A Great (Scientific) Divergence: Synergies and Fault Lines in Global Histories of Science

Helen Tilley

Abstract: Historians of science have a lingering Europe (and U.S.) problem, even as the field has undergone its own transnational, imperial, and global turns that have broadened its scope. Likewise, area studies scholars have a lingering science problem, in spite of the growing chorus of voices insisting that non-European peoples' knowledge and innovations warrant a place in global histories about science, technology, and medicine. This essay examines these two fault lines using the biochemist-turned-historian Joseph Needham as a point of departure. Needham's studies of science in China not only decentered Europe but also raised central questions about how science and its companions, reality and reason, would be defined. The essay takes a closer look at debates arising from these fault lines and urges scholars to experiment with polycentric histories of science that are coterminous and intersecting. It also underscores the need for new syntheses of research on the ways intellectuals, bricoleurs, and polities the world over have generated and transformed ideas and tools, and set them in motion.

> ***No people or group of peoples has had a monopoly in contributing to the development of Science.***
> **—Joseph Needham (1954)**

> ***The last thing [historians of science] wanted to hear about was non-European science, and that is partly because of their strongly Eurocentric vision.***
> **—Joseph Needham (1981)**

At the turn of the twenty-first century, two historians of East and South Asia, Kenneth Pomeranz and Dipesh Chakrabarty, helped consolidate debates about the problems of telling "Europe-centered" stories. In their view, to explain industrial capitalism and contextualize political modernity, respectively, required not just "reciprocal comparisons" across places, so that like was compared with like and scales of analysis matched, but also attention to conceptual cat-

Helen Tilley explores the interplay among environmental, medical, and human sciences in nineteenth- and twentieth-century sub-Saharan Africa, with an emphasis on empires, development, and law. She is currently writing a transnational history of "traditional medicine" and its imperial and Cold War genealogies. Department of History, Northwestern University, 1881 Sheridan Road, Evanston, Illinois 60208-2220, USA; helen.tilley@northwestern.edu.

Acknowledgments. My heartfelt thanks to Florence Hsia and Dagmar Schäfer for inviting me to contribute to this special section and for their and two anonymous referees' helpful suggestions.

Isis, volume 110, number 1. 0021-1753/2019/0110-0011$10.00.

egories and "habits of thought," so that hidden assumptions were judiciously dissected and brought into the open. Although neither Pomeranz nor Chakrabarty sought to contribute to the history of science, their methods forced them to consider, on the one hand, how technologies arose (and were used) for industrial production in different parts of Eurasia and, on the other, which definitions of reason and rationality were permitted to "non-European peoples," who tended to be deemed "not yet" or insufficiently modern. In their aims to decenter Europe—especially in stories about industrial economies—and debunk flawed arguments about extra-European "lack," they also addressed a set of epistemological issues—relating to credit, circulation, rationality, efficacy, and scale—at the heart of debates about the history of science itself. Their books, in other words, built on some of the same scholarly grooves that have called into question the earlier so-called divergence between the West and the rest in relation to "modern science."[1]

Indeed, nearly fifty years earlier, in the first volume of *Science and Civilisation in China* (*SCC*), Joseph Needham had criticized certain nineteenth-century historians of science for their "bland unconsciousness of even the existence of the contributions of other peoples to the history of man's understanding of his environment." It was impossible, Needham insisted, to trace the history of "developed scientific thought" and "modern science and technology" without examining intellectual and technological debts incurred beyond European borders. While Needham did push a counterfactual question about divergence—Why had "*modern* science . . . developed around the shores of the Mediterranean and the Atlantic [in the seventeenth century] and not in China or any other part of Asia"?—he drew the line at supporting any lingering belief in the "intrinsic superiority of the European peoples." "Are not Europeans," he asked, "viewing the effects of modern science and technology in the complete transformation of the habitable globe, tempted too often to say to themselves that after all, this began in Europe . . . and to conclude that Wisdom was born with us?" The truth of the matter, in Needham's view, was more complicated and interesting. Historical evidence revealed centuries of fusion and cross-cultural traffic: "no people or group of peoples has had a monopoly in contributing to the development of Science."[2] He might have added another provocative aside: no place or continent has had a monopoly either.

Although there are many aspects of Needham's analysis that scholars today might wish to tweak or abandon, especially his assumption that science could be conceived of as a singular and universal phenomenon, several dimensions of his heuristic framing from the 1950s have stood the test of time.[3] These include his impulse to push historians of science to see their work in terms of "world history"; his desire to place European trends in a wider context of circulation and exchange; his move to relocate stories of discovery, innovation, and even "genius" to the extra-European world; and his stipulation that debates over credit (for different ideas and tools) cannot be separated from scholarly ignorance and amnesia, because without comparative in-

---

[1] I invoke these authors for heuristic purposes and recognize that there are many other scholars responsible for these debates. See Kenneth Pomeranz, *The Great Divergence: China, Europe, and the Making of the Modern World Economy* (Princeton, N.J.: Princeton Univ. Press, 2000), p. 10 and passim; and Dipesh Chakrabarty, *Provincializing Europe: Postcolonial Thought and Historical Difference* (Princeton, N.J.: Princeton Univ. Press, 2000), pp. 4–8 and passim. For a complementary discussion as it relates to African history and the problem of global histories of science see Helen Tilley, "History and Historiography of Science," in *Oxford Research Encyclopedia of African History*, 20 Nov. 2018, http://oxfordre.com/africanhistory/abstract/10.1093/acrefore/9780190277734.001.0001/acrefore-9780190277734-e-353. For the epigraphs see Joseph Needham, *Science and Civilisation in China*, Vol. 1: *Introductory Orientations*, with Wang Ling (Cambridge: Cambridge Univ. Press, 1954), p. 9; and Needham, *Science in Traditional China* (Cambridge, Mass.: Harvard Univ. Press, 1981), p. 7.

[2] Joseph Needham, *Science and Civilisation in China*, Vol. 2: *History of Scientific Thought*, with Wang Ling (Cambridge: Cambridge Univ. Press, 1956), pp. 3, 9.

[3] Needham's view of a universal Science, writ large, was undermined in practice by the multiplicity of subjects covered in the *SCC* volumes themselves.

tellectual histories such credit could be (and has been) inaccurately awarded.[4] Needham's inclusive vision arose, in part, as a response to the horrific effects of World War II and also from helping galvanize scientists to craft a "view from everywhere," through the specialized agency UNESCO.[5] By taking up these aspects of Needham's intellectual project, historians of science can continue to reorient the field's objects of analysis and move toward polycentric studies that do justice to developments and precedents the world over. This should help the field escape the pull of unjustified Eurocentrism, while also reminding scholars to avoid the assumption—as Needham never quite could—that there is a generic essence to "modern science" against which everything else must be measured and without which it could not have gone global.[6]

DECENTERING: EXCEPTIONALISM AND FRONTIERS IN THE HISTORY OF SCIENCE

In the last several decades, historians of science working alongside scholars in area studies have doubled down on efforts to decenter Europe through the simple act of taking the regions and subjects they study seriously on their own terms.[7] Whatever their scale of analysis—local, dynastic, national, regional, imperial, continental, or some mixture of these—this new research has produced a vast array of evidence from the Americas, the Caribbean, Africa, Asia, and oceanic regions that explains not just peoples' different ways of knowing and mastering their worlds but also how and why ideas, instruments, objects, and experts of all kinds have circulated and mixed in different locations and times.[8] Such decentering impulses have tended to exist in natural synergy with studies of science and empire as well as research on other geo-

---

[4] For several of these impulses see Robert Finlay, "China, the West, and World History in Joseph Needham's 'Science and Civilization in China,'" *Journal of World History*, 2000, *11*:265–303; Gregory Blue, "Science(s), Civilization(s), Historie(s)," in *Situating the History of Science: Dialogues with Joseph Needham*, ed. S. Hirfan Habib and Dhruv Raina (New Delhi: Oxford Univ. Press, 1999), pp. 29–72; and Leon Antonio Rocha, "How Deep Is the Love? The Engagement with India in Needham's Historiography of China," *BJHS Themes*, 2016, *1*:13–41.

[5] Perrin Selcer, "The View from Everywhere: Disciplining Diversity in Post–World War II International Social Science," *Journal of the History of the Behavioral Sciences*, 2009, *45*:309–329.

[6] I am here paraphrasing an argument Timothy Mitchell makes about how scholars use the label "alternative" to make capitalism and modernity plural; such a move, while understandable, assumes "a fundamentally singular capitalism underneath, modified by local circumstances into alternative forms." See Timothy Mitchell, *Rule of Experts: Egypt, Techno-Politics, and Modernity* (Berkeley: Univ. California Press, 2002), p. 248.

[7] Beyond research monographs, these trends can be observed in edited collections and special journal issues. For a selection in English, featuring postcolonial studies, Latin America, Africa, the Caribbean, and South/East Asia, see Warwick Anderson, ed., "Postcolonial Technoscience," special issue, *Social Studies of Science*, 2002, 32(5–6); Anderson, Suzanne Moon, and Sulfikar Amir, eds., "Emergent Studies of Science and Technology in Southeast Asia," *East Asian Science, Technology, and Society*, 2009, 3(2–3); Sujit Sivasundarum, ed., "Focus: Global Histories of Science," *Isis*, 2010, *101*:95–158; Gabrielle Hecht, ed., *Entangled Geographies: Empire and Technopolitics in the Global Cold War* (Cambridge, Mass.: MIT Press, 2011); Stuart McCook, ed., "Focus: Global Currents in National Histories of Science: The 'Global Turn' and the History of Science in Latin America," *Isis*, 2013, *104*:773–817; Jahnavi Phalkey, ed., "Focus: Science, History, and Modern India," *ibid.*, pp. 330–380; Eden Medina *et al.*, eds., *Beyond Imported Magic: Essays on Science, Technology, and Society in Latin America* (Cambridge, Mass.: MIT Press, 2014); and Clapperton Chakanetsa Mavhunga, ed., *What Do Science, Technology, and Innovation Mean from Africa* (Cambridge, Mass.: MIT Press, 2017). For an article advocating polyvocality in the history of science see Carla Nappi, "The Global and Beyond: Adventures in the Local Historiographies of Science," *Isis*, 2013, *104*:102–110.

[8] For select examples of cross-cultural entanglements see Richard Grove, *Green Imperialism: Colonial Expansion, Tropical Island Edens, and the Origins of Environmentalism, 1600–1860* (Cambridge: Cambridge Univ. Press, 1996); Kapil Raj, *Relocating Modern Science: Circulation and Construction of Knowledge in South Asia and Europe, 1650–1900* (London: Palgrave Macmillan, 2007); Florence Hsia, *Strangers in a Strange Land: Jesuits and Their Scientific Missions in China* (Chicago: Univ. Chicago Press, 2009); Simon Schaffer *et al.*, *The Brokered World: Go-Betweens and Global Intelligence* (Sagamore Beach, Mass.: Science History, 2009); Marwa Elshakry, *Reading Darwin in Arabic* (Chicago: Univ. Chicago Press, 2013); and Pablo Gomez, *The Experiential Caribbean: Creating Knowledge and Healing in the Early Modern Atlantic* (Chapel Hill: Univ. North Carolina Press, 2017).

political phenomena—such as missions, trade networks, expeditions, and transnational organizations—that involved movement and communication across borders and between peoples.[9] As evidence from these studies has accumulated, new composite pictures emerge that show how important such flows have actually been to producing various now-dominant epistemic cultures. To put it differently: without a world beyond Europe (and North America), revolutionary insights and powerful new tools might never have developed or flourished. Leaving the wider world out of grand narratives about any number of scientific developments, and their attendant infrastructures, effectively treats places and people as epiphenomena rather than constitutive and foundational to fields.

This fault line is one Joseph Needham and his collaborators also stressed: the conundrum of seeing science as a strictly European, or Europe-centered, product. No matter how many different ways scholars have pushed back against the focus on hermetically sealed origin stories—or simply chosen to ignore questions of genealogy altogether—a certain scholarly (and popular) compass seems to reset predictably to European lands and actors, much like a global positioning system with a tamper-proof homing device.[10] There are justifiable reasons for this focus, given that many different kinds of scientific, technological, and medical changes over the last four centuries took place *within* the borders of European countries and reverberated elsewhere with dramatic consequences. Area studies scholars risk making mistakes of their own if they downplay or sidestep the interlocked nature and effects of such regional developments. Yet if Europe is considered impermeable, if it is reified into a single unit, and if outside influences go unexamined or unarticulated, many other important insights about knowledge and expertise tend to get lost in the shuffle.[11] This includes the comparative understanding that different epistemic cultures coexisted and interacted for centuries and millennia without any one of them becoming globally dominant. Were it possible to take dozens of snapshots in different parts of the world to capture epistemic cultures (using an equal number of languages as our guide), even as late as 1840 or 1850 they would reveal the absence of widely shared standards and definitions by which to compare, much less *rank*, forms of knowledge and expertise globally.[12]

---

[9] For select work in different regions on these themes see Londa Schiebinger, ed., "Focus: Colonial Science," *Isis*, 2005, *96*:52–87; Hal Cook, *Matters of Exchange: Commerce, Medicine, and Science in the Dutch Golden Age* (New Haven, Conn.: Yale Univ. Press, 2007); Daniela Bleichmar *et al.*, eds., *Science in the Spanish and Portuguese Empires, 1500–1800* (Stanford, Calif.: Stanford Univ. Press, 2009); James Delbourgo and Nicholas Dew, eds., *Science and Empire in the Atlantic World* (New York: Routledge, 2009); Helen Tilley, *Africa as a Living Laboratory: Empire, Development, and the Problem of Scientific Knowledge, 1870–1950* (Chicago: Univ. Chicago Press, 2011); and Perrin Selcer, *The Postwar Origins of the Global Environment: How the United Nations Built Spaceship Earth* (New York: Columbia Univ. Press, 2018).

[10] For an example of a sort of applied history that takes this viewpoint see Steven Pinker, *Enlightenment Now: The Case for Reason, Science, Humanism, and Progress* (New York: Viking, 2018); for a judicious and deeply researched approach linking the history of science and economic history see Joel Mokyr, *A Culture of Growth: The Origins of the Modern Economy* (Princeton, N.J.: Princeton Univ. Press, 2017).

[11] To be clear, these are methodological dangers; while few scholars succumb to them in their entirety, the danger of falling prey to one or more remains real. These dangers become most evident in companion volumes to the history of science, which tend to maintain a Eurocentric or U.S. focus.

[12] These reconstructive efforts are ongoing. For a few examples dealing with South Asia and North Africa see Sheldon Pollock, *The Language of the Gods in the World of Men: Sanskrit, Culture, and Power in Premodern India* (Berkeley: Univ. California Press, 2006); Pollock, ed., *Forms of Knowledge in Early Modern Asia* (Durham, N.C.: Duke Univ. Press, 2011); Seema Alavi, *Islam and Healing: Loss and Recovery of an Indo-Muslim Medical Tradition* (New York: Palgrave, 2008); Jane Murphy, "Improving the Mind and Delighting the Spirit: Jabarti and the Sciences in Eighteenth Century Ottoman Cairo" (Ph.D. diss., Princeton Univ., 2006); Daniel Stolz, *The Lighthouse and the Observatory: Islam, Science, and Empire in Late Ottoman Egypt* (Cambridge: Cambridge Univ. Press, 2018); and Muzaffar Iqbal, *Science and Islam* (2002; New York: Routledge, 2018). For a brief discussion of scholarship on precolonial sub-Saharan Africa see Tilley, "History and Historiography of Science" (cit. n. 1).

This fact alone makes multisited approaches justified, yet they also come in handy when trying to explain how certain epistemic cultures were able to scale up and embed themselves in different places over the last several centuries while others were hindered and inhibited (if not outright prohibited). To address inherently global processes, especially when they are uneven, requires foregrounding geopolitics of all kinds, including the history of free and forced migrations of people from Europe and Africa across the Atlantic world and beyond; the violence, epidemiological decimations, and intellectual impositions that stemmed from empire and state building; and, of course, the use of laws and ideologies that vilified certain expert groups and stereotyped whole populations, often in the name of progress. That it has been largely since the 1850s that certain disciplines, professions, institutions, regulatory regimes, and concepts came to dominate cultures of knowledge production around the planet and that this period corresponds to so many social upheavals in which technoscientific assemblages have been integral—war, conquest, occupation, development, pandemics, extractive economies, surveillance—seems to call for methods that are spatially distributed.[13] Only in this way is it possible to see fully and precisely the different causes and effects, flows and influences.

A parallel problem exists for at least some kinds of studies focused on the United States in the twentieth century, which imply that precedents set and innovations developed in the United States have been indebted to nowhere and no one else and yet have gone on to establish benchmarks and standards for the rest of the world. To take an example that bridges the United States and Western Europe, studies of influential laboratories and research groups make this point implicitly because their authors have often been less interested in understanding how their findings relate to trends in any other part of the world and more focused on exploring the imagined "worlds" of their actors.[14] This literature, important as it is, can be usefully contrasted to work by area studies scholars and historians of field and human sciences who examine how entire countries (e.g., South Africa, Mexico, and Egypt), oceans (e.g., the Pacific), and continents (e.g., Africa) are turned into sites of experimentation and scientific extraction.[15] The cautionary tale contained in these comparisons is twofold: a single cluster of scientists at a single university or laboratory in the United States (or England, or France, or Germany) can not only wield an outsized influence in their day but can continue to do so within the history of science itself, effectively reinscribing radically unequal geopolitical and epistemological patterns.

Such Eurocentric and U.S.-centric stories leave too many people with the impression that to understand the world, and its encounters with science, technology, and medicine, it's enough to understand developments within certain centers of power or frontiers of knowledge production. By setting to one side the copious scholarship on areas outside Europe and Anglo-America, these studies also tacitly imply that engaging with this literature would alter neither their arguments nor their intellectual projects. In other words, they inadvertently shore up the view that

---

[13] See, e.g., Keith Breckinridge, *Biometric State: The Global Politics of Identification and Surveillance in South Africa* (Cambridge: Cambridge Univ. Press, 2014).

[14] See, e.g., Rebecca Lemov, *World as Laboratory: Experiments with Mice, Mazes, and Men* (New York: Wang, 2005); Bruno Latour, "Give Me a Laboratory and I Will Raise the World," in *Science Observed: Perspectives on the Social Study of Science*, ed. Karin Knorr-Cetina and Michael Mulkay (London: Sage, 1983), pp. 141–170; and Bernard Lightman, ed., "Focus: Laboratory History," *Isis*, 2008, 99:761–802.

[15] Saul Dubow, *Scientific Racism in Modern South Africa* (Cambridge: Cambridge Univ. Press, 1995); Omnia Elshakry, *The Great Social Laboratory: Subjects of Knowledge in Colonial and Postcolonial Egypt* (Stanford, Calif.: Stanford Univ. Press, 2007); Gabriella Soto Laveaga, *Jungle Laboratories: Mexican Peasants, National Projects, and the Making of the Pill* (Durham, N.C.: Duke Univ. Press, 2009); Roy MacLeod and Philip Rehbock, eds., *Darwin's Laboratory: Evolutionary Theory and Natural History in the Pacific* (Honolulu: Univ. Hawaii Press, 1996); and Tilley, *Africa as a Living Laboratory* (cit. n. 9).

norms set by the scientifically powerful, however parochial they may have been in the past, inevitably become global norms. Because these assumptions are so widespread, it also makes it difficult to dislodge the idea that the West experienced a great scientific divergence while the rest did not. In truth, a less pithy but more accurate shorthand would be: the imagined singularity of the West hides a multiplicity of movement and fusion everywhere. When only some parts of the world are held up as having been *exceptional* and *essential* to the history of science, this very global dynamism and its attendant forms of innovation, improvisation, and even precedent get erased or forgotten.

REORIENTING: BOUNDARY WORK BETWEEN SCIENCE AND NONSCIENCE AT A GLOBAL SCALE

The schism of Eurocentrism leads into a second fault line that affects both historians of science and area studies scholars and has to do with the history of boundary work both within disciplines and between the borders of science and nonscience. Interregional histories, for instance, of chemistry, germ theories, racial sciences, eugenics, nuclear science, evolutionary theory, psychoanalysis, and even economics have revealed how norms and expert understandings can differ radically across the globe at the same time.[16] Ideas and technoscientific assemblages, in other words, have been in constant flux as they were translated into other languages, modified to suit new purposes, and reassembled for different places and institutions. As Marwa Elshakry reminds us, the multilingual nature of the world challenges facile ideas that concepts or disciplines in motion have ever been immutable: "the practice of translation involves often very substantial epistemological, authorial, and literary shifts across cultures and over time."[17]

For scholars focused on regions of the world that experienced different forms of colonialism, such circulations and accompanying translations have had paradoxical effects. From the late nineteenth century onward, fieldworkers focused on human subjects increasingly used questionnaires and surveys that encouraged them to seek out and describe aspects of non-Western societies that fell into the categories of "medicine" or "technology" or "natural science." The research goal was to offer as complete a description as possible of each group, while the categories presumed that every society found ways to address illness and disease, understand and manipulate their surroundings, and manufacture tools. This helps to explain why, as early as 1930, Bronislaw Malinowski took the provocative stand that even groups of people without print cultures possessed "genuine science." By this, he meant that they worked in terms that were accurate, empirically sound, rational, and able to be transmitted systematically to others. Having worked for years in Melanesia, Malinowski was alert to the ways in which an absence of "texts" and printed records had

---

[16] A sampling of literature includes Lissa Roberts, ed., "Exploring Global History Through the Lens of Chemistry," special issue, *History of Science*, 2016, 54:335–361; Suman Seth, ed., "Focus: Relocating Race," *Isis*, 2014, *105*:759–814; Alison Bashford and Philippa Levine, eds., *The Oxford Handbook of the History of Eugenics* (Oxford: Oxford Univ. Press, 2010); Mary Morgan, "'On a Mission' with Mutable Mobiles," Working Paper on the Nature of Evidence: How Well Do Facts Travel? no. 34/08, London School of Economics and University of Amsterdam (2008); Nancy Tomes and John Harley Warner, eds., "Rethinking the Reception of Germ Theory of Disease," special issue, *Journal of the History of Medicine and Allied Sciences*, 1997, 52:7–157; Warwick Anderson, Deborah Jensen, and Richard Keller, eds., *Unconscious Dominions: Psychoanalysis, Colonial Trauma, and Global Sovereignties* (Durham, N.C.: Duke Univ. Press, 2011); special essays on "Global Darwin" by Jürgen Buchenau, James Pusey, David Flannery, Daniel Todes, and Marwa Elshakry, *Nature*, 2009, *461* and *462*; and Gabrielle Hecht, *Being Nuclear: Africans and the Global Uranium Trade* (Cambridge, Mass.: MIT Press, 2012).

[17] Marwa Elshakry, "Knowledge in Motion: The Cultural Politics of Modern Science Translations in Arabic," *Isis*, 2008, *99*:701–730, on p. 704. Ruth Rogaski makes a similar point about the gradual transformation of the concept *weisheng* in her book *Hygienic Modernity: Meanings of Health and Disease in Treaty Port China* (Berkeley: Univ. California Press, 2004).

made it easier to treat islanders' intellectual accomplishments, especially with navigation, as falling squarely into the category of nonscience, if not relativistic nonsense.[18]

During the very decades that historians of science were focused on tracing the origins of "modern science" within Europe (circa 1920 to 1960), anthropologists, often relying heavily on intellectuals in their sites of study, were developing their own philosophies of science and generating critiques of colonial epistemologies in the process. (It was no accident that Malinowski and his colleagues taught the first seminars on "colonial studies" at the London School of Economics.) From the interwar period onward, then, ethnographically minded scholars and administrators in different imperial settings began to codify new polysemous categories called "traditional medicine" and "traditional knowledge," situating them in a liminal zone between science and nonscience.[19] Ethnographers tended to construct their categories on cross-cultural ideas about efficacy, experience, and experimentation that they also seemed to imagine were constitutive of "modern science." Many ethnosciences, in other words, have depended on field sciences and other state-sanctioned infrastructures to achieve legibility and legitimacy in the first place. This process, in turn, allowed these new categories to proliferate and circulate, albeit within circumscribed limits. To ask just what status these epistemic cultures deserve opens the door to questions about reality itself.

These kinds of boundary questions—should different people's expertise and ingenuity be called science or not, real or not—often get glossed as a problem of belief (versus science) and relativism (versus truth). Indeed, most area studies scholars interested in the history of science are only too aware of how people's expertise in their parts of the world has often been loosely characterized not just as local and particular (as distinct from universal) but also, by turns, as primitive, backward, irrational, and superstitious. As James Secord has pointed out, this problem is not unique to area studies scholars but affects anyone interested in forms of knowledge and groups of professionals that do not map easily onto dominant cultures and identities: "We study 'popular' science, 'subaltern' or 'indigenous' knowledge; but to varying degrees these categories are too easily framed through a contrast with an assumed story of elite Western knowledge."[20]

Historians of science have stopped trying to draw clear distinctions between science and "superstition" or science and "pseudo-science," a vocabulary even Joseph Needham occasionally used, because they now widely accept that such conceptual boundaries have been neither certain nor absolute over time and tend to result from sustained social negotiations. The very existence of a science/nonscience border, however, does raise important questions for anyone interested in what happens when certain objects of analysis rarely, if ever, fit within *any* categories of formal or official science, such as deities and ancestors, while the social and expert practices to which they are linked, including such things as architecture, mathematics, forestry, agriculture, navigation, or healing, still do.[21] Scholars interested in both ethnoscience (as science) and indigenous knowledge systems (as systems) have been prone to write the invisible parts of their subjects' thought-worlds out of the story and focus more on instrumental or "useful" forms of knowledge. The gaps are telling.

---

[18] Bronislaw Malinowski quoted in Helen Tilley, "Global Histories, Vernacular Science, and African Genealogies; or, Is the History of Science Ready for the World?" *Isis*, 2010, *101*:110–119, on p. 110. On indigenous and comparative epistemologies see David Turnbull, *Masons, Tricksters, and Cartographers* (New York: Routledge, 2000); and Julie Cruikshank, *Do Glaciers Listen? Local Knowledge, Colonial Encounters, and Social Imagination* (Vancouver: Univ. British Columbia Press, 2006).

[19] I take the idea of polysemy from Steven Epstein and Laura Mamo, "The Proliferation of Sexual Health: Diverse Social Problems and the Legitimation of Sexuality," *Social Science and Medicine*, 2017, *188*:176–190.

[20] James Secord, "Knowledge in Transit," *Isis*, 2004, *95*:654–672, on p. 656.

[21] I discuss these subjects at more length in Tilley, "History and Historiography of Science" (cit. n. 1).

To draw out this point, area studies scholars and historians of science are typically well versed in talking about invisible agency and are especially deft in describing how different actors have detected and documented its traces and connected these steps explicitly to prediction and prognostication. Yet the objects these scholars have focused on have very different epistemological status. One set of invisible objects—atoms, electricity, germs, quarks, quantum energy, and black holes—has far-reaching legitimacy in the wider world today and is usually discussed in survey classes in the history of "modern" science. Another set, which includes ancestors, spirits, animating matter, witches, devils, and deities, may also be included in a history of science canon, but it is more likely to be covered in early modern surveys and then perhaps picked up for the recent period (if it is covered at all) in histories of religion and medicine. To exaggerate the patterns somewhat, while one set of objects ascends over time, at least for historians of science, the other set declines, a pattern corresponding to increasingly secular and material understandings of matter and causality.

But what if historians of science took the endurance of such preternatural categories not as a sign of a form of thinking that no longer hews sufficiently to true statements about the world but, instead, as a sign of the persistence of far-reaching debates around the world about just what constitutes reality and about whether scientists' definitions are correct? And what if this sort of science/nonscience fault line were examined more carefully and comparatively in global histories of science? While the dangers of a "relativistic nightmare" are real enough, as Peter Dear notes, such a research agenda actually builds strategically on leading studies of early modern Europe and foregrounds the question of why certain forms of invisible agency have been so integral for so long to so many different innovative epistemic cultures.[22] Indeed, this struggle to define what counts as real has led at least some scholars, once again in anthropology, to insist that there are not just competing epistemologies, among experts and laypeople alike, but also multiple ontologies.[23] This scholarly move seems to allow inexplicability, as distinct from incommensurability, to move back to the center of philosophical debate, after having been sidelined for a few decades.[24] It also might allow the field to forge new syntheses that can bridge these fault lines going forward.

---

[22] Peter Dear, "What Is the History of Science the History *Of*? Early Modern Roots of the Ideology of Modern Science," *Isis*, 2005, 96:390–406, esp. p. 392.

[23] Annemarie Mol, *The Body Multiple: Ontology in Medical Practice* (Durham, N.C.: Duke Univ. Press, 2002); Stacey Langwick, *Bodies, Politics, and Healing: The Matter of Maladies in Tanzania* (Bloomington: Indiana Univ. Press, 2011); and Martin Holbraad and Morten Axel Pedersen, *The Ontological Turn: An Anthropological Exposition* (Cambridge: Cambridge Univ. Press, 2017).

[24] Martin Hollis and Steven Lukes, eds., *Rationality and Relativism* (Cambridge, Mass.: MIT Press, 1982).