'For the Sciences Migrate, Just Like People': The Case of Botanical Knowledge in the Early Modern Iberian Empires

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In his writings, Francis Bacon emphasized the interrelatedness between the migration of people and knowledge, arguing that Europeans of his time had surpassed the greatest civilizations because of their ability to traverse the world freely. Concentrating on Spanish observers who investigated New Spain's flora, this article bridges theory and practice by examining the Iberian roots of Bacon's views. The article examines scientific approaches for acquiring bioknowledge by Iberians who specialized in European medicine, including Francisco Hernández, Juan de Cárdenas and Francisco Ximénez. While the article recognizes the contribution of travellers and expatriates to Spain's bioprospecting project, it also points to the ways in which the limitations of the transfer of botanical information was acknowledged and discusses its meaning. By presenting the complexities in the communication of knowledge, I argue, naturalists in the colonies could highlight their unique vantage point in relation to "armchair" specialists in the metropole.

The English natural philosopher and statesman Sir Francis Bacon (1561–1626) belonged to a generation that experienced first-hand the opportunities that resulted from the rise of European empires. In his *De augmentis scientiarum*, Bacon commented that "sciences migrate, just like peoples" (Bacon [1623] 1635, p. 91). The Iberian expansion into the Atlantic and the Pacific, in particular, served as the impetus for the Lord Chancellor to urge the English court to follow a similar imperial course with the intention of reconstituting a New Science (Marroquín Arredondo and Bauer 2019, p. 4; see also Findlen 2018, pp. 1–4; Cañizares-Esguerra

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2004; Gaukroger 2004, p. 117). This seemingly simple contention by one of the most prominent champions of early modern science provides a starting point to connect geopolitical and demographic developments at the beginning of European colonialism with epistemological transformations that founded modern science.[1]

The beginning of the modern era was characterized by massive and unprecedent migration across the four quarters of the world. Among these waves of people in movement were the many refugees who sought asylum following religious wars and political strife that tore the European continent apart (Terpstra 2015). Additionally, the colonial expansion of Europe, for its part, connected the continent to Asia, Africa and America, consolidating a global economy that increased the movement of people and brought about, what Serge Gruzinski has described, "the first stage of globalization" (Gruzinski 2004). The socio-demographic changes that followed this process had undoubtedly negative impacts, even catastrophic ones, for many indigenous communities. Yet, these developments were fruitful for Western scientific activities, and especially for botanical and pharmacological exchange which developed mainly as a result of commercial interests and the desire to find new sources of revenues for European states (Cook 2007; Schiebinger and Swan 2004; On Habsburg Spain's vision for imperial knowledge: Brendecke 2016; Pimentel 2000). Administrators, merchants, missionaries, soldiers, explorers, and emigrants, with the collaboration of indigenous populations and other ethnic groups (for instance, enslaved Africans),[2] forged new, long-distance knowledge networks that "became a defining feature of the early modern world" (Findlen 2018, p. 4).

In this context, historians have devoted considerable attention to the processes of circulation and cultural translation of knowledge, seeing, especially in the natural sciences, a dynamic "form of communication" (Secord 2004). This paradigm privileges the social environment that supported the transmission of ideas and objects and highlights the information-gathering techniques that brought about "knowledge in transit." Experience outside of one's native country became a salient feature that frequently accounted for the move and exchange of knowledge. For instance, the historian of science, Peter Burke, in a sense corroborated Francis Bacon's aphorism by elaborating on the connection between the displacement of knowledge and people. Focusing on the "disproportionate contribution" of exiles and

1. On European colonialism and the vision of scientific progress as two ideologies that developed in parallel and in conjunction during the sixteenth-century, see Burns 2016, p. 42; Maravall 1966.

2. On botanical knowledge and the institute of slavery: Gómez 2018; Carney 2004.

expatriates to modern science, Burke viewed the experience of displacement as "a tough form of education" that supported the scientific program in the West. Expatriates, he explains, spread ideas between their original homeland and hostland, often by creating innovative hybrid studies which were marked by a detached approach and a more objective perspective of "the stranger" (Burke 2017, pp. 8, 12, 17, 22–31). This positive consequence of an alien gaze is true not only for exiles, but is also one that most distinctively affected colonial observers of nature.

The scholarly attention to the field of natural history, including the histories of ethnobotany, pharmacological and medical exchange plays no small part in the historiographical reorientation toward the migration of knowledge. The utility of the transfer of botanical knowledge for empire building became a prominent topic that sheds light on the interactions of regional, global, and commercial networks that supported the circulation of information and specimen (for instance, Schiebinger 2004; Drayton 2000). In particular, historians of the Iberian expansion have examined the intrinsic links between imperial endeavors, commerce and empiricism that matured by colonial bioprospecting in Asia and the Americas (Županov and Barreto Xavier 2014; Walker 2009; de Vos 2006; Bleichmar 2004; Barrera-Osorio 2001). These studies provided a complex understanding of science that emphasized both the utilitarian approach that emerged due to the desire to exploit natural resources and to the adaptations of bioknowledge for use in particular geo-cultural contexts in the Atlantic and the Pacific. The field of early modern botany thus became a prism through which colonial encounters are viewed as well as a mirror of the developments in the Iberian monarchies' epistemic culture. The focus on the production of knowledge in the colonies has further helped to reveal the agency of local interlocutors who took part in the exchange of bioknowledge and botanical specimens. As Susan Parrish has asserted colonial subjects "were not mere collectors for the knowledge makers of the metropole" (Parrish 2006, p. 4).

In this context, this article revisits the topic of the mobility of bioknowledge in the age of modern science, roughly from the end of sixteenth century to the first decades of the seventeenth century (not incidentally, a period that coincided with the life of Bacon himself). Focusing on Iberian expatriates and travellers who specialized, formally and informally, in European medicine, including Francisco Hernández, Juan de Cárdenas, and Francisco Ximénez, my intention is to study Iberian scientific attitudes towards acquiring bioknowledge, and through this, bridge theory and practice regarding the mobility of knowledge in Bacon's times. Studies about these medical practitioners and more broadly about the botanical and medicinal activities in the viceroyalty of New Spain have been central

to the integration of Iberian and Amerindians scientific attitudes and systems of knowledge into the revised and globally-conscious narrative of modern science (for example, Fresquet Febrer and López Piñero 1995; for the geographical reorientation of modern science, see: Burns 2016; Raj 2007). Nevertheless, this article aims to go further than reiterating the role of travelers in the making of natural knowledge (on eyewitness and reliability in the knowledge produced by travelers: Pimentel 2003, pp. 25–109; see also Hayden 2016), or by stressing the links between Bacon's ideas and earlier, Iberian global explorations (see Marroquín Arredondo and Bauer 2019, pp. 3–5). Studying discursive strategies of naturalists in the colonies, I argue, also allows us to nuance Baconian (read: metropole) views on the incremental accumulation of information by examining the multiple perceptions of movement of knowledge in early science. This shows not only knowledge migration as a multi-vectored process, but also highlights the limitations of the transfer of information. Contrasting distinct views of early science will point to instances in which the possibility of transferring bioknowledge was questioned by overseas observers and the limitations of the imperial bioprospecting project were acknowledged. I will begin the article by presenting Bacon's ideas on the circulation of knowledge, stressing the impact of Iberian monarchies' experience on his writings. Then, I will re-examine the concept of the transfer of knowledge, arguing that by claiming that not all knowledge was indeed movable, colonial observers protected their special position in relation to those of "armchair" specialists in the metropole.

1. Chamber of Knowledge and Merchants of Light

The famous frontispiece of Bacon's *Instauratio Magna* (1620) offers a captivating visualization for the migration of science in the so-called Age of Discovery (see Figure 1). The image depicts a ship crossing through "the pillars of Hercules" (Gibraltar) that separates the Mediterranean Sea from the Atlantic Ocean. The straits, which were perceived in past eras as physical obstacles for pilots and a metaphorical barrier to knowledge of the wider world, was represented in Bacon's time as a gate through which ships would embark and return from the open seas, bringing new ideas and objects to Europe. Below the painting, a revealing inscription from the Book of Daniel 12:4—"*Multi pertransibunt et augebitur Scientia*" ["Many will pass through, and knowledge shall be increased"]—connects contemporary European expansion with biblical prophecy about the coming of a new era. The image and the epigraph together suggest the meaning of knowledge migration for Bacon and the European metropole at the dawn of modernity by associating scientific progress with maritime voyages and geographical expeditions, particularly in recently discovered America (see

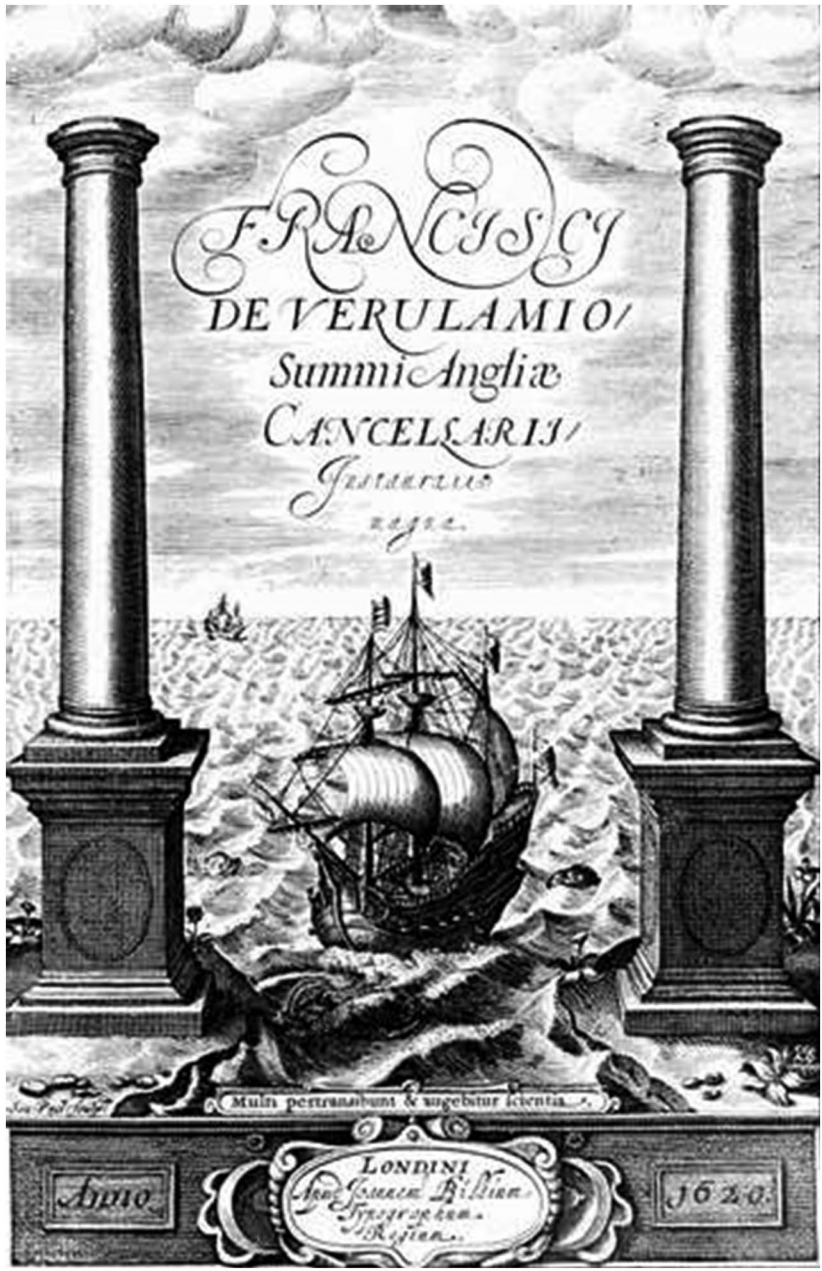

Figure 1. Title page to Francis Bacon, *Instauratio Magna* (London, 1620).

Grafton and Siraisi 1992, pp. 197–208). Whereas Bacon generally viewed knowledge as a practical tool for improving human existence (Vickers 1992; Pérez-Ramos 1988), he additionally recognized that new scientific discoveries entailed a religious, redemptive component for postlapsarian humanity (see Scalercio 2018, p. 80): a path for salvation in the spirit of the prophet Daniel whose words he quoted.[3]

For Bacon, the movement of people and the migration of knowledge were complementary and interrelated historical processes: Many will travel, and knowledge shall be increased. Bacon also used this quote from Daniel in his other writings in order to convey the idea that contemporary Europeans surpassed the knowledge held by the greatest classic civilizations, namely Greece and Rome, precisely because of the ability in his time to traverse the world freely.[4] The movement of people, Bacon reckoned, perhaps with excessive optimism (and naivety), would safeguard the progress of science (*scientia*) for the benefit of *all* of humankind—not just for the select group of "travellers." Without the flow of people, science would be stopped and with it, human progress.

Bacon further provided a blueprint on how to support the advancement of science by persistently carrying out and supporting the movement of people. In his posthumously published utopian work, *Nova Atlantis*, Bacon described how human societies should be organized and governed in a way that served science (For a discussion on these ideas and their impact on the British Empire: Irving 2008, pp. 1–46). The well-known fictional story tells about a group of English travellers who lost their way at sea and reached an imaginary kingdom on an island, Bensalem, where scientists receive utmost honor and the chief purpose of the state was to support science. The "lanthorn of this kingdom" is Salomon's House, a semi-academic institution in which scientific experiments and observations are conducted in multiple scholarly fields with the intention of "enlarging of the bounds of

3. The purpose of the study of nature was then to reinstate human's *dominium* on the created world that was impaired as a consequence of Adam's Fall. Francis Bacon, *Valerius Terminus*: Works iii.222; see discussion on Bacon's concept of sacred history: Matthews 2008, pp. 51–8 and 90–8.

4. For example, Bacon stated: "This proficience in navigation and discoveries may plant also an expectation of the further proficience and augmentation of all sciences; because it may seem that they are ordained by God to be coevals, that is, to meet in one age. For so the prophet Daniel speaking of the latter times foretelleth ['Many shall go to and fro on the earth, and knowledge shall be increased,'] :as if the openness and through-passage of the world and the increase of knowledge were appointed to be in the same ages" (Bacon [1605] 1974, p. 78; see also Francis Bacon's *New Organon*. Bacon [1620] 2000, p. 78. On the contribution of travels to expand the "narrow limits of the ancients" Bacon [1620] 2000, p. 69).

Human Empire, to the effecting of all things possible."[5] While the inhabitants of the isolated island keep their distance from the outside world, the "fellows" at Salomon's House continuously gather reports, instruments and specimens from around the world by special crews that are sent overseas on secretive "spying" missions. These "Merchants of light," as Bacon named these travellers, collect "books, and abstracts, and patterns of experiments" (Bacon "New Atlantis" (1627) in Bruce 1999, p. 183) from foreign countries that are later deposited in Salomon's House, which functions as a state of the art archive of natural history and all human scientific accomplishments.[6] Importantly, as Stephen Gaukroger has clarified, Bacon did not envisage public and universal access to the accumulated knowledge (i.e., on the part of all the kingdom's subjects), but rather, he imagined this operation as a function that served the sovereign (the king of England) (Gaukroger 2004, p. 9).[7]

Nova Atlantis was a fictional story, yet the way of collecting information and natural objects was not totally imaginary and was at least partially based on a reality that had developed following the sixteenth-century Iberian maritime expeditions (Barrera-Osorio 2006a, p. 11; Cañizares-Esguerra 2004, pp. 86–92). In particular, two critical elements in Bensalem's handling of data had a Spanish precedent, namely, first, the use of a centralized unit to accumulate massive amounts of information and, second, the recruitment of mobile agents for this purpose. The similarities are hardly surprising given that Bacon specifically addressed the Iberian expansion to the West and East Indies in his writings. The conquests of Spain are mentioned in *Nova Atlantis* when a ship that had embarked from Peru supposedly arrived at the island. Additionally, the residents of Bensalem spoke Spanish, the *lingua franca* which allowed them to obtain reports from afar. Spanish influence on Bacon can be seen also in the

5. Bacon described that Salomon's House was perceived by the islanders: "the noblest foundation (as we think) that ever was upon the earth; and the lanthorn of this kingdom" (Francis Bacon, "New Atlantis (1627)" in Bruce 1999, pp. 167, 177).

6. Bacon saw a special connection of King Solomon to botany since the king, in his words, "was a man so seen in the universality of nature that he wrote an herbal of all that was green upon the earth" (Bacon quoted in Gaukroger 2004, p. 73). Bacon's idea of taking advantage of passengers in foreign countries for gathering information under the aegis of a research institute was adopted by the Royal Society of London (est. 1660), which like Salomon's House was informed about the world by collaborating with informants. Gascoigne 2009, pp. 539–62.

7. Bacon understood the collection of reliable data by the state as an essential element in the reform of natural philosophy: The King should take "steps to ensure that a Natural and Experimental History be built up and completed: the true, strict history (without philological questions) which is the path to the foundation of philosophy [...] So that at last, after so many ages of the world, philosophy and the sciences may no longer float in the air, but rest upon the solid foundations of every kind of experience [...]" Bacon [1620] 2000, pp. 4–5.

frontispiece of *Instauratio Magna* that was printed in 1606 in *Regimiento de Navegación* by the Spanish Royal cosmographer Andrés García de Cespedés (1560–1611), as Juan Pimentel reminds us (Pimentel 2000, pp. 23–4). In short, Francis Bacon's scientific theories (and fantasies) articulated experiential methods that had been develop in previous generations, primarily across the Atlantic, as the Spanish administration devised innovative, long-distance empirical methods to overcome the vast maritime distances that separated Spain from its new possessions (Barrera-Osorio 2006a).

In this context, the activities at the House of Trade in Seville [*Casa de la Contratación de las Indias*], which was established in 1503 to oversee the movement of people and goods to and from America, demonstrates information-gathering practices in the Spanish world. The *Casa* collected and analyzed geographical reports as well as botanical and zoological specimens, taking advantage of the movement of people to the region and back for the utilitarian study of the Indies. For example, throughout the sixteenth century, the *Casa* gathered information on maritime navigation routes by demanding returning ships report upon their voyages and discoveries. The reports of longitude and latitude were copied onto a map of sea routes, islands and coastal areas that was preserved in Seville—the *Padrón Real*—and used as the basis for the creation and distribution of nautical maps among Spanish seafarers (Sánchez 2013). The Spanish administration supervised and regulated the flow of cosmographic information and functioned, inter alia, as a centralized "learning bureaucracy" that standardized knowledge (see Portuondo 2009). Such activities were characterized by "collective empiricism" (on this term, see Daston and Galison 2007, pp. 19–27) whose purpose was to accumulate the (partial) experience of individuals in order to piece together a broader geographical perspective. The project's success depended, not only upon the existence of a centralized bureaucracy, but also upon the movement of skilled people (in the aforementioned example, pilots) who received appropriate training.

Spain's experience paved the way for other European nations, who used similar scientific tools and programs to study colonial territories (Barrera-Osorio 2006b; Carey 2009). Antonio Barrera-Osorio and other historians have pointed to the similarity between the various empirical activities (and the secrecy) at the *Casa* and those that took place at Francis Bacon's imaginary Salomon's House.[8] Indeed, similar measures were later taken by the

8. "The Casa evolved through its activities into a veritable chamber of knowledge [...] The activities and programs of this chamber of knowledge pre-dated Francis Bacon's depiction of 'Solomon's House', as well as the knowledge gathering activities of such scientific institutions as the Royal Society of London" (Barrera-Osorio 2010, p. 134; on the secrecy of the Spanish cosmographic program: Portuondo 2009, pp. 6–7).

Royal Society of London that, like Spain's colonial administration, realized the importance of individual reports in compiling a large database on foreign lands (Gascoigne 2009).

2. Botany on the Move

From early on, the Spanish Crown recognized the potential of expatriates and travellers for valuable information on distant lands and issued decrees that aimed to take advantage of the mobility of people. The royal orders instructed in detail what kind of information was expected from the reports, including geographical and biological information that was necessary for governance and trade.[9] Moreover, the Spanish crown directly promoted and encouraged mobility, including by financing the costs of overseas research. A famous example of state-funded study was the expedition of Dr. Francisco Hernández (ca. 1515–1587), the chief medical officer (*protomédico general de todas las Indias*) in the court of King Philip II and a well-known physician who was sent from Spain to Mexico in the 1570s to study American nature.

Realizing the commercial and medicinal potential of plants in the Spanish American possessions, the royal instructions explicitly requested Hernández, whenever possible, to "experience and test at first hand" the plants' practical use.[10] His instructions also reveal that the Crown was informed that the quantities of known valuable plants is higher in Mexico than any other part of the Indies, and as such assigned Hernández primarily "to gather information generally about the herbs, trees and medical plants" in that land.[11] Like the "merchants of light" in Bacon's *New Atlantis* who brought to their island new empirical findings, Hernández's expedition expanded the botanical and zoological horizons of his days (Hernandez 1960; López Pinero 2007, pp. 115–30). After years of systematic field work in Mexico, Hernández returned to Spain (in May 1577) with the knowledge of over 3000 new plants and hundreds of species of birds and animals, which he described in detail in his manuscripts that were distributed across Europe (see López Piñero and Pardo Tomás 2000).

9. "*Ordenanzas para la formación del libro de las descripciones de Indias*," San Lorenzo de El Escorial, 3 Julio 1573. Pp. 16–74 in *Cuestionarios para la formación de las relaciones geográficas de Indias*, siglos XVI–XIX, edited by Francisco de Solano, Madrid: CSIC, 1988. On the importance of the royal decree: Barrera-Osorio 2006b, pp. 47–8; Alvarez Peláez 1993, pp. 170–215.

10. The Royal instructions to Francisco Hernández, January 11. 1570. (Diego de Encinas 1945, vol. 1, pp. 224–25).

11. The Royal instructions to Francisco Hernández, pp. 224–25.

The descriptions were supplemented by botanical specimens and additional paintings by artists who assisted Hernández in visualizing the unfamiliar nature for distant readers.

Facing the challenge of defining plants that had not yet been documented in existing literature, Hernández described his working method, which was also explained in the Royal appointment letter (unfortunately another essay in which he expanded upon the means to identify plants is lost) (Varey 2000, p. 52). The Spanish *protomédico* recognized that the experience of indigenous physicians with local plants was far greater than that of European immigrants, and therefore admitted that he preferred to learn directly from the natives about the properties of the plants, the climate and environmental conditions in which they grew, and their recognized medical use. His attitude stands in contrast with European botanists who tended to disregard and belittle the importance of the native informants in their writings (Pardo Tomás 2007, pp. 175–6, 181–2, 191–3). Unlike stories on the lack of cooperation among the Amerindians that were circulating in Europe, Hernández claimed to have found much assistance among them.[12] He employed a large number of native assistants including Indian doctors [*ticitl*], *pintores*, *intérpretes*, *herbolarios*, and urged the king to pay the Indians who brought him plants and reports from the different geographic and climatic regions of the viceroyalty.[13] While Hernández criticized what he considered to be the lack of theory in native medicinal practices,[14] he not only collected *relaciones,* herbs and seeds[15] from Indian doctors, he also incorporated Nahuatl classifications into his report (Bustamante García 1997).

12. Regarding the natives' lack of cooperation, consider the testimony of the soldier, Pedro de Osma y de Xara y Zejo, attached to Nicolas Monardes' *Historia Medicina*. Osma stated that Indians, being "our enemy," "would not disclose a secret [of plants] nor a property of an herb" even as "they saw us dying" (Monardes 1580, Fol. 62v; see also Monardes 1580, 58r. Compare with Viesca Triviño 1995).

13. Francisco Hernández's Letter to Phillip II, after returning to Spain in 1577 (Toribio Medina 1968, vol. 2, p. 291).

14. Hernández viewed the Indian doctors (*Titici*) as "mere empiricists" [*Son meros empíricos*] who prescribed traditional medicine without proper understanding on how they functioned: "Estos ni estudian la naturaleza de las enfermedades y sus diferencias, ni conocida la razón de la enfermedad, de la causa o del accidente, acostumbran recetar medicamentos, ni siguen ningún método en las enfermedades que han de curar. [...]." (Francisco Hernández, *Antigüedades de la Nueva España* edición de Ascensión H. de León Portilla, Madrid: Historia 16, 1986, p. 110).

15. On the collection of *relaciones*: letter by Francisco Hernández to Phillip II, dated December 1, 1574 (Toribio Medina 1968, vol. 2, p. 298). On the significance of the *relación* to Hernández's investigation: Marroquin Arredondo (2019).

As a trained doctor, Hernández understood the responsibility that rested upon his shoulders when he described species that were not found in the canonical botanical literature, including Pliny's *Naturalis Historia* which he himself translated for the first complete Spanish edition.[16] In addition to the priority Hernández gave to indigenous botanical knowledge, he also devised critical procedures for the verification of data, including testing specimens in different seasons and circumstances. Hernández describes the steps he took in order to avoid making a mistake in identifying the plants:

> I have relied both on the evidence of other curious persons and of the doctors of this land and my own experiences, beyond what can be deduced using the rules of medicine. In all this, great care has been taken that no plant is painted unless I have seen it ten or more times in different seasons, smelled and tasted all its parts and asked more than twenty Indians doctors, each one individually, and considered how they agree and differ, and unless I have subjected it to the rigorous methods of identification and examination that I developed here for this project.[17]

As much as the passage contains the information that Hernández could provide Europeans about the local plants, it is also saturated with data that could not cross oceans. Hernández's method demonstrates his strong preference for sensory experience in the identification process: touching, seeing, smelling, and even tasting the plant and its fruits in situ. Seasonal smells and tastes are naturally bound to time and space and cannot easily be reproduced in a different ecological environment. Above all, Hernández admits he did not settle for studying the physicality of things (i.e., their properties) but rather sought to explore the sensations they provoked. As with Franck Jackson's thought-experiment on Mary's room (i.e., the brilliant scientist who knows everything about the science of color, but has never experienced color in her black-and-white world), it seems that Hernández recognized (or at least, claimed so) that in his own "lab" sensations provided additional information to the study of physical properties (Jackson 2004). Complete knowledge had to be acquired in-person and in-situ, through personal experience; thus, not all knowledge gained in the peripheries did or could make its way back to the

16. Before embarking to Mexico, Hernández began translating Pliny's *Natural History*, adding annotations based on his experience. "Francisco Hernández's Letter to Phillip II" (Toribio Medina 1968, vol. 2, p. 292; see also Bustamante García 2013, pp. 25–37, 30).

17. Hernández quoted in Varey 2000, p. 52.

metropole.[18] Experiencing the plants in their native environment was not a possibility, however, for the foremost expert on New World plants, the Sevillian physician Nicolás Monardes (1493–1588), whose *Historia medicinal* was the most appreciated European source of New World *materia medica* in the late sixteenth century (see Bleichmar 2004). Monardes' decades of therapeutic experience and empirical evidence certainly helped to form the basis of his *Historia medicinal* (Pardo Tomás 2007, pp. 178–179). Yet, Monardes had never crossed the Atlantic, and despite his engagement with colonial botany and his long-term influence on the field (mainly through his translations by Clusius and others), his ability to repeat the same tests and to sense the plants were quite limited.

The work of naturalist-travellers like Hernández, and its long-term effect on the so-called *mestizaje cultural* in New Spain's medicine, can be compared to that of another famous Iberian physician, Garcia de Orta (ca. 1500–1568), whose experience outside of his native country helped him to integrate Far East medical knowledge into European consciousness.[19] In the backdrop of discovery expeditions in Asia and the continual persecution of Jews in the Iberian Peninsula, de Orta's life and book, *Colóquios dos simples e drogas e coisas medicinais da India* [*Colloquies on the Simples and Drugs of India*] (1563), reflect the connections between knowledge and people movements. De Orta, was a member of an exiled Sephardic Jewish family who had settled in Portugal, who returned to Spain to study medicine at the important universities of Salamanca and Alcalá (c. 1515–1525). After several years of teaching in Portugal, he moved in 1534 to Goa, the centre of the Portuguese Empire in India. In subsequent years, de Orta travelled and surveyed the west coast of India from Gujarat to Ceylon, before returning to Goa in 1538 where he practiced medicine for high-ranking clients until his death in 1568 (Fontes da Costa 2012; on de Orta's work in the context of converted Iberian Jews see Arrizabalaga 2015). De Orta's journeys on the Indian subcontinent and his position as a prominent physician in Portuguese India allowed him to gather a wealth of information on the Eastern *materia medica* (Pimentel and Soler 2014). Like

18. In fact, in one of Hernández' last letters, he pleaded with the king to support the speedy publication of his work, stating that if this were not done, due to Hernández' age and the pestilence that wiped out many of his Indian informers, the beneficial data would be lost. In his view, the loss would be irreversible. "*Ni seria posible restaurar esta pérdida aunque fuese en muchos años, por haberse muerto en esta pestilencia última gran cuantidad de médicos y pinctores {sic} indios que dello han dado y pudieran dar razón*." Letter to Phillip II after FH returned to Seville in 1577 (Toribio Medina 1968, vol. 2, p. 292).

19. The term *mestizaje cultural* is borrowed from Fresquet Febrer and López Piñero (1995). Garcia de Orta's *Colóquios* ([1563] 1987) was reprinted and translated into many languages shortly after its publication. It was also the first scientific book to be published in India by a European subject (Pimentel and Soler 2014, p. 109).

Hernández, in the places that de Orta visited, he exchanged ideas and information with physicians, scholars, merchants, and officials, either Europeans or natives, who provided him with vital details on the properties and use of herbs, medicines and spices including cinnamon, cloves, nutmeg, mangosteen and others.[20] This information was presented in the *Colóquios* in the form of an imaginary dialogue in which de Orta himself explains the medical cultures of the East by applying them to academic teachings in medicine (e.g., the works of Pliny, Galen, Avicenna, etc.).

Similar to the way De Orta integrated bioknowledge of the East into the European medicinal consciousness, on the other side of the globe, physicians like Juan de Cárdenas, wrote about American nature by bridging new empirical findings with academic teachings (López Pinero 2007, pp. 135–6). Cárdenas, unlike Hernández's and de Orta, did not aim to compile an exhaustive medicinal survey of local flora and fauna but sought, in his words, to "provide a solution and cause" for the "secrets" of the New World (Cárdenas 1591, fol. 63r). Born around 1563 in a village near Seville, Cárdenas migrated to the viceroyalty of New Spain while he was still young (approximately 1577) and studied medicine at the University of Mexico (he obtained a doctorate in 1590). At the young age of twenty-six, he wrote *Problemas y secretos maravillosos de la Indias* [*Problems and Marvellous Secrets of the Indies*] (1591), in which he employed Hippocratic-Galenic humeral principles to explain American natural phenomena. Cárdenas attributed the peculiar characteristics of his adopted home to the qualities of "heat and humidity that reigns in these Indies" (Cárdenas 1591, fol. 6v; see also 7r. 63r). According to his explanation, the close proximity to the equatorial sun had created the humoral conditions that were responsible for the frequent earthquakes, volcanoes, wind patterns, and even the qualities of the plants. From this perspective, he opposed "absurd stories" that attributed "magical" powers to indigenous healing practices, choosing, instead, to explain nutritional and other properties of local plants and herbs by the humoralism of Hippocrates and Galen (On the importance of humoralism in the Spanish world, and specifically to understandings of the New World, see: Earle 2012). In the case of herbs, he exclaimed, "we should doubt, and likewise explain how herbs can work and operate naturally in our bodies without the intervention of a pact with the devil or a miracle."[21]

20. Harold J. Cook and Timothy Walker remind us that spices and medicine were interchangeable concepts in Iberian languages (Cook and Walker 2013, p. 338).

21. "Me pareció declarar, y dar a entender al vulgo, qué sea esto que comunmente llaman todos hechizos, y enhechizar, o dar bocado, porque acerca desto, oygo dezir cada día dos mil quentos, y otras tantas historias patrañas [...] lo mucho que acerca de todo esto ay qué dudar, y assí mesmo dar a entender, lo que las yervas pueden hazer, y obrar en nuestros cuerpos naturalmente, sin intervenir pacto con el demonio, o por ventura negocio de milagro [...]." Cárdenas 1591, Fol. 234r–235r.

Cárdenas emphasized that nature operated within a framework of universally-applicable natural laws that could be discovered by joining academic theory and empirical facts through experience and reason ("*experiencia y razón*"). Written after another traveller-author, Gonzalo Fernández de Oviedo (1478–1557), gave eyewitness accounts a privileged place, Cárdenas, too, stressed his special position as an "expatriate" who could provide "inside" information to Europeans about the fourth part of the earth (On Oviedo's rhetorical strategies: Myers 2007, pp. 1–5, 63–81). While Cárdenas did acknowledge that the quality of his education in Mexico was not comparable to that available in Europe,[22] he insisted that being present in the colony offered him a unique and advantageous perspective to see and experience things directly. This rhetorical self-representation was particularly important to the young physician who had to build his authority in relation to well-reputed European physicians like Monardes. In this uneven competition, Cárdenas compensated for his young age and lack of a supposedly highly esteemed diploma from a prominent European academic institution (for instance, the prestigious university of Alcalá de Henares from which Monardes graduated) with something that he believed was, in the end, far more valuable: personal experience in the field.

This can be seen in the way Cárdenas described the plants of the West Indies, especially corn which he considered to be the "most balanced and moderate" plant (from the perspective of its qualities) in the botanical world. Corn, Cárdenas emphasized, was neither hot nor cold, neither dry nor humid. He added that because of its qualities it could be used for a variety of "complexions and illnesses."[23] Studying the plant *in situ*, Cárdenas reported the many virtues of maize for the Amerindians: from the fact it could grow in a variety of terrains and seasons to the fact that one could use the entire plant. This position also allowed him to reveal his deep familiarity with the natives' way of life, as he meticulously explored the different ways in which maize was prepared and used in Mexico. In one case, he offered a lengthy description of the various recipes of *atole*, a corn-derived porridge or drink. Using Nahuatl names and recipes, he differentiated between the "eight to ten most common" versions of *atole* (including mixed with chili, agave, fermented, and more), specifying for each the cooking technique and its digestive and nutritional advantages. Cárdenas argued that since *atole* was such a balanced food, the additives were what affected its humeral outcome, thus making it compatible to all complexions and "appropriate for every

22. Cárdenas even apologized in his text that he lacked the "erudition, polish and ornament" because of "the lack of teachers that I have had in the Indies" ("la falta que en Indias he tenido de maestros"). Cárdenas 1591, fol. 79r–80v.

23. Cárdenas 1591, fol. 142v–143r.

malady." For example, he tells of *xocoatole*, a sour *atole* that was fermented for "two or three days" and that was according to the doctor "refreshing, quenched one's thirst, and benefits all burning and great heat that one has in the human body" (Cárdenas [1591] 1998, pp. 175, 178).

Cárdenas obviously did not aim to write a colonial cookbook. By discussing the cultural use of the corn, rather than merely exploring its biological properties, Cárdenas could show his position as a man between worlds who could appropriate indigenous nutritional knowledge by providing it an additional European medicinal explanation. Unlike biological information on Aristotelian properties, shapes and colors of the plants, the information on specific sensations, such as "refreshing, quenched one's thirst" attest for a unique feeling that was not transferable to interpreters of information in the metropole. This sensual information was not surplus or redundant data as it had the capacity to explain the use and benefits of the corn-derived porridge by native peoples.

Notwithstanding their epistemic differences (as well as format of writing), the works of Iberian physicians such as de Orta in the East or Cárdenas and Hernández in the West, made it possible to expand the boundaries of European bioknowledge both by recognizing the importance of multigenerational botanical knowledge that had been accumulated among the local communities and by adopting critical methodologies to analyse their findings. As with Burke's insights on exiles' scientific production, their distance and perspective as strangers enabled these physicians to compile hybrid works that were based on both European and indigenous knowledge.

Despite the historiographical focus on the Spanish administration's empirical program, it should be remembered that the agents of knowledge were not solely the emissaries of the State. More than fulfilling evangelical duties, the Catholic Mission also took a leading part in the production and circulation of medicine and bioknowledge, as can be seen in the famous discovery of *antimalarial* Cinchona bark from Peru that Jesuit priests had introduced into European pharmacopoeia (Harris 1998, pp. 289–93; for a discussion on Jesuit accomplishments in natural history see Millones Figueroa and Ledezma 2005). The ability of missionaries to obtain valuable information and botanical resources from far-flung countries was an asset to both the Spanish monarchy and the Roman Catholic Church, which also underwent centralization processes during the Counter-Reformation period. In many ways, missionaries matched the ideal of the "empirical traveller."[24] They were mobile, erudite and literate and often excelled in

24. This notion is borrowed from Joan-Pau Rubiés who used it to describe the sixteenth-century writers who produced and disseminated anthropological knowledge (Rubiés 1993, pp. 161, 168).

foreign languages and natural sciences. Beginning in the mid-sixteenth century, royal decrees instructed members of religious orders and clergy to send detailed reports of their whereabouts (Jiménez de la Espada 1965, vol. 1, p. 50). Missionaries like the Carmelite Antonio Vásquez de Espinosa provided detailed reports based upon his experience in Spanish America to both the Spanish Crown and Rome. In his writings, Espinosa, who left for America in 1608, included information on American flora and indigenous medicinal knowledge, including one of the first descriptions of quinine (Segev 2018; Espinosa 1992).

Thanks to religious orders' intellectual infrastructure (including colleges, hospitals), global networks and collaboration with local elites, missionaries took a leading role in Spain's botanical activities. In fact, one of the earliest and most impressive examples of botanical transfer in the Spanish Atlantic is related to the evangelical activities of a religious order—the Franciscans at the *Colegio* de Santa Cruz in Tlatelolco, Mexico. The *Colegio* was established by the Franciscans in the 1530s as part of a large complex that included a monastery and library, in order to provide Christian instruction to the young Nahua elite of the Valley of Mexico. In 1552 the Franciscans there prepared a unique book for the Spanish Crown that explained the medicinal plants in Mexico, *Libellus de Medicinalibus Indorum Herbis* [*The Book of the Medicinal Herbs of the Indians*] (Badiano [1552] 2000; on the *Colegio* and the production of *Libellus* Pardo Tomás 2014, pp. 24–9). This Aztec herbal was first written in Nahuatl by Martín de la Cruz, a native healer with extensive medicinal knowledge, and then was translated into Latin (the original in Nahuatl is lost). Influenced by Pliny's *Natural History*, this book was nonetheless the first to be written about medical and botanical knowledge in central Mexico and included descriptions of some 250 Nahua therapeutic plants and many illustrations (Afanador Llach 2011, p. 21).

As with intercultural exchange in the Colegio, Colonial *hospitales* also contributed to the Atlantic bioknowledge production. The Dominican friar, Francisco Ximénez, worked at the *Hospital de la Santa Cruz* in Huaxtepec, Mexico, an institution that was associated with traditional Aztec herbal medicinal learning (Somolinos 1960, vol. I, pp. 202–3). Ximénez who was born in a village in Aragon, spent significant time outside the Iberian Peninsula including in Genoa, Italy, and Florida, before he arrived in New Spain in the year 1605 (For biographical notes: Varey and Chabrán 1994, pp. 128–9). Despite having no formal trainings in medicine, from his position at the hospital at Huaxtepec he succeeded in getting a selection of Dr. Hernández's botanical writings (whose expedition was discussed above) and published a Spanish edition that aimed to provide practical, autochthonous remedies for settlers who lived in regions far from

medical attention.[25] In his book, *Cuatro libros de la naturaleza* [*Four Books on Nature*] (Mexico, 1615), Ximénez described the plants and herbs found in New Spain, emphasizing their therapeutic qualities and uses. In addition to relying on Hernández's findings, Ximénez added comments from medical experience at the hospital, asserting that there is nothing in his work that "has not been certified by experience" ("*no va cosa en esta obra que la experiencia no la aya certificado*"). This clarification is particularly meaningful in the context of the authority that Monardes's work had enjoyed in Spain and beyond, but whose "errors" Ximénez aimed to correct. In the preface Ximénez noted the advantages of using local medicinal plants because, as he claimed, during the long oceanic crossing, herbs and plants tend to lose their potency ("*pierdan de su virtud*").[26] Ximénez was here referring to the medicines that were shipped from Spain and not to it; however, his observation reveals his opinion about the many advantages of studying the properties of plants in their natural environment where they are significantly more potent. Ximénez's contention is critical given the enduring data-gathering activities promoted by the Spanish administration and its visionary attempt to establish an Iberian "chamber of knowledge" that regulated and oversaw the process of knowledge-making. Historian Daniela Bleichmar is right to point out that Europeans acquired information about *materia medica*, as well as food and spices on European soil and thus "colonial botany was practiced not only in the Americas" but also in the courts, gardens, and pharmacies "throughout the world" (Bleichmar 2004, p. 84). Yet, as Ximénez noted, long distances could lead to incomplete knowledge and contradicting results. Joining Hernández who prioritized sense-based knowledge that could only be fully undertaken in situ, Ximénez added that the physical characteristics of plants also changed once they were picked and transported. This non-Eurocentric perspective problematizes Bacon's ideas about the fluidity of knowledge and its possibly of arriving intact to an establishment like Salomon's House. From the traveller's or expatriate's point of view, not all sciences could possibly migrate as easily and smoothly as people. There were clear advantages, both sensual and physical, to producing biological information in a particular location, and here globalization was hard-pressed to compete.

25. "para los que viven en estancias y minas do no ay Medico ni Botica a donde acudir por el Remedio" (Francisco Ximénez "Al lector," 1615). Scholars estimate that probably a copy of Recchi's abridgment traveled back to Ximénez in New Spain (for example, Varey and Chabrán 1994, p. 130).

26. "las medicinas que traen de España, passando tanta inmensidad de mares, pierden de su virtud la mayor parte causa de que el effeto no sea el que los médicos pretenden." Ximénez 1615, "Al lector."

3. Conclusions

The movement of people around the world was a prominent feature of the early modern era, which contributed to a new paradigm of knowledge. As we have seen in Bacon's writings, it helped establish the superiority of the "moderns over the ancients" and promoted the development of a consciousness of progress that, in subsequent years, stood at the heart of the narrative of the "scientific revolution." By exposing the approaches of Iberian expatriates and travellers to the study of plants and herbs, this article has related theoretical aspects of knowledge creation (i.e., Bacon's natural philosophy) to the pragmatism of the production of bioknowledge. Before Bacon envisioned the means to collect and compile global data in his fictional New Atlantis, Spain had already recognized the importance of people on the move, and devised tools to gather and analyze the resulting "wisdom of the masses." Such agents, whether state officials, merchants, settlers, or missionaries, were seen as a part of a chain that initiated the migration of knowledge; a chain whose very existence was perceived by Bacon and his generation as the fulfilment of Daniel's prophecy. Of course, these European "merchants of light" did not work alone, but instead operated within broader local partnerships that voluntarily or under duress explained or "translated" local nature to European immigrants and travellers. Together with the violence and exploitation that shaped the colonial system, the migrations of knowledge and people played a critical role in the formulation of modern science based upon observation, experimentation and the critical interpretation of the findings, the fundamental conditions that set out what Harold Cook has labelled the refusal "to speculate beyond the observable" (Cook 2007, p. 409).

Nonetheless, while expatriates and travellers participated in imperial knowledge networks, they still had to justify their particular scientific position by articulating views that often problematized, if not undermined, the idea of the complete transferability of knowledge in a Baconian sense. After all, if information could truly and fully be transported, what were the advantages of botanical research conducted in the colonies? On what basis could a colonial botanist claim scientific authority over one in the metropole? What prevented a colonial agent, even an untrained one, from simply sending a biological specimen and *materia medica* to European specialists? As we have seen, as expatriates, missionaries, and travellers compiled information about local flora, they employed several arguments that aimed to confront this unresolved tension regarding the communication of knowledge. We can detect an "environmentalist" approach in Ximénez's writings that suggested that due to the greater effectiveness of medicinal plants in their natural environment their observation is more accurate *in situ*. I also showed how migrants emphasized that their diverse

experiences on the ground—from sensual experience to the observation and exchange of ideas with native specialists—had an indisputable advantage for acquiring reliable bioknowledge. These various discursive strategies ultimately favored the vantage point of colonial botanists by acknowledging that not all types of information were indeed transportable. Such claims mirror conflicting interests in the process of knowledge migration that emerged as a result of a dual position of those who came to newly colonized lands: on the one hand, they were essential actors in the bioprospecting project, who needed recognition for the valuable information they provided (hence, they supported the claim that the knowledge they gathered did and could migrate in some basic sense). On the other hand, they also were required to reveal the epistemic weakness and limitation of this same knowledge migration (i.e., not all information travels or travels well) in order to justify their position and any possible esteem which they felt they might be owed. In short, Bacon's paradigmatic phrase "sciences migrate, just like people," in fact depends on who's asking, where and in what context.

References

Afanador Llach, Maria José. 2011. "Nombrar y representar. Escritura y naturaleza en el Códice De la Cruz-Badiano, 1552." *Fronteras de la Historia* 16(1): 13–41. https://doi.org/10.22380/2027468872

Alvarez Peláez, Raquel. 1993. *La Conquista de la naturaleza americana*. Madrid: CSIC.

Arrizabalaga, Jon. 2015. Garcia de Orta in the Context of the Sephardic Diaspora. Pp. 11–32 in *Medicine, Trade and Empire Garcia de Orta's Colloquies on the Simples and Drugs of India (1563) in Context*. Edited by Palmira Fontes da Costa. New York: Ashgate. https://doi.org/10.4324/9781315594729-9

Badiano, Juan. 2000. *An Aztec Herbal: The Classic Codex of 1552*, trans. William Gates Dover. Mineola: Dover Publications.

Bacon, Francis. [1605] 1974. *The Advancement of Learning and New Atlantis*. Edited by Arthur Johnson. Oxford: Oxford University Press.

Bacon, Francis. [1623] 1635. *De dignitate et augmentis scientiarum*. Argentorati.

Bacon, Francis. 2000. *The New Organon*, eds. Lisa Jardine and Michael Silverthorne. Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9781139164030

Barrera-Osorio, Antonio. 2001. Local Herbs, Global Medicines: Commerce, Knowledge, and Commodities in Spanish America. Pp. 163–181 in *Merchants and Marvels: Commerce, Science, and Art in Early Modern Europe*. Edited by Pamela H. Smith and Paula Findlen. London/New York: Routledge.

Barrera-Osorio, Antonio. 2006a. *Experiencing Nature: The Spanish American Empire and the Early Scientific Revolution*. Austin: University of Texas Press. https://doi.org/10.7560/709812

Barrera-Osorio, Antonio. 2006b. "Empire and Knowledge: Reporting from the New World." *Colonial Latin American Review* 15(1): 39–54. https://doi.org/10.1080/10609160600607424

Barrera-Osorio, Antonio. 2010. "Experts, Nature, and the Making of Atlantic Empiricism." *Osiris* 25(1): 129–148. https://doi.org/10.1086/657266

Bleichmar, Daniela. 2004. Books, Bodies, and Fields: Sixteenth-Century Transatlantic Encounters with New World Materia Medica. Pp. 83–99 in *Colonial Botany: Science, Commerce, and Politics*. Edited by Londa Schiebinger and Claudia Swan. Philadelphia: University of Pennsylvania Press.

Brendecke, Arndt. 2016. *The Empirical Empire: Spanish Colonial Rule and the Politics of Knowledge*. Berlin: De Gruyter. https://doi.org/10.1515/9783110369847

Bruce, Susan, ed. 1999. *Three Early Modern Utopias: Thomas More: Utopia / Francis Bacon: New Atlantis / Henry Neville: The Isle of Pines*. Oxford: Oxford University Press.

Burke, Peter. 2017. *Exiles and Expatriates in the History of Knowledge, 1500–2000*. Waltham, MA: Brandeis University Press. https://doi.org/10.2307/j.ctv102bczp

Burns, William E. 2016. *The Scientific Revolution in Global Perspective*. Oxford: Oxford University Press.

Bustamante García, Jesús. 1997. Francisco Hernández, Plinio del Nuevo Mundo: Tradición clásica, teoría nominal y sistema terminológico indígena en una obra renacentista. Pp. 243–268 in *Entre dos mundos: Fronteras culturales y agentes mediadores*. Edited by Berta Ares Queija and Serge Gruzinski. Sevilla: Escuela de Estudios Hispano-Americanos.

Bustamante García, Jesús. 2013. Un libro, tres modelos y el Atlántico. La obra naturalista de Francisco Hernández y sus concreciones escritas. Pp. 25–37 in *Il tesoro messicano: Libri e saperi tra Europa e Nuovo mondo*. Edited by Maria Eugenia Cadeddu and Marco Guardo. Florence: Leo S. Olschki Editore.

Cañizares-Esguerra, Jorge. 2004. "Iberian Science in the Renaissance: Ignored How Much Longer?" *Perspectives on Science* 12(1): 86–124. https://doi.org/10.1162/106361404773843355

Cárdenas, Juan de. 1591. *Primera parte de los problemas, y secretos marauillosos de las Indias*. Mexico.

Carey, Daniel. 2009. "Hakluyt's instructions: The Principal Navigations and Sixteenth-Century Travel Advice." *Studies in Travel Writing* 13(2): 167–185. https://doi.org/10.1080/13645140902891496

Carney, Judith. 2004. Out of Africa: Colonial Rice History and the Black Atlantic. Pp. 204–222 in *Colonial Botany: Science, Commerce, and Politics*. Edited by Londa Schiebinger and Claudia Swan. Philadelphia: University of Pennsylvania Press.

Cook, Harold J. 2007. *Matters of Exchange: Commerce, Medicine, and Science in the Dutch Golden Age*. New Haven: Yale University Press. https://doi.org/10.12987/yale/9780300117967.001.0001

Cook, Harold and Timothy Walker. 2013. "Circulation of Medicine in the Early Modern Atlantic World." *Social History of Medicine* 26(3): 337–351. https://doi.org/10.1093/shm/hkt013

Daston, Lorraine and Peter Galison. 2007. *Objectivity*. New York: Zone Books.

Drayton, Richard. 2000. *Nature's Government: Science, Imperial Britain and the "Improvement" of the World*. New Haven: Yale University Press.

Earle, Rebecca. 2012. *The Body of the Conquistador: Food, Race and the Colonial Experience in Spanish America, 1492–1700*. Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9780511763359

Encinas, Diego de. [1596] 1945. *Cedulario Indiano: recopilado de D. de Encinas. Reproducción facsímil de la edición única de 1596*, vol. 1. Reprinted. Madrid: Ediciones Cultura Hispanica.

Findlen, Paula, ed. 2018. *Empires of Knowledge: Scientific Networks in the Early Modern World*. London/New York: Routledge. https://doi.org/10.4324/9780429461842

Fontes da Costa, Palmira. 2012. "Geographical Expansion and the Reconfiguration of Medical Authority: Garcia de Orta's *Colloquies on the Simples and Drugs of India* (1563)." *Studies in History and Philosophy of Science* 43: 74–81. https://doi.org/10.1016/j.shpsa.2011.09.015, PubMed: 22530483

Fresquet Febrer, José Luis, and José María López Piñero, eds. 1995. *El mestizaje cultural y la medicina novohispana del siglo XVI*. Valencia: Universitat de València, C.S.I.C.

Gascoigne, John. 2009. "The Royal Society, Natural History and the Peoples of the 'New World(s)', 1660–1800." *The British Journal for the History of Science* 42(4): 539–562. https://doi.org/10.1017/S0007087409002210, PubMed: 20503959

Gaukroger, Stephen. 2004. *Francis Bacon and the Transformation of Early-Modern Philosophy*. Cambridge: Cambridge University Press.

Gómez, Pablo. 2018. *The Experiential Caribbean: Creating Knowledge and Healing in the Early Modern Atlantic*. Chapel Hill, NC: University of North Carolina Press. https://doi.org/10.5149/northcarolina/9781469630878.001.0001

Grafton, Anthony, and Nancy Siraisi. 1992. *New Worlds, Ancient Texts: The Power of Tradition and the Shock of Discovery*. Cambridge: Cambridge University Press.

Gruzinski, Serge. 2004. *Les quatre parties du monde. Histoire d'une mondialisation*. Paris: Editions de la Martinière.

Harris, Steven J. 1998. "Long-Distance Corporations, Big Sciences, and the Geography of Knowledge." *The Scientific Revolution as Narrative*, eds. Mario Biagioli and Steven Harris, special issue of *Configuration* 6: 269–305. https://doi.org/10.1353/con.1998.0018

Hayden, A. Judy. 2016. *Travel Narratives, the New Science, and Literary Discourse, 1569–1750*. London/New York: Routledge. https://doi.org/10.4324/9781315549736

Hernández, Francisco. 1960. *Francisco Hernández, Obras completas*. Edited by G. Somolinos. Mexico: UNAM.

Hernández, Francisco. 1986. *Antigüedades de la Nueva España*. Edited by Ascensión H. de León Portilla. Madrid: Historia 16.

Irving, Sarah. 2008. *Natural Science and the Origins of the British Empire*. London/New York: Routledge.

Jackson, Frank. 2004. *There's Something about Mary: Essays on Phenomenal Consciousness and Frank Jackson's Knowledge Argument*. Cambridge, Mass.: MIT Press.

Jiménez de la Espada, Marcos. 1965. *Relaciones geograficas de Indias, Peru*, vol. 1. Biblioteca de Autores Españoles 183. Madrid: Ediciones Atlas.

López Pinero, José María. 2007. *Medicina e historia natural, en la sociedad española de los siglos xvi y xvii*. Universitat de València.

López Piñero, José María, and José Pardo Tomás. 2000. The Contribution of Hernández to European Botany and *Materia Medica*. Pp. 122–137 in *Searching for the Secrets of Nature: The Life and Works of Dr. Francisco Hernández*. Edited by Simon Varey, Rafael Chabrán, and Dora Weiner. Stanford: Stanford University Press.

Maravall, José Antonio. 1966. *Antiguos y modernos (La idea de progreso en el desarrollo inicial de una sociedad)*. Madrid: Sociedad De Estudios Y Publicaciones.

Marroquin Arredondo, Jaime. 2019. The Method of Francisco Hernández: Early Modern Science and the Translation of Mesoamerica's Natural History. Pp. 45–69 in *Translating Nature Cross-Cultural Histories of Early Modern Science*. Edited by Jaime Marroquín Arredondo and Ralph Bauer. Philadelphia: University of Pennsylvania Press.

Marroquín Arredondo, Jaime, and Ralph Bauer, eds. 2019. *Translating Nature Cross-Cultural Histories of Early Modern Science*. Philadelphia: University of Pennsylvania Press.

Matthews, Steven. 2008. *Theology and Science in the Thought of Francis Bacon*. Aldershot: Ashgate.

Millones Figueroa, Luis, and Domingo Ledezma, eds. 2005. *El saber de los Jesuitas: Historias naturales y el Nuevo Mundo*. Madrid: Iberoamericana; Frankfurt: Vervuert. https://doi.org/10.31819/9783964563989

Monardes, Nicolas. 1580. *Primera y segunda y tercera partes de la historia medicinal de las cosas que se traen de nuestras Indias Occidentales, que sirven en medicina*. Seville.

Myers, Kathleen Ann. 2007. *Fernández de Oviedo's Chronicle of America: A New History for a New World*. Austin, TX: University of Texas Press. https://doi.org/10.7560/717039

Orta, Garcia de. [1563] 1987. *Colóquios dos simples e drogas da India. (Goa, 1563)*, ed. Conde de Ficalho. Facsimile of the 1891 edition. Reprinted: Lisbon, 1987. https://doi.org/10.5962/bhl.title.105341

Pardo Tomás, José. 2007. Two Glimpses of America from a Distance: Carolus Clusius and Nicolás Monardes. Pp. 173–193 in *Carolus Clusius: Towards a Cultural History of a Renaissance Naturalist*. Edited by Florike Egmond et al. Amsterdam: Amsterdam University Press.

Pardo Tomás, José. 2014. La medicina de la conversión: el convento como espacio de cultura médica novohispana. Pp. 17–46 in *Geografías médicas. Orillas y fronteras culturales de la medicina (siglos XVI y XVII)*. Edited by José Pardo Tomás and Mauricio Sánchez Menchero. Mexico: UNAM.

Parrish, Susan Scott. 2006. *American Curiosity: Cultures of Natural History in the Colonial British Atlantic World*. Chapel Hill: University of North Carolina Press.

Pérez-Ramos, Antonio. 1988. *Francis Bacon's Idea of Science and the Maker's Knowledge Tradition*. Oxford: Oxford University Press.

Pimentel, Juan. 2000. "The Iberian Vision: Science and Empire in the Framework of a Universal Monarchy, 1500–1800." *Osiris* 15("Nature and Empire: Science and the Colonial Enterprise"): 17–30. https://doi.org/10.1086/649316

Pimentel, Juan. 2003. *Testigos del mundo. Ciencia, literatura y viajes en la Ilustración*. Madrid: Marcial Pons.

Pimentel, Juan, and Isabel Soler. 2014. "Painting Naked Truth: The Colóquios of Garcia da Orta (1563)." *Journal of Early Modern History* 18: 101–120. https://doi.org/10.1163/15700658-12342386

Portuondo, María. 2009. *Secret Science: Spanish Cosmography and the New World*. Chicago: University of Chicago. https://doi.org/10.7208/chicago/9780226675374.001.0001

Raj, Kapil. 2007. *Relocating Modern Science: Circulation and the Construction of Knowledge in South Asia and Europe, 1650–1900*. London: Palgrave Macmillan. https://doi.org/10.1057/9780230625310

Rubiés, Joan-Pau. 1993. "New Worlds and Renaissance Ethnology." *History and Anthropology* 6(2): 157–197. https://doi.org/10.1080/02757206.1993.9960828

Sánchez, Antonio. 2013. *La Espada, la Cruz y el Padrón: soberanía, fe y representación cartográfica en el mundo ibérico bajo la Monarquía Hispánica, 1503–1598*. Madrid: CSIC.

Scalercio, Mauro. 2018. "Dominating Nature and Colonialism. Francis Bacon's View of Europe and the New World." *History of European Ideas* 44(8): 1076–1091. https://doi.org/10.1080/01916599.2018.1512282

Schiebinger, Londa. 2004. *Plants and Empire: Colonial Bioprospecting in the Atlantic World*. Cambridge: Harvard University Press.

Schiebinger, Londa, and Claudia Swan, eds. 2004. *Colonial Botany: Science, Commerce, and Politics*. Philadelphia: University of Pennsylvania Press.

Secord, James. 2004. "Knowledge in Transit." *Isis* 95(4): 654–672. https://doi.org/10.1086/430657, PubMed: 16011300

Segev, Ran. 2018. Spatial Evidence in a New World: Fray Antonio Vázquez de Espinosa's Geography. Pp. 209–227 in *Evidence in the Age of the New Sciences*. Edited by James Lancaster and Richard Raiswell. Dortrecht: Springer. https://doi.org/10.1007/978-3-319-91869-3_9

Solano, Francisco de, ed. 1988. *Cuestionarios para la formación de las relaciones geográficas de Indias, siglos XVI–XIX*. Madrid: CSIC.

Somolinos, D'Ardois Germán. 1960. "Vida y obra de Francisco Hernández." In *Francisco Hernández, Obras completas*. Vol. 1 Mexico: UNAM.

Terpstra, Nicholas. 2015. *Religious Refugees in the Early Modern World: An Alternative History of the Reformation*. Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9781139170055

Toribio Medina, José. 1968. *Biblioteca Hispano-Americana 1493–1810*, vol. 2. Amsterdam: N. Israel.

Varey, Simon. ed. 2000. *The Mexican Treasury: The Writings of Dr. Francisco Hernández*. Stanford: Stanford University Press.

Varey, Simon, and Rafael Chabrán, 1994. "Medical Natural History in the Renaissance: The Strange Case of Francisco Hernández." *Huntington Library Quarterly* 57(2): 124–151. https://doi.org/10.2307/3817754

Vázquez de Espinosa, Antonio. 1992. *Compendio y descripción de las Indias Occidentales*, ed. Balbino Velasco Bayón. Madrid: Historia 16.

Vickers, Brian. 1992. "Francis Bacon and the Progress of knowledge." *Journal of the History of Ideas* 53(3): 495–518. https://doi.org/10.2307/2709891

Viesca Triviño, Carlos. 1995. "El Códice de la Cruz-Badiano, primer ejemplo de una medicina mestiza." Pp. 71–90 in *El mestizaje cultural y la medicina novohispana del siglo XVI*. Edited by José Luis Fresquet Febrer and José María López Piñero. Valencia: Universidad de València, C.S.I.C.

Vos, Paula de. 2006. "The Science of Spices: Empiricism and Economic Botany in the Early Spanish Empire." *Journal of World History* 17(4): 399–427. https://doi.org/10.1353/jwh.2006.0054

Walker, Timothy. 2009. Acquisition and Circulation of Medical Knowledge Within the Early Modern Portuguese Colonial Empire. Pp. 247–270 in *Science in the Spanish and Portuguese Empires*. Edited by Daniela Bleichmar

et al. Stanford: Stanford University Press. https://doi.org/10.11126/stanford/9780804753586.003.0014

Ximénez, Francisco. 1615. *Quatro libros de la naturaleza y virtudes de las plantas y animales que estan receuidos en el uso de la medicina en la Nueva España*. Mexico.

Županov, Ines G., and Ângela Barreto Xavier. 2014. "Quest for Permanence in the Tropics: Portuguese Bioprospecting in Asia (16th–18th Centuries)." *Journal of the Economic and Social History of the Orient* 57: 511–548. https://doi.org/10.1163/15685209-12341357