On Ignored Global “Scientific Revolutions”

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Abstract

The categories that structure the study of early modern science are organized around the epistemological liberal regime of facts, objectivity, skepticism, print culture, the public sphere, and the Republic of Letters. The regime of early-modern science in the global Spanish Monarchy is not well known because it was forged in a very different system, one of rewards and legislation in which most activities were transacted through one-on-one epistolary correspondence and intimate transference of information in translation workshops. This global system, nevertheless, engendered ceaseless technical and scientific innovations. I study three cases: the extraction and transformation of silver ores in several spaces; the production of ships and new botanical resources that reorganized global dockyards; and the creation of local translation workshops to facilitate the circulation of knowledge within the global empire. “European” science, the “West,” and instrumental reason have always been global co-creations. However, colonial and postcolonial Manichean dichotomous historiographical categories have made this truism hard to see.

Keywords

Scientific Revolution – mining – amalgamation – hydraulics – dockyards – silk production – materia-medica – translation workshops – ethnobotanical piracy

Introduction

The narrative of the “Scientific Revolution” does magical historiographical work. It manages to make geographies and periods vanish. The term was coined to create stories on the exclusive significance of Northern-European agency in globalization.¹ Ultimately, the Scientific Revolution is the story of

1 Steven Shapin, *The Scientific Revolution* (Chicago, 1996).

the origins of industrial mechanization, Newtonian and Cartesian mathematization, and Baconian empirical histories of collection. According to this story, modern science originated in the streets, shops, and university halls of Cambridge, Leyden, London, and Paris and culminated as industry in canals in the Midlands and steam-engine factories in Manchester, Liverpool, and the American Northeast.² Between 1570 and 1620, however, a system of some twenty-four artificial lakes emerged around Potosi, then a city with 160,000 souls. The dams, aqueducts, tunnels, canals, and bridges moved some seven-million metric tons of water for hundreds of water-wheel-driven-factories down the streams. The twenty-foot high by six-foot thick dams ran for miles. There were tunnels that cut through massive Andean rock for hundreds of feet. The resulting network was a marvel of engineering. The only somewhat technical (and shallow) study of the system I have found came out in 1936.³ Had this massive machine-driven factory system emerged in the English Midlands, we would have already had entire history departments, historical categories, and rhetorics of revolution devoted to describing the phenomenon.

The case of Potosi as the forgotten Midlands is not an empty complaint for attention by the marginalized south, a version of "scientific-revolution" penis envy. It goes much deeper. It is about elucidating how historiographical categories silence. The categories that structure the study of early modern science are organized around the epistemological liberal regime of facts, objectivity, and skepticism. The narratives of early-modern and modern science are built on the assumptions of the "liberal" regime. They are all narratives on the history and prehistory of print culture, the public sphere, and the Republic of Letters. The regime of early-modern science in Potosi is invisible because it was forged in a very different system, one of rewards and legislation in which most activities were transacted through one-on-one epistolary correspondence. Knowledge was also transferred and modified in intimate workshops specialized in cultural translation. Print culture, the public sphere of academies, coffee shops, and aristocratic salons were almost non-existent in Potosi. Yet those twenty-four artificial lakes emerged out of an epistemological regime of skepticism, radical hermeneutical suspicion, vibrant debate, merchant empiricism, and trade.⁴

2 Margaret Jacobs, *Scientific Culture and the Making of the Industrial West* (Oxford, 1997).

3 William E. Rudolph, "The Lakes of Potosi," *Geographical Review* 26, no. 4 (1936): 529–554. The Bolivian engineer Luis Serrano has largely built on the reports of Rudolph in his studies of the colonial lakes. See Luis Serrano and Julio Peláez, "Potosí y sus lagunas," *Revista de Investigaciones históricas / Universidad Autónoma Tomás Frías* 1 (1997): 14–97.

4 On a full-fledged alternative to the Eisenstein-Habermas model of print culture and public sphere as the origin of "modernity," see our forthcoming (with Adrian Masters) *Sixteenth-*

Potosi also challenges post-colonial narratives of the history of science that have completely ceded the category of the “West” to a miniscule corner of the planet. The “provincialization of Europe” has in fact meant the unwitting universalization of three countries north of the Pyrenees. For all the insistence on hybridity, post-colonialism has created a Manichean history of instrumental reason and Enlightenment in which “science” is always the monopoly of handful of early modern “Europeans.”⁵ Potosi, allegedly, was “European.” But Potosi was from its inception “Indian.” It began in the 1540s as a center of indigenous entrepreneurship, specialized in the smelting of high grade silver ores. By the 1560s, Potosi had become a mountain in the middle of the barren *puna* blanketed with some 6,000 indigenous furnace ovens. Potosi’s *huairas* were fueled with dung of llamas, *puna* high grasses, and the Andean wind. Potosi was a new city of *yanaconas* and *forasteros*, only a handful of whom were “Europeans.” It was this Potosi of Indians, Senegalese, Angolans, Goans, Calicutans, Japanese, and Chinese that experienced the technological revolution that was amalgamation. It was a revolution that resulted from the chemical manipulation of low-grade silver ores.⁶ Potosi is not the only example of the early-modern scientific, technological revolution triggered by the Iberian globalization. In the following pages, I study three cases: the extraction and transformation of silver ores in several spaces; the production of ships and new botanical resources that reorganized global dockyards; and the creation of local translation workshops to facilitate the circulation of knowledge within the global empire.

Mining Four Spaces of Production

American innovations were not random and serendipitous. They happened in the workshops of learned alchemists first in Pachuca and later in Potosi. They led to relentless innovation in the design of ovens, furnaces, mixers, mills, regents, distillers, turbines, water works, ships, and containers. The archives of the Indies are filled with patents by late-sixteenth and early-seventeenth-century inventors

Century Forgotten Radical Modernites: The Global Iberian Ancien-Regime Origins of Science, Abolitionism, Skepticism, and Legal Democracy. The book recasts entirely the narrative of liberal progress.

- 5 For a scathing critique of these tendencies in postcolonial theory, see Frederick Copper, *Colonialism in Question: Theory, Knowledge, History* (Berkeley, 2005).
- 6 On the early history of Potosi’s technological revolution, see Luis Capoché, *Relación General de la Villa Imperial de Potosi* (1585), ed. Lewis Hanke (Madrid, 1959).

and entrepreneurs. A few of these petitions have survived with illustrations and technical drawings of mills, pumps, turbines, and chemical processes.⁷

To appreciate the innovation and mechanization that took place in Spanish America in the long seventeenth century, one needs to compare the mining machinery of Potosi and central and Northwestern Mexico with the technologies featured in Georg Agricola's 1556 *Res Metallica*. Agricola's fascinating *Res Metallica* includes an extraordinary catalogue of Central European mining traditions. A dizzying variety of pulleys, wells, shafts, tunnels, hammers, crow-bars, hide-buckets, stave-buckets, trays, wheelbarrows, rollers, drawing chains, troughs, pits, canals, fans, bellows, pyres, racks, ovens, cakes, wheels, toothed and rundle drums, horizontal and upright axles, fly-wheels, piston rods, cranes, stumps, mortars, axles, sieves, ladders, crucibles, millstones, hoppers, buddles, riffles, pipes, launders, strakes, settling pits, canvasses, and sluices parade before our eyes. Agricola's stumping and millstone water mills along with mechanical systems to stir chemical amalgams were all imported into Mexico and Peru. In Potosi, Agricola's mechanisms demanded millions of liters of running water. Twenty-four large artificial lakes appeared in the surrounding highlands, along with dams, sluices, and aqueducts.⁸

Agricola's bewildering catalogue of items, however, omitted a few that were used in the Americas: copper *cazos* (containers to warm amalgamated sludge that came from lower grade ores [*negrillos*]); ovens for toasting amalgams; *vilques* to drain mercury from the *pallas* (amalgamated sludge); *dezasogaderas* (containers to separate silver from mercury amalgams while distilling the mercury); and *aludele* ovens to get liquid mercury from ores. All these new chemical and mechanical technologies were the result of endless experimental trials between 1550 and 1650 by physicians, entrepreneurs, and clerics in Northern Mexico and the Andean highlands.⁹ Central Europe got silver by melting high-grade ores in furnaces. Mexican and Peruvian methods allowed for the exploitation of low-grade ores. Mercury was central to the process. To get silver ingots one needed first silver amalgams and enormous quantities of mercury. In 1633 in Huancavelica, the physician Lope de Saavedra Barba obtained mercury out of mercury ores through distillation in new ovens he invented. The breakthroughs in alchemical experimentation carried out by the likes of Bartolomé

7 For examples, browse the sections "Ingenios" and "Minas" at the Archivo General de Indias (AGI), Mapas y Planos.

8 Modesto Bargalló, *La minería y la metalurgia en la America Española durante la época colonial* (México, 1955). Peter Bakewell, *Miners of the Red Mountain: Indian Labor in Potosí, 1545–1650* (Albuquerque, 1985).

9 Bargalló, *Minería*; Bakewell, *Miners*.

de Medina in Pachuca, Alvaro Alonso Barba in Potosi, and Lope de Saavedra Barba in Huancavelica were not the serendipitous findings of empirics with too much time to spare. The new technologies were the product of theories of matter and deliberate experimentation.¹⁰

These entrepreneurial inventors in the American mines were firmly tethered to the much larger social realities of urbanization, globalization, and industrialization. We often confuse silver with one city: Potosi. There were indeed dozens of these mining cities. Spanish America, however, is better imagined as a series of four spaces in which extraction and transformation of silver took place.

The first space was the sprawling mines in the bowels of the earth. Every twist and turn in those large underground complexes had a name and a sacred sobriquet. El "Real" was a mine so huge that the main artery connecting the many tunnels was depicted as a grid that demanded a map of its own for orientation. These immense beehives had not only to get ore up onto the surface but also, and even more relevantly, avoid getting flooded. Water pumps of all kinds and complex aqueducts circulated within the mazes, bringing water from a level below up into the next: the upside mirror image of a cascade.¹¹

The second space was on the surface of the earth. Both mercury and silver ores demanded very large compounds, small cities within cities. The distillation ovens to get pure mercury out of mercury ores occupied large spaces, and so too did the mills to crush ores and mills to transform the crushed ore into fine powders to be burnt in kilns. The processing of silver was even more convoluted because every large ore processor had both forge-ovens for smelting and infrastructure to handle lower graded ores through amalgamation. Amalgamation with mercury, in turn, could follow two paths depending on the purity of the ore. The lowest graded rocks not only had to be crushed, sieved, powdered, mixed (with salted water, copper and iron files, and lots of fluid mercury), raked, washed out and wrung, and distilled as any typical low grade ore, but they also had to be toasted and baked in copper vessels. The compounds where these operations happened, therefore, were huge. They included large water works and aqueducts to move the mills and washed-out amalgams. They also included housing and dozens of rooms to store salt, mercury, and myriad other reagents. Every compound also had a chapel and the headquarters of

10 Luis Muro, "Bartolomé de Medina, introducción del beneficio de patio en Nueva España," *Historia Mexicana* 13 (1964): 517–531.

11 For a description of the many spaces introduced in this paragraph, see Bakewell, *Silver and Entrepreneurship in Seventeenth-Century Potosí: The Life and Times of Antonio López de Quiroga* (Albuquerque, 1988).

the overseer and her family (there were plenty of women overseers often portrayed carrying large lashes).

The third space was the mint. It included *aduanas*, a center to store and distribute mercury to miners, as well as a "bank" to handle credit on mercury. Mercury was the business and monopoly of the state. Output of silver could be easily controlled by the fixed allocation of liquid mercury to producers. Yet, silver was also produced without access to mercury via the smelting of high-grade ores in small, indigenous-owned furnaces. Smuggling therefore flourished. The mint was also the place where coinage took place and the hub for dozens of busy assayers and slave ingot-cutters and pressers. They were crowded spaces full of presses, kilns, and ovens.

The fourth space encompassed the decentralized shops of *plateros* that crowded entire city quarters in Potosi, Zacatecas, Guanajuato, Oruro, Lima, and Mexico. These were the silversmiths and jewelers that churned out thousands of wares for households and particularly churches. Each city developed specific corporate identities of their own, languages, cults, and religious organizations.

What is remarkable about these sprawling multifaceted spaces inside mountains and around moving bodies of water is that the sciences and technologies that made them possible were never acknowledged as such in Northern Europe. The patio technologies of cold amalgamation of Bartolomé de Medina and those of heated amalgamation of Barba appeared as Central European German innovations in a treatise by the mineralogist Ignaz von Born in 1786. Von Born claimed these technologies as his own.¹²

The narrative of the Scientific Revolution is an extraordinary instrument of political-cultural dominium, and so too are many other historiographical categories, including The Renaissance, The Reformation, and The Enlightenment. They sanction hierarchies of power and foreground what are in fact provincial narratives as universal. These categories silence and obfuscate as much as they illuminate. There are countless consequential episodes of globalization linked to knowledge breakthroughs that do not even register in any of the new histories of global Scientific Revolution.¹³

12 Ignaz von Born, *Ueber das Anquicken der gold- und silberhältigen Erze, Rohsteine, Schwarzkupfer und Hüttenspeise* (Austria, 1786).

13 For a recent critique of these historiographical silences, see Angela Barreto Xavier and Ines G. Županov, *Catholic Orientalism. Portuguese Empire, Indian Knowledge (16th-18th Centuries)* (Oxford, 2014).

Ships, Dockyards, and Global Natural History

Caravels, naos, and galleons were floating factories at sea. Lateen sails and keels allowed large Mediterranean hulls to tack oceans against wind currents. The aerodynamic “lift” of lateen sails and keels allowed Portuguese sailors to crack the clockwise and counterclockwise logic of northern and southern Atlantic currents. This new technology made European transoceanic voyages in the Atlantic and Pacific Oceans possible.¹⁴ These technologies transformed global trade and cosmography. A world of very large oceans relative to land-masses slowly began to emerge at the offices of pilots and cosmographers commissioned by the Portuguese and Spanish monarchies to draw new portolan maps.¹⁵

Caravels, naos, and galleons were large complex pieces of machinery made up of ropes, sails, masts, cannons, tars, caulking fibers, block and tackle pulleys, and hulls. Guilds of specialized craftsmen produced each one of these objects. Hemp cordage was twisted into large ropes in immense running corridors kept by ropers’ guilds. Rope rotted from the inside out and needed to be treated with pine tar. So too did the wood in underwater hulls, rudders, and keels. And shipworms could destroy wood. Caulking also demanded specialized fibers and tars.

The fifteenth-century Iberian expansion to Africa, America, and Asia put systems of ethnobotanical piracy in motion. These systems were the foundation of a new global distribution of dockyards. Spanish and indigenous conquistadors were always on the lookout for alternative fibers for cordage, woods for hauls and masts, and resins and tars for waterproofing. After 1513, parties of entrepreneurial raiders (yes including Indian conquistadors) began reconnoitering the Pacific coast of the newly emerging continent that was America. Soon these parties found woods in Central and South America whose natural resins made them resistant to rot caused by shipworms. New shipyards and ports were afterwards set up in El Realejo and Guayaquil, for example. The same happened in the Philippines. Ethnobotanical intelligence yielded the Manila tree, a palm whose leaves created fibers for cordage that did not require treatment with pine tars. New woods and new fibers led to the creation of the shipyard of El Cavite, a few miles to the south of Manila. There are countless

14 Palmira Fontes da Costa and Henrique Leitão, “Portuguese Imperial Science, 1450–1800,” in Daniel Bleichmar et al., *Science in the Spanish and Portuguese Empires, 1500–1800* (Stanford, 2009), 35–53.

15 Antonio Sánchez, *La Espada, la Cruz y el Padrón* (Madrid, 2013).

botanical examples of this trend: Mexican sisal replaced hemp for ropes, and coconut substituted tarred hemp fibers in caulking.¹⁶

This history of ethnobotanical piracy as the cause of the globalized production of lateen naos is not the province of historians of the Scientific Revolution. Historians of early-modern natural history know nothing, for example, about the deliberately planned global botanical exchange initiated by conquistadors like Hernán Cortés.

After having conquered Tenochtitlan in 1521, Cortés decided in 1523 it was time to get the spice islands of Borneo under his command. Cortés established a dockyard on the Pacific coast in Zihuatanejo, rich in woods, tars, fibers, and cotton for hulls, rudders, masts, ropes, and sails. Using cast and wrought iron, he also set up smelters and forgers to produce cannons, anchors, and parts of pulleys. The sulphur for gunpowder came from the active volcano Popocatepetl near Tenochtitlan. After Balboa reached the South Sea in 1513, many slave raiding parties left Darien trying to figure out the nature of the new sea, while looking particularly for any potential oceanic crossing. Cosmography and slavery went hand in hand.¹⁷

In 1520, for example, a second circumnavigating expedition sent by Charles V and led by Antonio Niño arrived on the Atlantic coast of Panama and had the three 110-ton nao fleet disassembled. Crews, slaves, and Indian allies took the pieces across the isthmus. On the Pacific coast, Niño had the three naos reassembled and four others built. Niño then sailed into the Pacific with indigenous crews never to be seen again. Cortés did not know any of these details about Niño because he was then busy holding Moctezuma hostage in Tenochtitlan. By 1523, however, Cortés was ready to launch an assault into the South Sea. Cortés was already familiar with the news brought by Sebastian el Cano and Antonio Pigafetta in 1522 regarding the clove islands of Ternete and Tidore (in the Moluccas). In fact, Cortés knew that the crew of *La Trinidad*, which along with the *Victoria* was the only surviving ship of Magellan's expedition out of the original five, had been left behind in Tidore under the leadership of Gonzalo Gómez de Espinosa with orders to cross the Pacific back to Panama with a cargo of cloves. Gómez de Espinoza could not find the currents back to Panama and most of the crew died trying. Gómez de Espinoza was forced to get back to Tidore after many months at sea. He spent years rotting in jail in Portuguese Molucca in the company of his Norwegian gunner Hans Vargue.

16 On Spanish global dockyards and woods, see John T. Wing, *Roots of Empire: Forests & State Power in Early Modern Spain c. 1500–1750* (Leiden, 2015).

17 Miguel Leoón Portilla, *Hernán Cortés y la Mar del Sur* (Madrid, 1985).

Hoping to connect with Gómez de Espinoza, Cortés had three 100-ton ships built in Zihuatanejo and delegated the fleet to his cousin Alvaro de Saavedra. In addition to casks of water and wine, pigs, goats, fowl, and loads of bread and corn tortillas, Cortés gave Saavedra a letter in Latin addressed to the king of Tidor and Ternete. Cortés reasoned that Saavedra would find in the Spice Islands a learned Jewish merchant capable of translating Latin. He also gave Saavedra two translators who had accompanied Cortés in the campaigns of Mexico: a slave from Calicut and a morisco, fluent in Arabic. Cortés also gave Saavedra hundreds of fine Mexican printed-cottons to trade and a large indigenous crew. Finally, Cortés gave Saavedra an anonymous botanist as well as instructions on how to bring a live clove tree back to Mexico. The solution to the problem of competing with the Portuguese in the Moluccas, thought Cortés, was to bring the Moluccas back to Mexico in botanical crates. Saavedra was unable to return across the Pacific, and, like Gómez de Espinoza, he was caught by the Portuguese in Ternete.

Cortés's great botanical plans of transforming Mexico into a substitute for the Spice Islands was stymied by the lack of knowledge of the oceanic currents of the South Sea. It was the pilot, mathematician, and cosmographer in Mexico, the Augustinian Andrés de Urdaneta, who in 1564 finally solved the riddle of how to return from the Philippines to Mexico. As an original member of the crew assembled by the raider Miguel López de Legaspi to conquer Cebu, Urdaneta was to take the fleet back safely to the dockyards of Acapulco. The Augustinian cosmographer accomplished this piloting feat by going way north off the coast of Nagasaki to then catch the clockwise circulating North Pacific currents. His insight came from his own understanding of a new sublunary physics for the Americas.

The failure to get cloves from the Moluccas did not deter Cortés. By 1524 it was clear to most Europeans that the Caribbean and Mexico were not part of India. America was a new continent and not just a gateway to China. Cortés nevertheless thought that China could be brought to America. In 1523, Cortés got mulberry plantings, silkworms, and Moriscos into Mexico to begin a silk industry. By the 1530s the production of silk in Mexico was well established. In the 1550s the Dominicans in the Mixteca Alta ran an 8,000-acre plantation. By 1580 Mixtec communities were producing 20,000 pounds of silk yarn annually. The peoples of the Sierras of the Mixteca traded silk for all sorts of new goods, including cast-iron key locks, swords, and water wheels. The growth of the industry was so rapid that the encomendero of Yaguiran (in the Mixteca), Gonzalo de las Casas, published a book in Granada, the heart of the Morisco and European silk industry, instructing Granadinos how to raise silkworms properly. The arrival of silk transformed the Mixtec and the textile industry.

Morisco and Mixtecs found each other in the streets of Mixtec towns. In 1580, however, the Manila Galleon arrived for the first time to Acapulco, bringing tons of woven Chinese silks and yarns. The new physics of the Augustinian Urdaneta allowed cheaper Chinese imports to crush Mexico's fledgling manufacturing silk industries.¹⁸

Global Workshops of Translation

The story of Cortés's bioprospecting and his successful grafting of the silk industry in Oaxaca was typical of the Iberian global monarchies in Africa, Asia, and America. Entrepreneurial physicians, merchants, raiders, and mendicants all sought to establish workshops of translation to get acquainted with local resources and peoples everywhere they went. The workshops of converso physicians García de Orta and Cristóvão da Costa in Goa are well known. So too that of Nicolás Monardes in Seville. These doctors assembled regional and transoceanic networks that gathered knowledge of the new staples in Asia and America to translate them into substitutes for spices in food, perfumes, and medicine. These information networks also sought to expand the objects available in *materia medica*. In the Americas these translation workshops yielded numerous herbals and treatises, including the mid-sixteenth-century indigenous Badianus Codex, Bernardino Sahagún's polyglot and monumental *Florentine Codex*, and the 1570s expedition of the humanist doctor Francisco Hernández. These are well known.¹⁹ Less well known are the workshops set up by mendicants in the Philippines. Take for example the natural history and ethnography of ca. 1590 known as the Codex Boxer.

Codex Boxer is an impressive "natural history" made by a Sangley artist in Manila of the dozens of ethnic groups occupying the islands of the Philippines, including settlers and merchants from Vietnam, Aceh, Sumatra, China, Malacca, Borneo, and Marianas. The Codex also documents the local ethnic groups of the Vizayas, Mindanao, Sulu, and Luzon. We don't know the exact origins of the Codex, but it can be traced to the governor of the Philippines Gómez Pérez Dasmariñas. Gómez Pérez Dasmariñas ruled Manila only three years. As soon as he arrived in 1590, he fortified the port against Muslim raiders and farmed out the invasion of Mindanao to the merchant privateer Estevan Rodríguez de Figueroa. In 1592 Gómez engaged in diplomatic correspondence

18 Woodrow Borah, *Silk Raising in Colonial Mexico* (Berkeley, 1943).

19 See, for example, Timothy Walker, "Acquisition and Circulation of Medical Knowledge within the Early Modern Portuguese Colonial Empire" in Bleichmar et al., *Science*, 247–70.

with Toyotomi Hideyoshi over Spanish legitimacy in the South China Sea. And in 1593 Gómez Pérez received an embassy and two elephants from the king of Cambodia, who was desperately seeking allies to repel an invasion by the neighboring king of Siam. In 1593 Gómez Pérez led a fleet of 200 caravels, galleys, and smaller ships to invade the Portuguese fort of Terrenate in the Moluccas. On his way to Terrenate, however, Gómez Pérez was murdered by his crew of Chinese galley slaves. Gómez Pérez Dasmeriñas's twenty-five-year-old son, Luis, took over the governorship and inherited a beautiful set of ethnographic drawings by a Chinese artist. The artist, most likely, was a member of the translation workshop set up by the Dominican Juan Cobo in Manila to produce materials for the spiritual conquest of Canton.²⁰

Upon arrival to Manila, the Dominican Juan Cobo found himself surrounded by the Sangley, the large Chinese community of peasants and merchants that had settled the western coast of Luzon for generations. The Sangley shared the island with the native Pampanga and the Tagalog who were in the business of trading captives with the sprawling Muslim Sultanates of Borneo and Sulu, then aggressively establishing themselves in Manila. When the Spaniards arrived in Luzon they found traces of Ottoman and al-Andaluz alliances with Borneo merchants. The Spaniards, however, established alliances with the victims of the trade in captives to reverse the expansion of Borneo and Sulu Sultanates into Manila.

Just as the learning of the Mandarin class in Beijing would later impress Matteo Ricci, Cobo was dazzled by the literacy and learning of the Sangley, even though the latter were just poorly educated relatives of their Ming brothers in the continent. Like Ricci, Cobo was a master of the art of memory and in a matter of a few months, he managed to read more than 3,000 Chinese characters. Cobo became a competent speaker and writer of Chinese, enough to preach and hear confessions. Like Ricci was to do later, Cobo surrounded himself with a cadre of learned Chinese men and translators. A decade before Ricci's workshop in Beijing, Cobo began a workshop in Manila with converted Sangley men with Hispanized names as Juan Sami and Antonio Lopez. Sami and Lopez introduced Cobo to school primers like the Mingxin baojian, 明心寶鑑, "The Precious Mirror," a mengshu collection of Confucian, Buddhist and Daoist aphorisms to teach the young to behave virtuously. "The Precious Mirror" was first edited in Wulin in 1396 by Fan Liben, one of many compilers of popular primers that began to circulate in late Yuan and early Ming dynasties. Fan Liben's mengshu became very popular in Japan, Korea, and Vietnam

20 On the history of the Codex, see George Bryan Souza and Jeffrey S. Turley, eds. *Codex Boxer* (Leiden, 2016).

from the 1500s to even the present. It was also popular with the Chinese diaspora in Luzon. A cadre of translators of many Chinese dialects helped Cobo come up with a bilingual Spanish-Chinese edition of Fan Liben's primer. "Libro chino Beng Sim Po Cam: Mirror and treasure of the one with a shining heart," the product of this Dominican workshop, appeared in print in Manila in 1590. It was the first Chinese text in a European alphabet ever.²¹

But Cobo was not only interested in learning moral and political Confucian, Buddhist, and Daoist Chinese philosophies. He was also interested in teaching Aristotelian and Ptolemaic cosmographies to the Sangleys in the Philippines, so he decided to translate into Chinese a text of physics and natural history, the *Símbolo de la Fe* of his coreligionist Luis de Granada. The translation appeared in 1593 in Manila under the title "Bian zheng jiao zhen chuan shi lu seng shi Hemu Xian zhuan." "The 'Apología de la verdadera religión o Tratado de la verdad de Dios' was printed on rice paper with wooden type blocks. This Chinese treatise on Aristotelian and Ptolemaic cosmography anticipated the much better-known translations of scholastic cosmography that would be offered by Ricci's circle of learned mandarins after 1600. Like Ricci, Cobo was trained in humanist philology. Cobo graduated in Alcalá, but it is apparent that Cobo learned his workshop techniques of translation in Mexico, where he spent two years in the missions.²²

Conclusion: Erasing Provenance

Just like the historiography of the Scientific Revolution created a strange and parochial narrative that erased entire regions and periods, the global Iberians also sought to erase the participation of indigenous authors in their many ethnobotanical and ethnographic workshops of translation. The early modern period is one of movement of objects as well as the erasure of memory.

Take, for example, the Uppsala Map (1551), an indigenous map of Tenochtitlan. It is an extraordinary document.²³ It sheds light on the social history of the Central Valley of Mexico thirty years after the fall of Tenochtitlan.

21 On Cobo, see José Antonio Cervera, "Misioneros en Filipinas y su relación con la ciencia en China: Fray Juan Cobo y su libro *Shi Lu*", in *Llull: Revista de la Sociedad Española de Historia de las Ciencias y de las Técnicas* 20 (1997): 491–506,

22 José Antonio Cervera, "Relaciones entre España y China a través de Filipinas: Fray Juan Cobo y su aportación a la astronomía en el Extremo Oriente," in María Carmen Beltrán ed., *La enseñanza de las ciencias: una perspectiva histórica* (Madrid, 2003), 117–130.

23 Uppsala University Library.

Scattered over its five by three foot surface, a world of Nahua place-glyphs, city states, hospitals, new animals (cattle, pigs, sheep, dogs, horses), street brawling, and old and new economic activities (log hauling, tree ax chopping, cactus cropping, pulque making) parade before our eyes. The most strikingly beautiful aspect of this map, nevertheless, is the lacustrine culture around Mexico-Tenochtitlan: chinampas, dams, canals, aqueducts, fishing, and bird catching. It dazzlingly captures an indigenous world of complex water works, fishing techniques, and the deliberate cultivation of feathers.

Historians assume that natives of Tlatelolco based their map on the one by the royal cosmographer Alonso de Santa Cruz's included in his *Islario*.²⁴ A quick perusal of Santa Cruz's *Islario*, however, clearly demonstrates that the borrowing happened the other way around. Santa Cruz assembled a collection of some one-hundred maps of islands off the coast of Asia (Java, Borneo, Sumatra, etc.), Africa (Cape Verde, Canaries, etc.), Europe (Britain, Iceland, Mallorca, Malta, Cyprus, Sicily, etc.), and America (Cuba, Puerto Rico, Jamaica, etc.). Curiously, there are only two maps of "island" cities in the collection: Venice and Tenochtitlan. The maps of Venice and Mexico are completely different in style. Both, in turn, are completely different from the remainder island maps. Clearly, Santa Cruz got his map of Tenochtitlan from Mexico. Paradoxically the Uppsala map claimed to model itself after Santa Cruz's (or so it says the cartouche). This is the way archives and memory are created: erasure, mislabeling, and recirculation. The delicious irony in the process of erasure is that the early seventeenth-century royal cosmographer Andrés García de Céspedes scrapped Santa Cruz's name from the title and put his instead. García de Céspedes did to Santa Cruz what the latter did to the Nahua scribes of Central Mexico. Finally, Francis Bacon had García de Céspedes disappeared.²⁵ For the narrative of the Scientific Revolution to emerge, multiple archival erasures had to occur.

24 Biblioteca Nacional de Madrid, Ms. Res/38.

25 Cañizares-Esguerra, "Renaissance Iberian Science: Ignored How Much Longer?" *Perspectives on Science* 12, no. 1 (2004): 86–125.