followed by a series of other contributions, among which two exceptional books are notable: Henrique Lopes de Mendonça, *Estudos sobre navios portugueses dos séculos XV e XVI* (Studies on Fifteenth- and Sixteenth-Century Portuguese Ships), and Sousa Viterbo, *Trabalhos náuticos dos portugueses nos séculos XVI e XVII* (Nautical Works of the Portuguese in the Sixteenth and Seventeenth Centuries).⁵

The polemic between Joaquim Bensaúde (1859–1952) and some German scholars who questioned Portuguese priority led to the publication of a number of important works. In a series of seven volumes under the title of *Histoire de la science nautique portugaise* (The History of Portuguese Nautical Science), Bensaúde published a collection of essential documents and proceeded to demolish the German claims in a number of separate works, of which the most important was *Les légendes allemandes sur l'histoire des découvertes portugaises* (German Legends of the History of Portuguese Discovery; 1917–20).

A certain romanticism permeates these works and they are sometimes influenced by a nationalistic bias. Scientific accomplishments became a weapon that was used to define and increase national politics. It is no surprise that a connotation of “glorious” period or “golden age” was coined to describe the scientific achievements of this period and that historical facts were sometimes greatly exaggerated in order to justify a Portuguese excellence in nautical matters.⁶ But despite its failings, this

historiographical tradition revealed a considerable amount of facts that showed a deep connection between the needs of the empire and the practice of science.

The next generation of scholars introduced higher levels of precision and technical command. Authors such as António Barbosa (1892–1946), Luciano Pereira da Silva (1864–1926), Abel Fontoura da Costa (1869–1940), and Quirino da Fonseca (1868–1939) combined a full technical competence of the matters addressed with a keen sense of historical problems. These works laid the foundations for a modern and scholarly study of the Portuguese contributions to science.

This approach would reach its high point with the works of Avelino Teixeira da Mota (1920–1982), Armando Cortesão (1891–1976), and above all with the prolific contributions of Luís de Albuquerque (1917–1992). These authors brought the field to its maturity and produced scholarly works of the highest level such as, for example, the many critical editions of nautical guides published by Albuquerque or the magnificent *Portugaliae monumenta cartographica* (Cartographical Monuments of the Portuguese), by Cortesão and Teixeira da Mota.⁷

It was from within this tradition of studies that the question of Portugal's role (if any) in the Scientific Revolution was framed. This question interested not only some Portuguese historians but also distinguished foreign specialists, in particular the Dutch historian Reijer Hooykaas.⁸ Two aspects in particular have been highlighted: the fact that, on the one hand, as a direct consequence of the maritime expansion, from a very early date in Portugal the authority of the old masters (Ptolemy, Pliny, Pomponius Mela, Strabon, and so on) was severely questioned and, on the other hand, that it is possible to identify in some Portuguese authors, in particular the celebrated D. João de Castro, an “experimental” and “modern” approach to the study of nature. (See also Almeida in Chapter 4.)

Yet, for all their many accomplishments, these historians and the intellectual tradition they established were restricted to a cognitive approach that omits cultural practices, social considerations, more institutional aspects, and material culture from the field of inspection.

Much broader perspectives are required, for example, in the case of institutions. The needs created by the Portuguese empire led to the creation of new institutions, but the story of these institutions and their relation to scientific practice is still poorly known. Until now, historians have focused only on one such institutional setting, the position of *cosmógrafo-môr* (chief cosmographer).⁹ The state responded to the need for personnel trained in nautical matters by establishing the position of chief cosmographer, whose nature (duties and privileges) is defined in the

“Regimentos do Cosmógrafo-Môr.” While this legislation is known to have existed from at least 1559, the first extant document is from 1592. According to this “Regimento,” the chief cosmographer should examine makers of nautical instruments and cartographers; it was also his duty to authenticate all nautical charts, globes, and instruments; and finally, he was in charge of training future nautical pilots in mathematics, cosmography, and astronomy. Creation of the position of chief cosmographer signals the attempt to centralize the training and certification of pilots. The position was kept in essentially the same form until 1779, when it was completely reformed.

Much less is known about the relation between the university and the technical achievements and scientific practice of the maritime expansion. The university has traditionally been described as a very conservative institution, unaffected by the novelties brought from overseas by sailors and merchants. But there are reasons to suspect this to be a simplistic description of events.



A different historical tendency has focused attention in the informal, noninstitutional mechanisms of collecting and exchanging information. The many different groups that constituted the Portuguese empire—sailors, missionaries, soldiers, merchants, and the like—engaged in massive collections of information about the regions they were living in or traveling through. (See also Walker’s arguments in Chapter 13 concerning the circulation of this knowledge in the Portuguese empire.) This information is preserved in an abundant literature—such as travel books, geographical descriptions, *roteiros* (mariners’ logbooks), and missionary correspondence—most of which has been examined only partially and never integrated in a larger narrative of imperial science.

BUILDING NETWORKS FOR SCIENTIFIC PRACTICE

The somewhat loose channels of communication and practice of science in the Portuguese empire underwent profound changes with the arrival of the Society of Jesus.

The examination of the Jesuit contributions to science is a recent phenomenon in Portugal. While it is also relatively new as a field of study in historiography per se, its emergence in Portugal seems to have been more delayed than elsewhere. This is surely a consequence of a persistent anti-

Jesuit and, more generally, anticlerical bias that has afflicted much of Portuguese historiography, especially in the history of culture and education. Two good examples are the immensely influential, four-volume history of the university by Teófilo Braga, *História da Universidade de Coimbra* (Lisbon, 1892–1902), whose virulent critiques of Jesuit education have become canonical, and Francisco Gomes Teixeira's, *História das matemáticas em Portugal* (Lisbon, 1934), whose main theses were adopted by the majority of the historians of science.¹⁰



Recently, however, under the pressure of an international historiography that has directed a great deal of attention to “Jesuit Science,” Portuguese historians have looked into these questions with more objective and more dispassionate eyes. These new developments are crucial to the understanding of Portuguese imperial science since, whatever judgment one may make, it is beyond doubt that the Jesuits radically altered the educational and scientific scenario in Portugal and that their action was done on a planetary scale.

From 1540, date of the arrival of the first members of the Society of Jesus to Portugal, to 1759, the year of their expulsion (which anticipated the suppression of the Society by the pope, in 1773), the Jesuits created a system of colleges of which the main characteristics, from the point of view of the history of science, can be summarized as follows. The Jesuits established the first organized and stable educational network at the “secondary” and “preuniversity” level and inserted educational institutions located in Portugal in a large, supranational context. Furthermore, they established the first truly regular teaching of mathematical disciplines in Portugal and sponsored scientific activities on a scale never before experienced there.

The complexity of the Jesuit educational enterprise in Portugal cannot be addressed here, but the sheer numbers are impressive, at least for Portugal. It is estimated that, by 1759, when the Jesuits were expelled and their educational network disrupted, approximately twenty thousand students were attending Jesuit institutions. Comparable numbers of youngsters attending schools in Portugal were only reached again more than a century later.¹¹ Moreover, this network extended beyond the European borders of Portugal, covering most regions where Jesuits were engaged in missionary work. Education in Jesuit colleges was planned along the rules of the *Ratio studiorum* (Method of Study), but this document gave only general guidelines that left ample room for local variations and even for the initiative of isolated teachers.¹²

Furthermore, these guidelines were not always put into practice. Thus, although in a broad picture one can say that all Jesuits had a similar training, a more microscopic analysis shows that regional variations could be very marked.

In 1574, following a demand made by the king, the Jesuits created their first mathematical class in Portugal—the *Aula da Esfera* (Course on the Sphere)—at the *Colégio de Santo Antão*, in Lisbon. Differently from mathematical studies in Jesuit colleges in other countries, this class was established not exactly to comply with the Jesuits' own plan of mathematical studies but rather with the objective of providing mathematical and technical training to personnel engaged in the Portuguese maritime expansion, that is, with the needs of the empire in view. The mathematical curriculum at this college was therefore substantially different from that of other Jesuit colleges in Europe. Although part of a supranational context, Jesuit scientific teaching and practice in Portugal reflected the specific conditions prevailing locally. After the pioneering studies by Luís de Albuquerque and especially after the careful investigation by Ugo Baldini, the *Aula da Esfera* of the College of Santo Antão is today recognized as the most important center for scientific activities in the period from the end of the sixteenth century to the expulsion of Jesuits in Portugal.¹³

From the point of view of the history of science, the network of educational institutions that the Jesuits established in Portugal and its empire is of great interest and corresponds to a new situation. Unlike any other educational system ever implanted in Portugal, the Jesuit system was organically connected to other institutions in Europe and to the missionary activities outside Europe. It was a stable and reasonably well organized long-range network of communication within which different scientific activities were practiced.



Recent works have overcome the ideological constraints imposed by older historiography and greatly improved on our knowledge of the practice of science within the Jesuit network, both on a global scale and on a detailed level.

The work of Ugo Baldini on the scientific practice in the Iberian Assis-tancias and, in particular, on the Lisbon college of Santo Antão provides both fundamental elements and the theoretical framework to understand the nature and peculiarities of Jesuit science in the Portuguese empire.¹⁴ Historians have been progressively addressing the many issues related to the history of Jesuit science in the Portuguese empire. Some important

Portuguese Jesuit scientists such as Inácio Monteiro were studied;¹⁵ the relations between the Jesuit mathematicians in Beijing and the Academy of Sciences of St. Petersburg were analyzed;¹⁶ and specific cases of transfer of scientific instruments via the Jesuit network were studied.¹⁷ In confirmation of the increased interest of these matters, three international conferences were set up to study the scientific activities of Portuguese Jesuits in Portugal and the Portuguese empire.¹⁸

Brazil is obviously a special case within the Portuguese empire, and it would require a separate study. Some studies have already analyzed the practice of science in Brazil mediated by the Jesuits. Authors have studied aspects of natural history and also astronomical observations of Jesuits, most of all by the Bohemian missionary Valentin Stancel.¹⁹ A topic that has interested historians for several decades and continues to attract some fine scholarship has been the study of cartographic missions in Brazil.²⁰ The role of the Jesuits in studying and diffusing natural historical knowledge has also attracted some attention.²¹ However, much is still to be accomplished. The famous *Flora cochinchinensis* (Flora of CochinChina), by the Jesuit João de Loureiro, is still to be studied in detail and to be incorporated in the broader narrative of imperial science.²² The same can be said of other important works on this subject, such as the observations by the Jesuits Manuel da Nobrega, José de Anchieta, and Fernão Cardim on the natural world of colonial Brazil.²³ The need for further studies on the contribution of the Jesuit Luís de Almeida to the introduction of European medical practices in Japan should also be stressed.²⁴ A comprehensive study of Jesuit scientific practice in Portuguese India is still a desideratum. Some older works have inspected isolated episodes,²⁵ and the number of studies on natural history and medical activities seems to be growing, but there is still much to be done.²⁶ A comparative study between the different Jesuit missions has not been attempted. In general, the immense quantities of information collected by missionaries on indigenous scientific practice and non-European nature are still awaiting an historical analysis.

MEDICINE, NATURAL HISTORY, AND THE VISION OF THE EMPIRE

Most of the historiography on the Portuguese discoveries praises the contribution of Garcia de Orta's *Colóquios dos simples e drogas da India* (Colloquies on the Simples and Drugs of India) (1563) to the development of modern science. In fact, this was the first work to systematize the knowledge and medical applications of some of the new plants

encountered by the Portuguese in Asia.²⁷ However, it is rarely mentioned that the work become known in Europe due to the efforts of a foreigner. Carolus Clusius acknowledged that, on his visit to Lisbon in 1564, he found de Orta's *Colloquies* by chance, and since they pleased him so greatly and were written in a language that was understood by so few, he decided to publish an abridgement of the original in Latin with additional commentaries.²⁸ This work was printed in Antwerp in 1567 and enjoyed several editions.²⁹ In contrast, a second Portuguese edition of de Orta's work was published only in the late nineteenth century.³⁰

The majority of sources with original and valuable information on medicine and natural history in the context of the Portuguese colonial enterprise did not have the same fortune as de Orta's *Colloquies*. Several of them were never or only recently published. Others were destroyed by human agents or by natural disasters such as the 1755 Lisbon earthquake. A significant number remain uncatalogued in the Archives. One of the recurrent and crucial problems in the study of this subject has been the insufficient diffusion of sources and of scholarly work in the Portuguese-speaking countries as well as abroad. Already in the First Congress of the History of Portuguese World Expansion, organized in July 1937, Luis de Pina alerted his colleagues to the crucial need to publish bibliographical summaries of relevant Portuguese documents in a language more accessible than Portuguese.³¹ Unfortunately, the suggestion was not followed, and only very recently can we trace a few individual efforts to disseminate studies on Portuguese imperial science in other languages.

It is during the first half of the twentieth century that the beginnings of an interest in the history of Portuguese colonial medicine and natural history can be seen. (For a brief historiography of Portuguese colonial medicine, see Walker in Chapter 13.) The authors of works produced during this period usually shared a scientific background and a fascination for the pioneering role of Portuguese authors in accurate description of new species and diseases. It is with indignation and perplexity that some of them complain about insufficient acknowledgment abroad of the Portuguese role in the development of modern science. In an article from 1926, Portuguese physician Carlos França emphasized his surprise at the absence of Portuguese names in the history of the natural sciences. Knowing the scientific orientation of the Portuguese discoveries, he felt a great repugnance in being forced to admit that what is known of natural history "in the lands we first stood [on] and colonized" is due only to the efforts of foreigners.³²

It is therefore not surprising that one of the common themes of this historiography was the search for Portuguese predecessors in the devel-

opment of medicine and natural history. Scholars from this period vindicated not only the pioneering role of the Portuguese in the discovery of plants, animals, and diseases previously unknown in the Old World, but also the Portuguese development on a new basis for a series of disciplines. Pina, the most prolific author on the subject, even declared that botany, zoology, mineralogy, and tropical medicine “were born in Portugal during the age of the discoveries.”³³ Such exaggeration of Portuguese achievements should be understood within the political and historiographical situation of the period. Several of the contributions were made in a context of commemorative celebrations in which the political agenda of the regime sought political legitimization. It is, therefore, not surprising that this generation of historians has focused mainly on the sixteenth-century apogee of the empire. At the same time, we should not forget that the Portuguese contribution to the development of modern science has been and continues to be largely excluded in Anglo-American, French, and German scholarship.³⁴

It is true that this historiography is, in great part, patriotically biased, but we should not forget its valuable contribution to the field, since it involved the first efforts to uncover some of the primary sources associated with the history of Portuguese colonial medicine and natural history. One of the features of the works produced by this generation of scholars is its descriptive nature, together with the inclusion of long quotations from original documents. It may, consequently, be said that it still has considerable informative value. At the same time, some of the arguments running through this body of work still need to be challenged and reassessed by new historiographic approaches. It should also be noted that some of the authors from this period were the first to point, however concisely, to the diversity of literature, agents, and places involved in the Portuguese colonial experience. At least until the eighteenth century, the information relevant to the study of this subject was not to be found in medical and natural historical treatises, but in chronicles, travel literature, and letters written by authors who were involved in the Portuguese efforts to conquer and trade or to preach Christianity. The works of the physicians Amato Lusitano and Garcia de Orta are an exception to this trend.³⁵ A few studies also make reference to the reciprocal influences and multidirectional flows of animals, plants, and medical knowledge among the various dominions of the Portuguese empire as well as in Europe.³⁶ In addition, some studies reveal an initial interest in institutions associated with medicine that were first founded by the Portuguese in Asia and Africa, such as hospitals and charitable institutions.³⁷

THE STATE AND THE APPROPRIATION OF THE
COLONIAL NATURAL WORLD

The historiography of the subject has taken a new turn in the last two decades. The importance of scientists writing the history from which had flowed a Whig narrative of progress decreased considerably, and they were replaced by professional historians sharing some of the concerns and aims of the new historiography of imperial science.

The study of scientific expeditions in the Portuguese overseas territories during the second half of the eighteenth century has been the main topic of the new scholarly approaches to the field. William Simon's pioneering and wide-ranging study on this subject and several other recent works have pointed to an effective program, as broad as the Portuguese empire of the time, that led to a systematic inventory of Portuguese Asia, Africa, and America.³⁸ This was a program with political, economic, scientific, and cultural dimensions. On the one hand, the Portuguese colonies were crucial to the economic development of the metropolis and were of primordial importance from a geographical and strategic point of view. On the other hand, it is during this period that, following the Marquis of Pombal's rise to power during the reign of D. José I (1750–1777), a series of reforms were implemented in the Portuguese economic and educational system. These reforms were considered to be crucial for the Portuguese state to maintain hold over its empire.

One of the significant results of the project was the reformation of the University of Coimbra.³⁹ For the first time, it became possible to educate at the university level naturalists who were later employed in the Portuguese overseas expeditions. Consequently, and in contrast to the previous period, several of the authors of works on natural history had a specialized education in this subject. It should also be remarked that economic and educational reforms were closely linked, as can be seen in the work of Domingos Vandelli, professor of Chemistry and Natural History at the University of Coimbra and one of the main advocates of philosophical voyages in continental Portugal and in the overseas territories in order to define a strategy for the optimal allocation of available resources.⁴⁰ Vandelli also had a very important role in the 1768 creation of the Ajuda Palace Museum and Gardens in Lisbon, institutions that were a focal point for Portuguese overseas collecting activity.⁴¹ The reforms were further reinforced during the reign of D. Maria I (1777–1816), and it was during this period that the Royal Academy of Sciences in Lisbon was founded in 1779. This institution was of paramount importance in guiding scientific research conducted overseas, as well as in promoting discussion and the publication of numerous memoirs on the subject.⁴²

In the context of the educational reforms, it should also be stressed that when the Society of Jesus was expelled from Portugal (1759), military institutions became more and more influential as centers for the training and practice of mathematical sciences. Nearly all the late eighteenth- and nineteenth-century Portuguese mathematicians of some distinction had been trained in or were professors at military institutions, and these institutions were fundamental in the education of cartographers who participated in overseas expeditions. The importance of the military schools and of mathematicians affiliated with military institutions is well recognized today. However, the studies available are only exploratory attempts, and much work remains to be done.⁴³ One would like to have a comparative analysis of the organizational structure of military schools and universities; a study of the ways in which the needs of the empire affected or even shaped the establishment of military scientific activities.

Due first of all to its significant sugar production and then as a profitable source of precious metals, Brazil became of paramount importance to the economic balance of Portugal during the eighteenth century. The great importance given to Brazil is reflected in the historiography of the history of medicine and natural history. The increasing contribution of professional Brazilian historians of science to the subject should also be stressed.

The scholarship on the nine-year expedition of Alexandre Rodrigues Ferreira to the Amazon region from 1782 to 1792 is vast.⁴⁴ In his work on scientific expeditions in the Portuguese overseas territories, Simon provided an account of the aims and various stages of this trip together with information on Ferreira's description of several animal and plant specimens and their shipment to the Ajuda Palace Gardens and Museum in Lisbon. Information is also presented on the reports and memoirs of the naturalist as well as on the wide scope of Ferreira's collection and its fate during the Napoleonic invasion of Portugal. A significant part of it was expropriated by Étienne Geoffroy Saint-Hilaire to the Paris Muséum d'Histoire Naturelle. Ângela Domingues has shown that the expedition cannot be dissociated from the activities of territorial demarcation of the Portuguese and Spanish governments in the region.⁴⁵ Moreover, she has emphasized that political, geographical, astronomical, natural historical, anthropological, and ethnographical aspects of the expedition were profoundly intertwined. She has also pointed out that the Portuguese project of localizing, measuring, describing, and representing—which was conducive to the appropriation of the Amazon territory—involved a multitude of actors with various forms of expertise as well as persons with no scientific background and indigenous people. In addition, she

has stressed that the main efforts associated with the expedition were frustrated, since the issue of demarcation did not have a logical conclusion and the scientific results of the mission were limited to omission for a very long period of time.

Recent literature on the subject has emphasized that naturalists were not the only actors crucial to the venture of describing, collecting, and understanding the nature of the Portuguese empire. Governors and administrative employees, as well as draughtsmen, were also crucial to the success of this enterprise. In fact, governors of Portuguese America would often give instructions to alter voyage routes as well as halt or help investigations to suit their interests. The contribution of the draughtsman José Joaquim Freire to the natural knowledge of the Portuguese overseas territories has been the subject of a recent, valuable, and beautifully illustrated study by Miguel Faria.⁴⁶ The book examines the importance of drawing for natural history and military engineering during the eighteenth century, giving special relevance to the drawings produced by Freire in the context of the Ferreira expedition to the Amazon region. Faria's work is especially insightful in the affiliation between military and natural historical drawings during this period and on the complementarity of draughtsmen and naturalists in the description and study of nature. He also provides useful considerations on the relationship between text and image and on the general importance of drawings in the appropriation of Portuguese overseas territories. The gaps in the historiography of the illustration of nature in relation to the Portuguese empire are still considerable, and this is a very profitable area for future studies. (For a study of the importance of illustration for the Spanish colonial science, see Bleichmar's Chapter 15).⁴⁷

Mining knowledge in colonial Brazil is the other topic that has attracted increased attention. Silvia Figueiroa and Clarete da Silva have been at the forefront of the scholarship on this subject. Their excellent study on eighteenth-century mineralogists provides an introduction to the new approaches to mining in this period, together with a brief analysis of the work of two Luso-Brazilian mineralogists, Manuel da Câmara and José Vieira Couto.⁴⁸ From roughly 1700 until 1775, gold and diamonds from Brazil brought Portugal great wealth. Later, the production of these two minerals declined significantly. The Portuguese government set out to revitalize the industry by selectively introducing modern scientific theory and technology. Several students, most of them born in Brazil, were sent to the newly restructured University of Coimbra in order to learn the new scientific methods of metallurgy. A few of them were even subsidized by the Portuguese state to attend courses in mineralogy, chemistry, metallurgy, and other mining arts at the universities and technical schools

of Freiberg and Paris. The education received on the subject introduced these students to the growing importance of other minerals such as coal and iron and to new methods of extraction, as well as to the importance of mining administration. It was considered to be crucial for the Portuguese government to know that the scientific methods of metallurgy might lead to more efficient production, not only of gold but also of iron, coal, and other minerals that had a growing importance in Europe.

After Câmara's studies in Portugal and in Europe, he was commissioned to supervise important mines in Brazil. However, the reforms he desired were never implemented. Couto also studied at the University of Coimbra and was afterwards commissioned to undertake a mineralogical survey in the region of Minas Gerais in Brazil. One of the results of his activities were the mineralogical memoirs he published in the journal of the Royal Academy of Sciences in Lisbon. He also produced descriptions of the geography, climate, and population of the territory. Figueiroa and Silva have stressed that the study of this case reveals that Couto absorbed an ideology of integrated development and that, for him, the interests of the Portuguese colony and the crown were the same. They concluded that within the Portuguese empire there was great continuity of policy between the metropolis and colonial scientists, but with certain distinctions among the colonies. Silva's book on Couto based on a contextual analysis of his memoirs further enlightens the relevance of Couto's work.⁴⁹ The book's main aim is to understand Couto's vision of science, his scientific activity in relation to that practiced by scientists working in the same area, his position in mineralogical and geological controversies of the period, and the various difficulties that Couto had to face during the course of his work.

A relevant essay was published recently on the work of mineralogist João da Silva Feijó.⁵⁰ The authors acknowledge how historiography has literally condemned this naturalist to obscurity and aim to illustrate his contribution to the development of modern science. Between 1783 and 1797, Feijó had his first assignment in the islands of Cabo Verde and then in Ceará, Brazil. In Cabo Verde, he studied and clarified his ideas about volcanoes and listed the products that could be exploited commercially in these islands, such as sulphur, salt, and sulphates. In Ceará, he studied the characteristics for the identification of mineral deposits, and he investigated saltpeter, following explicit orders from the Portuguese government due to the mineral's military importance. He also conducted botanical and paleontological investigations of the region. The authors make it clear that mining remained at the center of the Portuguese Enlightenment political project and that it relied on co-opting groups of Portuguese in America. They demonstrate that the life and work of Feijó

illustrates practices, negotiations, and modes of publication that are typical of the process of globalization of science.

Great expeditions and scientific journeys collected natural historical material and data. As Janet Browne has emphasized, for a long period the material collected for medicine followed the same collecting institutions as natural history.⁵¹ At the same time, natural historical activities were often carried out by physicians. Recent studies on the history of medicine have also been done in the context of the Brazilian Portuguese empire. Lycurgo Santos Filho has provided a general view of the history of Brazilian medicine.⁵² It covers not only the impact of Iberian medicine in Portuguese America but also indigenous notions of illnesses and their treatment, African influences on the concept and treatment of diseases, and the role of the Jesuits in diffusing medical knowledge. Santos Filho relies on a vast number of sources but sometimes suffers from anachronism in his classification of a “prescientific” and a “scientific” medicine, associating the former with the medical practices of indigenous peoples and of Africans as well as with Jesuit priests and European healers without a medical degree.

In a more recent book, Márcia Ribeiro offers a concise but more appealing and complex view of the history of medicine in Brazil in the eighteenth century.⁵³ It provides insight into the rich mix of traditions that molded colonial science and into the relationship of interdependence between ruler and ruled, expert and general population. Ribeiro deals with the impact of some of the diseases introduced into Brazil by the Europeans and Africans during the period of colonization. In her view, colonial medicine should be seen as a scheme of knowledge that was the result of frequent exchanges between European, indigenous, and African cultures. She also makes clear that the great limitations in receiving medicines from Lisbon in sufficient number and in good condition enhanced the importance of the healing practices of non-European cultures. At the same time, throughout its colonial period, Brazil suffered from a chronic lack of surgeons and physicians. In Ribeiro’s view, it should therefore not be surprising that surgeons with little practice, amateur healers, midwives, wizards, and mere charlatans had such an important role in medical practices. The author stresses as well how the importance of the supernatural in the treatment of disease was shared by common people and the higher ranks of society, including many physicians. Considerable attention is given precisely to the issue of the thin boundary between medicine and magical practices.

Vera Marques’s book on medicine and pharmaceuticals in eighteenth-century colonial Brazil is another valuable contribution to the subject.⁵⁴ It shares some of the concerns of the previous work in terms of revalu-

ating the importance of the various actors involved in the history of healing in this territory with special relevance to the indigenous people. In contrast to Ribeiro, Marques does not attribute significant relevance to the diminutive number of surgeons, physicians, and *materia medica* that reached the colony from the metropolis. In her view, the diversity of cultural backgrounds of the Brazilian residents would be in any case sufficient to explain the persistence of plural healing practices. The narrative reveals processes in which the experience of colonizers and colonized intersected, showing how some of the plants of the territory were gradually incorporated into the Portuguese pharmacopoeia in a process that involved exchange of information, description, and classification. This was a process of appropriation that, during the eighteenth century and also before, was partly carried out in the colony and partly in the metropolis. Lisbon received from Brazil several specimens of medical interest, some of which were later exported back to the colony as accredited remedies. The author also calls attention to the role of the Medico-Chirurgical, Botanical and Pharmaceutical Academy founded in Rio de Janeiro in 1772.⁵⁵ This was to become a space of sociability for various men interested in medical knowledge and practices, which was guided by Enlightenment principles of ordering and classification in an attempt to control, and profit from, tropical nature. The author is also concerned with issues of secrecy motivated by the economic interests of the Portuguese government or by personal profit and, more important, by the fact that magic, religion, and science were, for a long time, intertwined in the territory. The two aforementioned works show how this is a fertile area for further studies.

The formation of networks of information and the processes of diffusing knowledge were crucial to the development of Portuguese colonial medicine and natural history. As was already mentioned, until the second half of the eighteenth century the Jesuits played a pivotal role in the circulation of European and indigenous information relevant to medical and natural historical practices. After this period, the agents involved in the exchange of information become more diversified and more closely linked to the state. In her 2001 essay, Ângela Domingues presented a clear and useful overview of the actors and institutions that were involved during the eighteenth century in the development of an information network that focused on the economic potential of the Portuguese colonies.⁵⁶ She has pointed out that information about the natural world flowed from all parts of the empire; it was propagated by agents with various backgrounds, aims and professional positions, and she has stressed that the main recipient was the Portuguese state. In her view, medical and natural historical knowledge gained from the colonies had an eminently practical nature, which

should be associated with the intended achievement of scientific, political, economic, and social goals. Domingues is, however, very doubtful of the success of the enterprise and, in particular, the ways the Portuguese state controlled and managed the available information, the ways the various kinds of information were integrated into a global knowledge of the Portuguese empire, and to what extent the information was used to improve the well-being of the population or was just lost in various archives.⁵⁷

Undoubtedly, one of the crucial problems running through the history as well as through the historiography of medicine and natural history in the context of the Portuguese colonial experience has been the insufficient dissemination of all the information gathered in the overseas territories, and this problem has manifested itself not only abroad but also at the very center of an empire whose high aspirations, purposes, and efforts were often annihilated by a dismissive view of the importance of the diffusion of knowledge.

CONCLUSION

From its fifteenth-century origins to the end of the period covered in this essay, the scientifico-technical dimension formed an integral element of Portuguese colonialism. Nautical, mathematical, and astronomical studies as well as natural historical and medical practices were crucial in defining and establishing the Portuguese colonial enterprise. The historiographical survey presented here shows that a significant amount of research has already been carried out on nautical science and on the Jesuit contributions to the development and diffusion of science. At the same time, the study of colonial Brazil during the second half of the eighteenth century has recently emerged as a fertile and even fashionable area of study. In addition, serious attempts have already been made to address complex and more theoretical questions such as, for example, the role of a specific Portuguese contribution to the "Scientific Revolution."

However, huge gaps still remain in our knowledge of the field in terms of period, place, and subject. New approaches to the sixteenth-century apogee of the empire are still absent, and the seventeenth century is almost completely avoided by historians. Very few works have been produced on material culture and visual representations of nature, or on environmental history. The history of the book and of the various processes of circulation of knowledge still need much further research. What knowledge was acquired and what was discarded, what knowledge was assimilated or transmitted because of European and colonial notions of gender is also an area open to future explorations.

The various studies covered in this essay suggest that an interest in the area of science and colonial studies is emerging in the Portuguese-speaking countries, but it is still difficult to speak of a discipline as such. The specific nature of the Portuguese empire and especially the gigantic geographical dispersal of the Portuguese presence around the world make it difficult to obtain a comprehensive view of the subject, but at the same time this will be all the more appealing and rewarding in terms of comparative studies with the history of other empires.

and the Maps of the *Relaciones Geográficas* (Chicago and London: University of Chicago Press, 1996), xix.

106. *Ibid.*, 72.

107. *Ibid.*, 213.

108. *Ibid.*, 216.

109. Duccio Sacchi, *Mappe dal Nuovo Mondo: Cartografie locali e definizione del territorio in Nuova Spagna (secoli XVI–XVII)* (Milan: Franco Angeli, 1997), 165.

110. *Ibid.*, 289.

111. Thomas F. Glick, “Imperio y dependencia científica en el siglo XVIII español e inglés: La provisión de los instrumentos científicos,” in Peset, *Ciencia, vida y espacio en Iberoamérica*, 3:49–63. Glick here announces (p. 49) that his student, Marta Ardila, was preparing a comparative study of science in eighteenth-century Spanish and British American colonies, but I am unaware of any subsequent publication.

Chapter Two

1. The literature on the history of the Portuguese empire is immense. The following English-language indications are useful and easily accessible, although without any intention of their being complete or systematic. By Charles Ralph Boxer, these slightly dated but still very important works should be mentioned: *The Portuguese Seaborne Empire, 1415–1825* (London: Hutchinson, 1969); *The Golden Age of Brazil, 1695–1750* (Berkeley and Los Angeles: University of California Press, 1969); *The Christian Century in Japan, 1549–1650* (Berkeley and Los Angeles: University of California Press, 1967). More recent studies of great importance are the following: Bailey W. Diffie and George D. Winnius, *Foundations of the Portuguese Empire, 1415–1580* (Minneapolis: University of Minnesota Press, 1977); A. J. R. Russell-Wood, *A World on the Move: The Portuguese in Africa, Asia, and America, 1415–1808* (Manchester: Carcanet Press, 1992); Sanjay Subrahmanyam, *The Portuguese Empire in Asia, 1500–1700* (London: Longman, 1993).

2. The subject is too vast to be summarized here. The following bibliographies confirm this assessment and provide extensive lists of relevant works: Alfredo Pinheiro Marques, *Guia de história dos descobrimentos e expansão portuguesa* (Lisbon: Biblioteca Nacional, 1987); *Repertório bibliográfico da historiografia portuguesa, 1974–1994* (Coimbra: Instituto Camões, Faculdade de Letras de Coimbra, 1995); Artur Teodoro de Matos and Luis Filipe F. Reis Thomaz (eds.), *Vinte anos de historiografia ultramarina portuguesa, 1972–1992* (Lisbon: Comissão Nacional para as Comemorações dos Descobrimientos Portugueses, 1993).

3. There is no overall view of the history of science in Portugal, but the following bibliography can be very helpful: Rómulo de Carvalho, “Bibliografia das obras de autores nacionais publicadas durante o século XX que se ocupam das actividades científica e técnica dos portugueses nos séculos anteriores,” in *História e desenvolvimento da ciência em Portugal (séc. XX)*, vol. 3 (Lisbon:

Academia das Ciências de Lisboa, 1992), 1781–1922. Reprinted in *Actividades científicas em Portugal no século XVIII* (Évora: Universidade de Évora, 1996), 683–840. The most recent production on the history of science is listed in Conceição Tavares and Henrique Leitão, *Bibliografia de história da ciência em Portugal, 2000–2004* (Lisbon: Centro de História das Ciências da Universidade de Lisboa, 2006).

4. For an overview of the development of this field of study, see the essay by Luís de Albuquerque, “Historiografia sobre a náutica portuguesa dos descobrimentos,” in *A historiografia portuguesa de Herculano a 1950: Actas do colóquio* (Lisbon: Academia Portuguesa da História, 1978), 357–69.

5. Henrique Lopes de Mendonça, *Estudos sobre navios portugueses dos séculos XV e XVI*, 2nd ed. (1892; Lisbon: Ministério da Marinha, 1971); and Francisco A. Marques de Sousa Viterbo, *Trabalhos náuticos dos portugueses nos séculos XVI e XVII* (1896, 1900; Lisbon: Imprensa Nacional Casa da Moeda, 1988).

6. Such is the case, for example, with the wild exaggerations around the so-called “School of Sagres.” For important analysis of the origin and repercussion of this myth, see W. G. L. Randles, “The Alleged Nautical School Founded in the Fifteenth Century at Sagres by Prince Henry of Portugal, Called the ‘Navigator,’” *Imago Mundi* 45 (1993), 20–28. See also Francisco Contente Domingues, “Horizontes mentais dos homens do mar no século XVI: A arte náutica portuguesa e a ciência moderna,” in *Viagens e viajantes no Atlântico quinhentista: Primeiras jornadas de história ibero-americana*, ed. Maria da Graça M. Ventura (Lisbon: Edições Colibri, 1996), 203–18.

7. Armando Cortesão and Avelino Teixeira da Mota, *Portugaliae Monumenta Cartographica*, ed. Alfredo Pinheiro Marques, 6 vols. (Lisbon: Imprensa Nacional-Casa de Moeda, 1988). See the extensive bibliographies of Albuquerque in Alfredo Pinheiro Marques, *Luís de Albuquerque na historiografia portuguesa: A serenidade e a convicção* (Coimbra and Figueira da Foz: Centro de Estudos do Mar, 1998).

8. See for example, Reijer Hooykaas, “Science in Manueline Style: The Historical Context of D. João de Castro’s Works,” in *Obras completas de D. João de Castro*, 4 vols. 1968–1982, ed. Armando Cortesão and Luís de Albuquerque (Coimbra: Academia Internacional da Cultura Portuguesa, 1982), 4:231–426; Reijer Hooykaas, “The Portuguese Discoveries and the Rise of Modern Science,” *Boletim da Academia Internacional da Cultura Portuguesa* 2 (1966), 87–107 [republished in *Selected Studies in the History of Science* (Coimbra: Acta Universitatis Conimbricensis, 1983), 579–98]. Hooykaas was not the only one to call attention to these facts. Another expert was David Waters; see “Portuguese Nautical Science and the Origins of the Scientific Revolution,” *Boletim da Academia Internacional da Cultura Portuguesa* 2 (1966), 165–91.

9. The *cosmógrafo-môr* and the problem of nautical teaching in general are analyzed in A. Teixeira da Mota, “Os regimentos do cosmógrafo-môr de 1559 e 1592 e as origens do ensino náutico em Portugal,” *Memórias da Academia das Ciências de Lisboa (Classe de Ciências)* 13 (1969), 227–91. See also Nuno Valdez dos Santos, *Setecentos anos de estudos navais em Portugal* (Lisbon: Academia de Marinha, 1985).

10. Luís Manuel Ribeiro Saraiva, “A Companhia de Jesus e os historiadores da matemática portuguesa,” in Nuno da Silva Gonçalves (ed.), *A Companhia de Jesus e a missão no Oriente: Actas do Colóquio Internacional, 21-23 Abril 1997* (Lisbon: Brotéria, Fundação Oriente, 2000), 311-30.

11. António Leite, “Pombal e o ensino secundário,” in *Como Interpretar Pombal? No bicentenário da sua morte*, ed. Manuel Antunes et al. (Lisbon: Brotéria, 1983), 165-81. The essential reference for any study of the Jesuits in Portugal is still the massive though somewhat dated multivolume work by the Jesuit historian Francisco Rodrigues, *História da Companhia de Jesus na assistência de Portugal*, 4 vols. in 7 bks. (Porto: Apostolado da Imprensa, 1931-1950). A recent, and excellent, contribution is Dauril Alden, *The Making of an Enterprise: The Society of Jesus in Portugal, Its Empire, and Beyond, 1540-1750* (Stanford, CA: Stanford University Press, 1996).

12. See Gian Paolo Brizzi (ed.), *La Ratio Studiorum: Modelli culturali e pratiche educative dei Gesuiti in Italia tra cinque e seicento* (Rome: Bulzoni, 1981); Frederick A. Homann (ed.), *Church, Culture and Curriculum: Theology and Mathematics in the Ratio Studiorum* (Philadelphia: Saint Joseph's University Press, 1999).

13. The pioneer study about this Jesuit mathematical course is Luís de Albuquerque, “A ‘Aula da Esfera’ do Colégio de Santo Antão no século XVII,” *Anais da Academia Portuguesa de História* 21 (1972), 337-91. This is today largely superseded by the works of Ugo Baldini. See, by Baldini: “As assistências ibéricas da Companhia de Jesus e a actividade científica nas missões asiáticas (1578-1640): Alguns aspectos culturais e institucionais,” *Revista Portuguesa de Filosofia* 54 (1998), 195-245; “The Portuguese Assistancy of the Society of Jesus and Scientific Activities in Its Asian Missions until 1640,” in *História das ciências matemáticas: Portugal e o Oriente* (Lisbon: Fundação Oriente, 2000), 49-104; “L'insegnamento della matematica nel Collegio di S. Antão a Lisboa, 1590-1640,” in *A Companhia de Jesus e a missão do Oriente* (Lisbon: Fundação Oriente/Brotéria, 2000), 275-310; “The Teaching of Mathematics in the Jesuit Colleges of Portugal from 1640 to Pombal,” in *The Practice of Mathematics in Portugal: Papers from the International Meeting Organized by the Portuguese Mathematical Society, Óbidos, 16-18 November, 2000*, ed. Luís Saraiva and Henrique Leitão (Coimbra: Imprensa da Universidade de Coimbra; Acta Universitatis Conimbricensis, 2004), 293-465.

14. See references in previous note.

15. Resina Rodrigues, “Física e filosofia da natureza na obra de Inácio Monteiro,” in *História e desenvolvimento da ciência em Portugal (até ao Século XX)* (Lisbon: Academia das Ciências de Lisboa, 1986), 1:191-242; Ana Isabel Rosendo, “Inácio Monteiro e o ensino da matemática em Portugal no século XVIII” (master's thesis, Universidade do Minho, Braga, 1996); Ana Isabel Rosendo, “O compendio dos elementos de mathematica do P. Inácio Monteiro,” *Revista Portuguesa de Filosofia* 54 (1998), 319-53.

16. João Manuel S. A. Miranda, “Alguns aspectos do intercâmbio científico e cultural entre a Academia das Ciências de Petersburgo e a comunidade dos

“Jesuítas Matemáticos” em Pequim nas décadas de 30–50 do século XVIII,” in Silva Gonçalves, *A Companhia de Jesus e a missão no Oriente*, 331–64.

17. Henrique Leitão, “Os primeiros telescópios em Portugal,” in *Actas do 1º Congresso Luso-Brasileiro de História da Ciência e da Técnica* (Évora, Portugal: Universidade de Évora, 2001), 107–18; Henrique Leitão, “Jesuit Mathematical Practice in Portugal, 1540–1759,” in *The New Science and Jesuit Science: Seventeenth Century Perspectives*, ed. Mordechai Feingold (Dordrecht, Netherlands: Kluwer, 2003), 229–47.

18. Luís Saraiva (ed.), *History of Mathematical Sciences: Portugal and East Asia*, vol. 1 (Lisbon: Fundação Oriente, 2000) and vol. 2 (Lisbon: EMAF-UL, 2001); Luís Miguel Carolino and Carlos Ziller Camenietzki (eds.), *Jesuítas, ensino e ciência* (Casal de Cambra, Portugal: Caleidoscópio, 2005).

19. Juan Casanovas and Philip C. Keenan, “The Observations of Comets by Valentine Stansel, a Seventeenth Century Missionary in Brazil,” *Archivum Romanum Societatis Iesu* 62 (1993), 319–30 and three works by Carlos Ziller Camenietzki: “O cometa, o pregador e o cientista: António Vieira e Valentim Stansel observam o céu da Bahia no século XVII,” *Revista da Sociedade Brasileira de História da Ciência* 14 (1995), 37–52; “Savants du bout du monde: Les Jesuites astronomes de Salvador,” in “Symposium: Mission et diffusion des sciences européennes en Amérique et en Asie—Le cas Jésuite (XVIe–XVIIe siècles)” (21st International Congress on the History of Science and Technology, Mexico City, 2001), *Archives Internationales d’Histoire des Sciences* 52, no. 148 (2002), 147–58; and “The Celestial Pilgrimages of Valentin Stansel (1621–1705), Jesuit Astronomer and Missionary in Brazil,” in *The New Science and Jesuit Science: Seventeenth Century Perspectives*, ed. Mordechai Feingold (Dordrecht, Netherlands: Kluwer, 2003), 249–70.

20. For exemple, see the classical works: Serafim Leite, “Diogo Soares SI, matemático, astrónomo e geógrafo de Sua Majestade no estado do Brasil (1684–1748),” *Brotéria* 45 (1947), 596–604 and Jaime Cortesão, “A missão dos padres matemáticos no Brasil,” *Studia* 1 (1958), 123–50. Or the more recent studies: André Ferrand de Almeida, *A formação do espaço brasileiro e o projecto do novo atlas da América portuguesa (1713–1748)* (Lisbon: Comissão Nacional para as Comemorações dos Descobrimentos Portugueses, 2001); Manuel Fernandes Thomaz and Isabel Malaquias, “Aspectos científicos das expedições de demarcação de limites na América meridional,” in *Actas do 1º Congresso Luso-Brasileiro de História da Ciência e da Técnica* (Évora, Portugal: CEHFC-Universidade de Évora, 2001), 201–13.

21. The standard history of the Jesuits in Brazil is still a good source of information: Serafim Leite, *História da Companhia de Jesus no Brasil*, 10 vols. (Lisbon and Rio de Janeiro: Portugália/INL, 1938–1950) [reprinted in 4 vols. (São Paulo: Edições Loyola, 2004)]. More recent studies are the following: Paulo de Assunção, *A terra dos Brasis: A natureza da América portuguesa vista pelos primeiros jesuítas (1549–1596)* (São Paulo: Annablume, 2001); Fernando Santiago dos Santos, “Os Jesuítas, os indígenas e as plantas brasileiras: Considerações preliminares sobre a triaga brasileira” (master’s thesis, Pontifícia Universidade Católica de São Paulo, 2003).

22. Bernardino António Gomes, *Elogio histórico do Pe. João de Loureiro* (Lisbon: Typographia da Aacdemia Real das Sciencias de Lisboa, 1865); E. D. Merrill, "A Commentary on Loureiro's 'Flora cochinchinensis,'" *Transactions of the American Philosophical Society* 2, no. 24 (1935), 1-13, 19-23, 28-29, 33-35, 38-49.

23. Carlos França, "Os portugueses do século XVI e a história natural do Brasil," *Revista de História* 15 (1926), 3-119.

24. Dorotheus Schilling, *Os Portugueses e a introdução da medicina no Japão* (Coimbra: Instituto Alemão da Universidade de Coimbra, 1931); Arlindo Camilo Monteiro, *De l'influence portuguaise au Japon* (Lisbon: Seara Nova, 1934); Luís de Pina, *Evangelização e medicina portuguesa no Japão quinbenista* (Coimbra: Tipografia Gráfica de Coimbra, 1950); Charles Boxer, "A Note on the Interaction of Portuguese and Chinese Medicine in Macao and Peking (16th-18th Centuries)," in *Medicine and Society in China*, ed. J. Z. Bowers and E. F. Purcell (New York: Josiah Macy Jr. Foundation, 1974), 22-39.

25. For example, the actions of Portuguese astronomers at the court of Jai Singh. See A. Delduque da Costa, "Os padres matemáticos no observatório de Jaipur," *Oriente Português* 4 (1932), 58-64; Amândio Gracias, "Uma embaixada científica portuguesa à corte dum rei indiano no século XVIII," *Oriente Português* 19-21 (1938), 187-202; G. Moraes, "Astronomical Missions to the Court of Jaipur, 1730-1743," *Journal of Bombay Royal Asiatic Society* 27 (1951), 61-65; Virendra N. Sharma, "Jai Singh, His European Astronomers, and the Copernican Revolution," *Indian Journal of the History of Science* 17 (1982), 333-44; Virendra N. Sharma and Lila Huberty, "Jesuit Astronomers in Eighteenth Century India," *Archives Internationales d'Histoire des Sciences* 34 (1984), 99-107.

26. See for example the work by Ines Zupanov, *Disputed Mission: Jesuit Experiments and Brahmanical Knowledge in Seventeenth-Century South India* (New Delhi and New York: Oxford University Press, 1999); M. N. Pearson, "Hindu Medical Practice in Sixteenth-Century Western India: Evidence from Portuguese Sources," *Portuguese Studies* 17, no. 1 (2001), 100-13; A. Salema (ed.), *Ayurveda at the Crossroads of Care and Cure: Proceedings of the Indo-European Seminar on Ayurveda Held at Arrabida, Portugal, in November 2001* (Lisbon and Pune, India: Centro de História de Além-Mar, Universidade Nova de Lisboa, 2002); I. Zupanov, "Drugs, Health, Bodies and Souls in the Tropics: Medical Experiments in Sixteenth-Century Portuguese India," *Indian Economic and History Review* 39, no. 1 (2002), 1-43.

27. See José Lopes Dias, "O Renascimento em Amato Lusitano e Garcia de Orta," *Estudos Castelo Branco* 4 (1964); Charles Boxer, *Two Pioneers of Tropical Medicine: Garcia d'Orta and Nicolás Monardes* (London: Hispanic and Luso Brazilian Councils, 1963); R. N. Kapil and A. K. Bhatnagar, "Portuguese Contributions to Indian Botany," *Isis* 67 (1976), 449-52; Luís Filipe Barreto, *Garcia de Orta e o diálogo civilizacional* (Lisbon: Instituto de Investigação Científica e Tropical, 1983).

28. Carolus Clusius, *Aromatum et simplicium aliquot medicamentorum apud indos nascentium historia* (Antwerp, Belgium, 1567), 4.

29. A detailed comparative study of de Orta's *Colloquies* and Clusius's *Aromatum et simplicium* is still a desideratum.
30. A second edition was printed in 1872 edited by Adolfo de Varnhagen, followed by another in 1891 (first volume) and 1892 (second volume). This was commented and edited by Conde de Ficalho and become the standard edition of the *Colloquies*. Conde de Ficalho was also the author of the first biography on the eminent Portuguese physician and naturalist: *Garcia de Orta e o seu tempo* (Lisbon: Imprensa Nacional, 1886). A more recent biography is provided in Jaime Walter, *Garcia da Orta: Relance da sua vida* (Lisbon, 1963).
31. Luís de Pina, *Contribuição dos portugueses quinhentistas para a história da medicina do Oriente: Nota preliminar* (Lisbon: Sociedade Nacional de Tipografia, 1938), 295.
32. Carlos França "Os portugueses da renascença, a medicina tropical e a parasitologia," *O Instituto* 73 (1926), 1–18.
33. Luís de Pina, *As ciências na história do império colonial português, séculos XV a XIX* (Porto: Imprensa Portuguesa, 1945), 4.
34. Jorge Canizares-Esguerra, "Iberian Science in the Renaissance: Ignored How Much Longer?" *Perspectives on Science* 12, no. 1 (2004), 86–124.
35. In his *In Discoridis Anazarbei de medica materia libros quinque enarrationes* (1553), Amato Lusitano presents the description of new materia medica from the Orient. Unlike Garcia de Orta, he had not visited or lived in territories from the New World. He obtained plant specimens and information from Portuguese and Venetian navigators. See José Lopes Dias, *Comentários ao "Index Discorides" de Amato Lusitano* (Castelo Branco, Portugal: Gráfica de S. José, 1968).
36. Carlos França, "Os portugueses do século XVI e a História Natural do Brasil," *Revista de História* 15 (1926), 3–119; Luís de Pina, *Contribuição dos portugueses quinhentistas para a história da medicina do Oriente: Nota preliminar* (Lisbon: Sociedade Nacional de Tipografia, 1938); Luís de Pina, *Flora e fauna brasileiras nos antigos livros médicos portugueses* (Coimbra: Coimbra Editora, 1944). A more recent study on the multidirectional flow and acclimatizing of plants is José Mendes Ferrão, *A aventura das plantas e os descobrimentos portugueses* (Macau: Comissão Territorial de Macau para as Comemorações dos Descobrimientos Portugueses, 1996).
37. Alberto C. Correia, *O ensino de medicina e cirurgia em Goa nos séculos XVII, XVIII e XIX: História do ensino médico-cirúrgico no Hospital Real de Goa, antes da fundação da Escola Médico-Cirúrgica de Nova-Goa* (Bastorá: Tipografia Rangel, 1941); Luís de Pina, *Expansão hospitalar portuguesa ultramarina: Séculos XVI e XVII* (Porto: Tipografia Porto Médico, 1943). More recent contributions on charitable institutions include Laurinda Abreu, "O papel das Misericórdias dos 'lugares de além-mar' na formação do império português," *História, Ciências, Saúde—Manguinhos* 8, no. 3 (2001), 591–611 and Isabel Sá, "Shaping Social Space in the Centre and Periphery of the Portuguese Empire: The Example of the Misericórdias from the Sixteenth to the Eighteenth Centuries," *Portuguese Studies* 13 (1997), 210–21.
38. William J. Simon, *Scientific Expeditions in the Portuguese Overseas Ter-*

rorities (1783–1808): The Role of Lisbon in the Intellectual Scientific Community of the Late Eighteenth Century (Lisbon: Instituto de Investigação Científica Tropical, 1983). A general survey of the topic is provided in David M. Knight, “Travels and Science in Brazil,” *História, Ciências, Saúde—Manguinhos* 8, supplement (2001), 809–22.

39. R. Carvalho, *A história natural em Portugal no século XVIII* (Lisbon: Biblioteca Breve, 1987), 39–62.

40. See José Luís Cardoso, “From Natural History to Political Economy: The Enlightened Mission of Domenico Vandelli in Eighteenth-Century Portugal,” *Studies in the History and Philosophy of Science* 34 (2003), 781–803.

41. See João Carlos P. Brigola, *Coleções, gabinetes e museus em Portugal no século XVIII* (Lisbon: Fundação Calouste Gulbenkian, Fundação para a Ciência e a Tecnologia, 2003).

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Chapter Three

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2. See also Antonio Barrera-Osorio, *Experiencing Nature: The Spanish American Empire and the Early Scientific Revolution* (Austin: University of Texas Press, 2006).

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