Sciences and the Global

On Methods, Questions, and Theory

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ABSTRACT

This essay explores the mechanics of researching and writing globally oriented histories of science. Thinking about how to approach sources is vital, especially given how often historians of science use the excuse of a lack of sources for constraining their projects to European topics. The first section suggests a method of cross-contextualization, where scarce and unorthodox sources are read within and alongside more plentiful and traditional ones. The next section considers historiography, critiquing the continuing hold of the terms "colonial" and "national" in current work that aspires to be more global. The final section considers practice and network theory, asking whether the way we utilize these tools in fact returns us, instinctively, to European and Eurocentric ways of conceiving how science works.

IT IS DIFFICULT to write up the "how to" for global histories of science. Various methods have been tried and have faltered; the most visible casualty in this respect is diffusionist narratives of the spread of Western science.[1] The tools in vogue in present histories of science—ranging from practice theory to local contextualization of sources—can also enforce the compartmentalization of the European history of science from those beyond. It is not clear that these methods work perfectly for global histories of science. If a new enterprise of globalist studies of science is to be undertaken, it is important that scholars who engage in it remain theoretically open. A close and recurrent scrutiny of methods is vital if historians of science are not to tie themselves unconsciously to a newly bounded notion of science that turns out to be a Western one after all.

I begin by critiquing established ways of interpreting sources in the history of science, advocating a strategy of "cross-contextualization" that involves reading across genres and cultures. Having considered method, the essay moves on to historiography, where I argue that the concern with science and empire and with science and the nation has narrowed

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[1] The most influential exposition of diffusionism is George Basalla, "The Spread of Western Science," *Science*, 1967, *156*:611–622.

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intellectual discussion by bifurcating knowledge traditions and moving questions of causation to center stage. New methods and new historiographical concerns will necessitate a creative take on the theoretical foundations of present history of science, as the concluding section of this essay argues.

GETTING THE SOURCES RIGHT

A set of questions relating to sources emerges as soon as the topic of global history of science is broached. How can radically different types of sources be woven together? How should the historian overcome the fact that, as far as production and preservation are concerned, the sources connected with the history of science in Europe far outweigh those from other parts of the world? These are questions that have been important for my work on both the Pacific and South Asia, where I have focused on the late eighteenth and early nineteenth centuries.

There is now a rich historiography on science in the Pacific Ocean region that draws on historical anthropology to open up questions of how science was located in voyages of exploration.[2] Yet what is striking is that for the most part scholars have had to rely on European accounts and collections of material culture in order to come to islanders' views of nature, the skies, and the seas. Indeed, my own work followed this very track.[3] Toward the end of my research on a book on missionaries and science, I came across a review of the evangelical South Pacific mission in a Tory periodical published in Edinburgh, the *Quarterly Review*.

The material in this article—which was very likely written by the poet Robert Southey—was striking for the unexpected opportunity it provided to reconstruct Pacific islanders' science. On the one hand, Southey poked fun at how the missionaries said they had discovered the Trinity in the Pacific. He noted that Tahitians believed that their maraes, burial grounds made of stone or coral, are visited by a mythical bird. "What more likely than that the missionaries hearing of this Eatooa Bird . . . should then have hastily concluded that they had found the Trinity in Taheite?" (See Figure 1.) There was, on the other hand, also an account of how islanders were keen to lay their hands on any objects of iron that came with the European voyagers: "the ring of an anchor which [Captain] Bougainville had lost was hoarded for ten years." The report that stood out, however, was that of a conversation between a resident missionary, a Mr. Turnbull, and the King of Tahiti. The monarch demanded to know where God lived, and in response the missionary pointed to the heavens; he then reported the king's objection: "We could bring down the sun and moon by means of our quadrant, —why could we not bring down our Saviour by similar means?"[4]

These throwaway lines show how cultural contact involved the meeting of different vocabularies of nature. Yet even in this interpretative observation it is important not to separate Europe from the rest of the world. It is difficult, for example, to see one side in this encounter as more religious than the other. Moreover, it is simplistic to posit—in light

[2] Of particular interest for historians of science of the Pacific in debating the question of how to overcome Eurocentrism is Michael Bravo, "The Anti-Anthropology of Highlanders and Islanders," *Studies in the History and Philosophy of Science*, 1998, *29*:369–389.

[3] Sujit Sivasundaram, *Nature and the Godly Empire: Science and Evangelical Mission in the Pacific, 1795–1850* (Cambridge: Cambridge Univ. Press, 2005).

[4] Robert Southey [?], "Transactions of the Missionary Society in the South Sea Islands," *Quarterly Review*, 1809, *2*:24–61, on pp. 39, 45, 54.

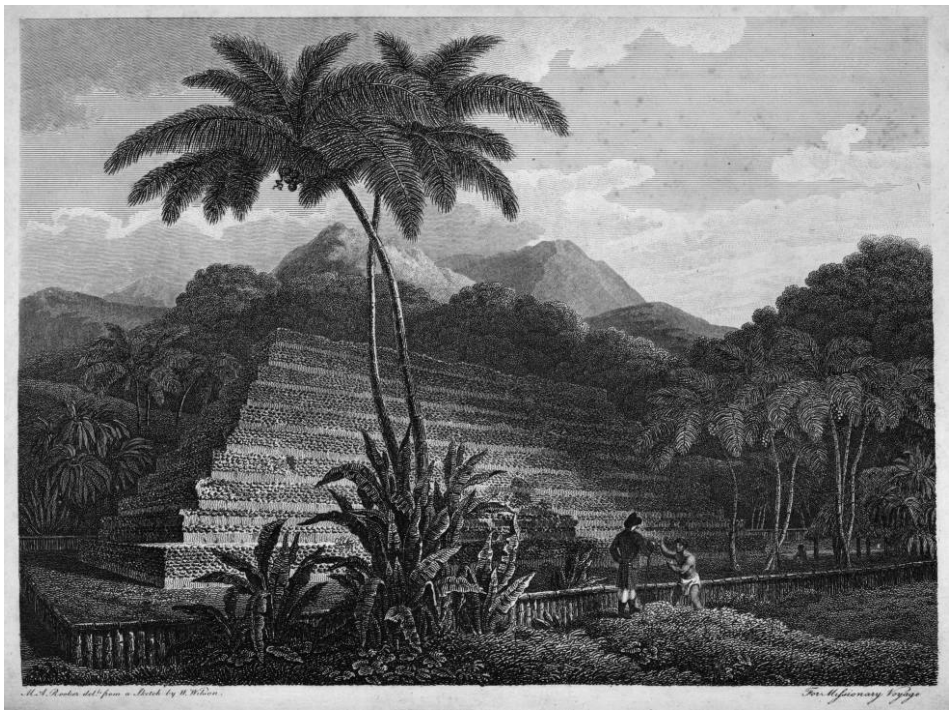

Figure 1. *"Great Morai at Temarre at Pappara in Otaheiti." From James Wilson,* A Missionary Voyage to the Southern Pacific Ocean *(London, 1799), facing p. 204. Wilson wrote: "This morai is an enormous pile of stone-work in the form of a pyramid." He noted that his guide, who is probably shown in the image, called on the Eatooa at an altar to the west of the edifice. Reprinted by permission of the Syndics of Cambridge University Library.*

of the comment about the islanders' interest in iron—that one culture collected and the other was collected. The article also shows that islanders were aware of the claims made by Western knowledge and critiqued them in a manner that was not so unlike colonial forms of epistemology. Yet all of this assumes that the *Quarterly Review* article should be read as an isolated piece. Might a fuller and better interpretation emerge if scholars read this source within Pacific traditions of knowledge rather than outside them?

Such an enterprise would require us to take seriously recent work in anthropology on the agriculture, astronomy, mathematics, timekeeping, and seafaring of the Pacific. One matter that is just emerging for critical scrutiny is the important question of whether some of the maraes should be seen not only as burial sites or even temples but as astronomical monuments as well.[5] Observation of the rising and setting positions of the stars was critical for islanders' long-distance ocean voyages. While there is debate about whether the ahu and moai platforms on Easter Island are aligned in accordance with solstice or equinox positions, the heiau or stone temples of Hawaii may have been constructed with advice from a class of priests who followed the movements of the stars and the sun and

[5] For an incisive summary of the literature see César Esteban, "Astronomical Monuments in Polynesia and Micronesia," in *Encylopaedia of the History of Science, Technology, and Medicine in Non-Western Cultures*, ed. Helaine Selin, 2nd ed. (New York: Springer, 2008), Vol. 1, pp. 284–292.

who reckoned months. In the literature on Polynesia a debate rages as to whether the orientation of some maraes accords with solstice orientations. In Atituiti, in the Gambier Islands, an observatory named Te Rua Ra (Pit of the Sun) has been located; it consists of a flat boulder from which observations could be made.

The reading of monuments should go hand in hand with the reading of evidence about migration and seafaring. The current wide consensus is that Pacific islanders migrated from west to east across vast distances.[6] The Polynesian navigational system is especially interesting. These islanders navigated strategically, deciding what to do in particular circumstances and calculating how far they had traveled from a point of reference, rather than worrying about where they were. Stars were read and the impact of current, drift, wind, and speed were taken into account in determining the distance traveled. Even as these long-distance migrations occurred, islanders adapted what they knew to suit new climates and terrains. This is especially clear with respect to agriculture. Before European contact, stone implements, as well as digging tools of wood, were commonly used for agricultural purposes.[7] In appropriating iron from Europeans, the islanders changed their agricultural tools in response to a new context.

This information shifts our view of the *Quarterly Review* article. It can be read as indicative of how islanders responded to European traditions of knowledge, rather than as an indicator of the absence of science in the Pacific—and this despite the fact that Southey compared the Pacific islanders' "physic" to jugglery and the secret arts.[8] The article also serves as evidence of Europeans' inability to contextualize islanders' ways of knowing. Returning to the King of Tahiti's conversation with the missionary, we might be prompted to ask what the monarch meant when—using the analogy of European astronomy—he chided the missionaries for being unable to bring their God "down." The king may have interpreted European astronomy as a system of representation: making likenesses and traces of the sun and moon was a way of bringing these objects "down." This was a different enterprise from the way islanders utilized the position of stellar objects to mark their own bearings. In talking of European astronomy as a "bringing down," the king displayed an awareness of difference, without presenting his own astronomy as inferior. He chided the Europeans for being unable to do what they promised: their astronomy did not meet the claims it made.

By attending to sources such as monuments, indications of long-distance voyaging, and oral accounts, historians can radically revise their interpretation of European sources—starting, as it were, from the Pacific rather than from Europe. In turning my research to South and Southeast Asia, I began with a sense of delight at the extent of local manuscripts that were available and as yet untapped. In particular, I have been working on what palm-leaf manuscripts can tell a historian of science about Sri Lanka. (See Figures 2 and 3.) Knowing the Sinhala language has been an asset in this research, but a number of palm-leaf manuscripts have in fact been translated into English (and my collaborative work has added to this number). Palm-leaf manuscripts dating from the medieval to the modern

[6] On Pacific navigation see David Lewis, *We, the Navigators: The Ancient Art of Landfinding in the Pacific*, 2nd ed. (Honolulu: Univ. Hawaii Press, 1994); and David Turnbull, "Comparing Knowledge Systems: Pacific Navigation and Western Science," in *Science of the Pacific Island Peoples*, Vol. 1: *Ocean and Coastal Studies*, ed. R. J. Morrison, Paul A. Geraghty, and Linda Crowl (Suva: Institute of Pacific Studies, 1994), pp. 129–144.

[7] See, e.g., Patrick V. Kirch, "Polynesian Agricultural Systems," in *Islands, Plants, and Polynesians: An Introduction to Polynesian Ethnobotany*, ed. Paul Alan Cox and Sandra Anne Banack (Portland, Ore.: Dioscorides, 1991), pp. 113–133, esp. p. 118.

[8] Southey [?], "Transactions of the Missionary Society in the South Sea Islands" (cit. n. 4), p. 42.

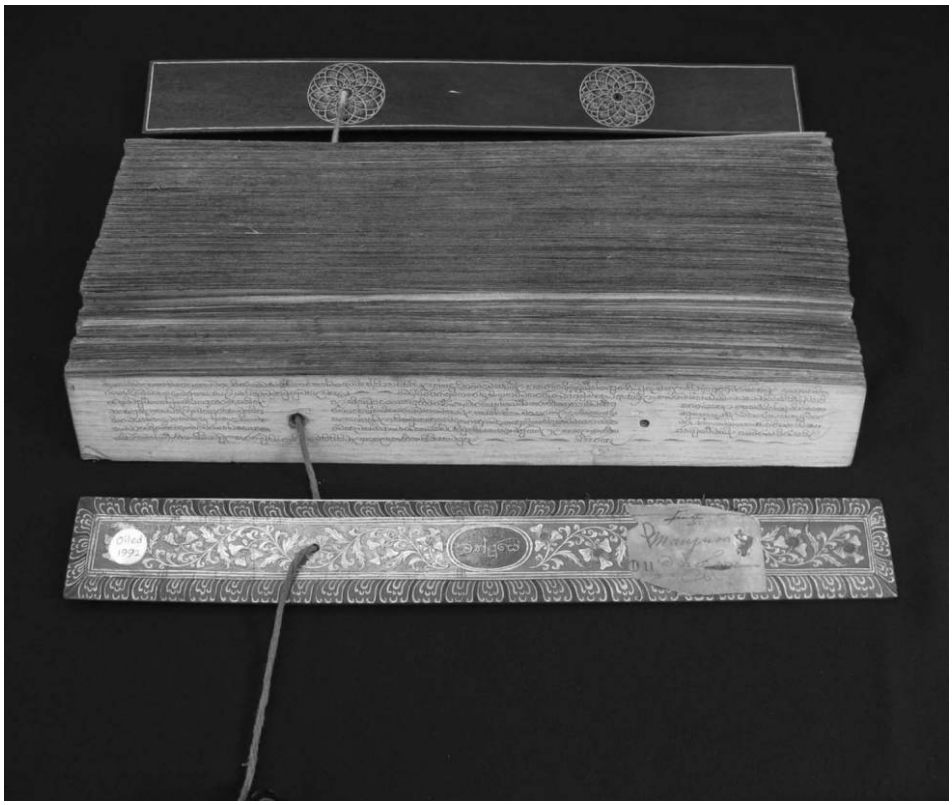

Figure 2. *One of the most important medical palm-leaf manuscripts of Sri Lanka, the* Bhesajjamanjusa-sanne *(V.8), from the Colombo Museum Library; reproduced by permission of the Director of the Colombo Museum. A Sinhala translation from the original Pali was completed by a Buddhist monk in the eighteenth century.*

period provide rich information about both courtly and peasant life in Sri Lanka, and a good number of them deal in particular with topography, architecture, food, agriculture, botany, and medicine.[9] The courtly manuscripts are sometimes ornamented with ivory or precious stones. As a class of sources, palm-leaf manuscripts were first systematically collected in centers of Buddhist learning, and Buddhist monks kept alive the traditions of writing on strips of palm leaf, usually of the talipot or Palmyra palm. Sri Lanka is not an exceptional case, as palm-leaf manuscripts are also to be found in other parts of South and Southeast Asia.

Faced with a wide range of manuscripts, I began with one of the most well known, which is central to current Sri Lankan nationalist politics: the *Mahavamsa*, a Buddhist chronicle of the history of Sri Lanka, spanning twenty-five centuries, which retells the acts of a line of the island's kings. In reading in this text of the deeds of the last kings of Kandy,

[9] For commentary on the palm-leaf manuscripts of Sri Lanka see Sirancee Gunawardana, *Palm-Leaf Manuscripts of Sri Lanka* (Colombo: Sarvodaya Vishva Lekha, 1997); and Adrian Senadhira, *History of Scientific Literature of Sri Lanka* (Colombo: Foremost, 1995).

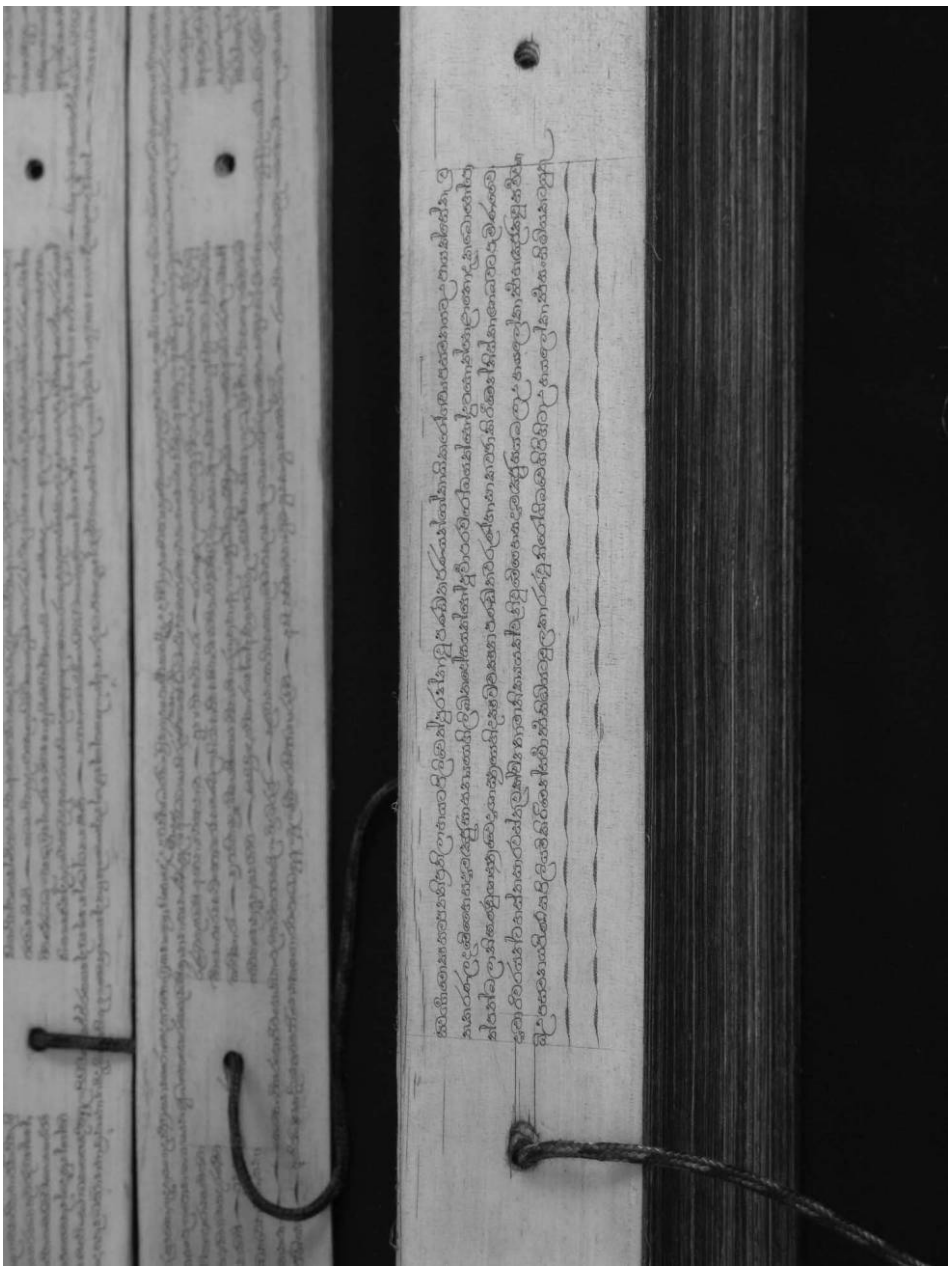

Figure 3. *Detail from the* Bhesajjamanjusa-sanne*; reproduced by permission of the Director of the Colombo Museum.*

who established a kingdom in the highlands of Sri Lanka that successfully resisted Portuguese, Dutch, and British colonialism but eventually fell in 1815, I came across some references to gardening. Like the bits of information gleaned from the *Quarterly Review* article, these were scattered and passing mentions. The reign of Kirti Sri Rajasimha

(r. 1747–1781) was marked by his interest in gardening.[10] For instance, outside the capital of Kandy he erected a temple and laid out a garden that could be viewed from it; according to the writer of the palm-leaf manuscript, this garden was "adorned with bread-fruit trees, mango trees, cocopalms and other fruit trees." Kirti Sri's interest in natural symbols also appears in his restoration of another temple, called Meddepola vihara. Here, in addition to a number of religious images of the Buddha, he made a triumphal arch with lion figures and a mandapa with a series of figures of lions, elephants, geese, creepers, and flowers.[11] These references to the king's interest in gardens seem to be consistent with the flowering of temple mural painting in his reign; Kandyan art shows particular attention to specific legendary trees. (See Figure 4.)

Yet what could I do with these scattered and seemingly inconsequential references? I adopted a method opposite to that I outlined for dealing with the information on the Pacific islanders. I started to read the palm-leaf manuscript and the murals within the context of European scientific sources.[12] Within the colonial archive was an important find: the Peradeniya gardens, which historians traditionally claim to have been set up by a British botanist named Alexander Moon, connected with Joseph Banks, in 1822, were in fact established on the site of a temple garden set up by a Kandyan king. Moon wrote: "I am of the opinion that the site of the late Kandyan King's Garden at Peradenia is better adapted than any other place for the proposed Botanic Establishment." The proposal to establish the new garden envisaged that some stones from the ruins in the area could be reused to build Moon's quarters.[13] From this revelation, it became clear to me that Moon himself was a man entangled within both European botany and Kandyan natural history. Take, for instance, his published catalogue of the plants of Ceylon, which was curiously hybrid, containing plants organized according to both the Linnaean and the Sinhalese modes of classification. It concludes with two indexes, one in Latin and one in Sinhala, to all the specimens catalogued in the book, with cross-listings to both the Linnaean and the Sinhalese classificatory terms.[14]

If not for the palm-leaf manuscript, the salience of Kandyan botany would not have emerged from the colonial archive. Kandyan and British attitudes to nature were parallel, interlocked, and competing activities. Though palm-leaf manuscripts and temple art can easily be separated out from the colonial archive and seen as different sorts of sources, reverberations can be read across them. Did Kirti Sri's gardens connect with and respond to colonial traditions? And similarly, from the other side, is the legacy of Kandyan gardening related to the colonial archive on botany?

In reading the *Quarterly Review* article from within Pacific material culture, and the palm-leaf manuscript from within British botanical sources, I have advocated two differ-

[10] For more on the cultural interests of the last kings of Kandy see Sujit Sivasundaram, "Buddhist Kingship, British Archaeology, and Historical Narratives in Sri Lanka, c. 1750–1850," *Past and Present*, 2007, *197*:111–142.

[11] William Geiger, *Culavamsa: Being the More Recent Part of the Mahāvaṃsa*, trans. C. Mabel Rickmers (London: Pali Text Society, 1930), Vol. 2, pp. 291–292 (quotation), 293, 295.

[12] This research culminated in Sujit Sivasundaram, "Islanded: Natural History in the British Colonisation of Ceylon," in *Geographies of Nineteenth-Century Science*, ed. David N. Livingstone and Charles Withers (Chicago: Univ. Chicago Press, forthcoming).

[13] T. Petch, "The Early History of Botanic Gardens in Ceylon," *Ceylon Antiquary and Literary Register*, 1921, *7*(2):63–73, on pp. 68–69. See, however, Ray Desmond, *The European Discovery of the Indian Flora* (Oxford: Oxford Univ. Press, 1992), p. 163, which claims that the site was a "former royal palace."

[14] Alexander Moon, *A Catalogue of the Indigenous and Exotic Plants Growing in Ceylon* (Colombo: Wesleyan Mission Press, 1824); and Sivasundaram, "Islanded" (cit. n. 12).

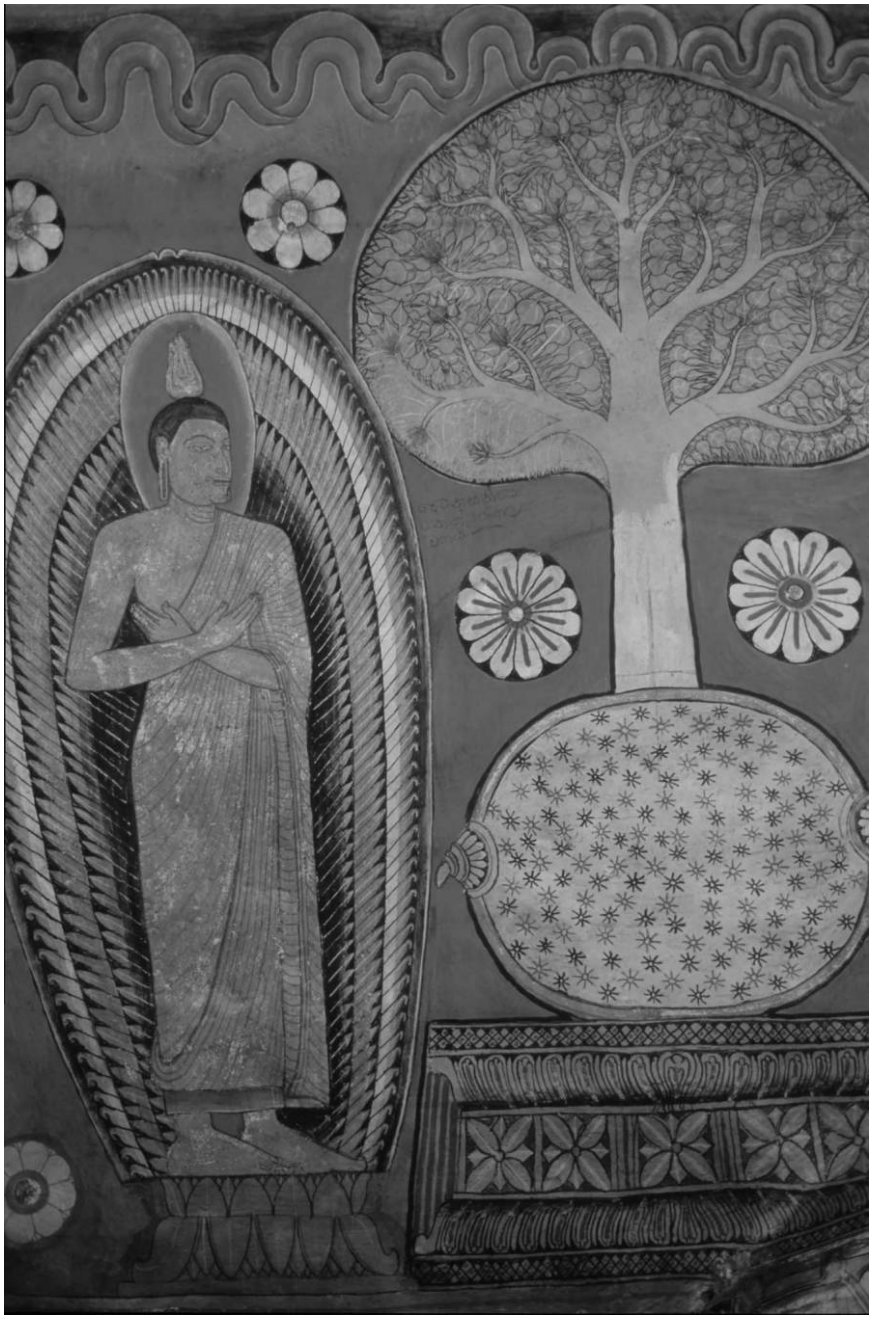

Figure 4. *An eighteenth-century temple mural showing the Buddha gazing at the Bo tree* (Ficus religiosa) *in the weeks after his enlightenment, from the Dambulla temple, Sri Lanka. Photographed by Roshan Perret of Studio Times Colombo; reproduced with kind permission from SinhaRaja Tammitta-Delgoda and the Studio Times of Colombo.*

ent directions of contextualization. The history of science is now well versed in what it means to write contextualist history, but scholars too readily constrain the project by limiting the types of sources they choose to study or by giving too much emphasis to genre. I do not mean to downplay the importance of the facts of production and reception surrounding periodical articles or palm-leaf manuscripts. Yet for a more globally representative history of science to emerge, it is necessary to experiment with divorcing sources from their usual sites of contextualization so as to take them to quite different contexts, at a distance from their obvious authors and readers. These two directions of contextualization—reading a European source within Pacific materials and a Kandyan source within European materials—are fruitful because they shift our sense of balance. While it is common to complain about the scarcity of sources stemming from a non-European perspective, this methodology allows us to see what happens when a European source is surrounded by other voices and when an unfamiliar non-European source is prioritized inside the colonial archive.

BEYOND COLONIAL AND NATIONAL HISTORIES

If such a project of cross-contextualization is to flourish, historians might be wise to be circumspect in their use of two categories that have until now diverted the global history of science into a narrower path and, in particular, into alternative historiographies. These two categories are the "colonial" and the "national."

An important question that has engaged historians of science in the last few decades is the relationship between science and European imperialism.[15] It is now clear that science was molded by the European imperial age. Its methodology—its commitment to laws, collections, and classifications—made sense of, and arose out of, imperialism. The structures of science, particularly those pertaining to the status of the man of science in the metropolis and the colonial fieldworker in the periphery, were inflected through imperialism. Science provided a language of command: it offered an influential vocabulary for othering, racializing, and gendering peoples across the imperial realms; note how the specifics of scientific vocabulary, such as the biogeographical notion of a "nation" of plants, bore the imprint of imperialism. The emergence of centers of science, such as museums, gardens, asylums, and universities, depended on the passage of data, material culture, and people across imperial networks. Scientific knowledge was also a means of popularizing empire, providing a route through which a wider class of Europeans came into contact with and intervened in the imperial narrative. Scientific advice from anthropologists and technicians, among others, was central to colonial governance—for instance, in times of rebellion or war. Colonized peoples, for their part, sometimes resisted the application of science: by interrupting eclipse expeditions or by refusing to be vaccinated against smallpox, for example. Despite all of these valid viewpoints, a focus on science in European empires takes us only so far.

Talk of science and European imperialism inevitably leads to a dichotomous view of knowledge in which colonial knowledge is identifiable and separable from colonized knowledge. This opens up the very question of the diffusion and institutionalization of Western science across the world that has proved to be a dead end of historical discussion. To move beyond such Eurocentrism necessitates an understanding of how European

[15] This was the subject of a Focus section on "Colonial Science": *Isis*, 2005, *96*:52–87.

empires came into collision with other imperial formations such as the Qing, the Mughals, or the Ottomans. Recent works on these empires show that Europeans did not have a monopoly over the combination of science and empire, for they fought to take over information networks and scientific patronage systems that were already in place.[16] The culture of science in European imperialism was indigenized to the extent that collecting plants in Canton meant relying on markets in port cities, rather than going into the field, and that practicing astronomy in India meant translating Sanskrit texts and engaging with *pandits* or learned men.

Discussing whether science influenced European imperialism, or how European imperialism influenced science, misses the point by taking scholars to a spurious question of causation. These ideologies were interwoven in complicated ways. At the surface of contact between this assembly of ideas, science and European empires reinvented each other, taking new forms and giving rise to new disciplines and technocratic regimes of empire. Instead of causation, scholars should attend to the malleability of the relationship between these ways of thought. At the same time, focusing on the causal question takes for granted the optimism of European colonial rhetoric about the application of science, medicine, and technology. But roads were washed away in monsoonal conditions, retardation problems and animals roaming loose created repeated difficulties for the telegraph, and long-planned stellar observations went awry in new environments.[17] This is not to deny the powerful binding of science and empire but to point to the need to attend to reinventions, limitations, and failures as well.

A global historian of science might make the study of colonial science part of a larger and richer tapestry. To understand colonial science, it is necessary to think beyond categories of colonized and colonial and to fragment traditions of knowledge on all sides. In the context of the Pacific, this would amount to seeing that, on the European side, there were contesting traditions of science, practiced—for example—by naval officers, by whalers, and by missionaries. At the same time, the traditions of each island group are distinct, but their contact with each other has resulted in cross-fertilization and changing cultures of ideas. But even such a fragmentation of the colonial and the colonized needs to be taken further, through an awareness of the impossibility of seeing some of these practices of knowledge as indigenous and others as external. Take, for instance, Mughal traditions, which were themselves part of a Persian world. If all of this is taken into account, the global history of science becomes the history of the shifts and reinventions of a variety of ways of doing science across the world. European imperialism becomes a chapter in this story, accelerating the meetings of different traditions of science by circulating knowledge with greater speed and bringing great power and centralization to bear on it. Yet this chapter needs to be contextualized within a broader account.

With the emergence of nationalist movements across the world in the era of decolonization, there arose the idea of national science—and this too has narrowed the view of historians. The idea of national science worked in the twentieth century in the service of anticolonialism. In South America, for example, creole elites forged nationalist accounts

[16] See C. A. Bayly, *Empire and Information: Intelligence Gathering and Social Communication in India, 1780–1870* (Cambridge: Cambridge Univ. Press, 1999); and Fa-ti Fan, *British Naturalists in Qing China* (Cambridge, Mass.: Harvard Univ. Press, 2004).

[17] See Daniel Headrick, *Tentacles of Progress: Technology Transfer in the Age of Imperialism, 1850–1914* (Oxford: Oxford Univ. Press, 1988). This is an argument I have developed in relation to cartography, surveying, and road making in Sujit Sivasundaram, "Tales of the Land: British Geography and Kandyan Resistance in Sri Lanka, c. 1803–1850," *Modern Asian Studies*, 2007, *41*:925–961.

of the land and its historical remains; in India and China nationalists urged the ancient history of their own science and, sometimes, the derivation of Western science from other sources.[18] Making a nation meant the need for a history of the science of that particular nation. Yet the political movements of nationalist science were in fact transnational: Chinese elites learned their science in Japan; Nehru was a science student in Cambridge; and discourses of nationalist science crossed different states in South America. The transnational origins of nationalist science have been lost in the literature because of the stamp of anticolonialism on contemporary writings. Far too often, historians have framed their accounts of science using the category of the independent nation.

The chief question about nationalist science in the current literature arguably concerns derivation and mimicry: Were nationalists appropriating the imperial powers' obsession with science and aiming to mimic it with a view to establishing their own political capabilities?[19] Yet this too is a question about causation. It leads to the contextualization of nationalist science in relation to colonialism, rather than other contemporaneous movements. It may be more fruitful, instead, to see nationalist science as indicative of globalization. By the twentieth century, intellectuals and politicians were living in an age where ideas shifted with great speed, but also where rival scientific schools linked to regions and areas proliferated. The local and the international were linked around the process of globalization. Nationalists certainly borrowed ideas from colonial masters, but this was not the whole story. Globalization enabled the precolonial, the colonial, and the postcolonial to fit together, across the South–South axis, as the displacements of modernity allowed multiple posturing.

Indeed, the question of modernity is one that needs to be addressed squarely by global historians of science. To be modern in a global age of knowledge, by the twentieth century, meant using science and technology to intervene in problems of hunger, disease, and development. Such modernity meant the tying of knowledge into the national economy—in order to increase returns on the land or by investing in health services. Yet here again what is interesting is that modernity did not lead to the flattening out of various traditions of expertise across the world. Instead, the modern and the traditional coexisted, entangled to the extent that being modern was sometimes proved by recourse to rejecting traditions while at other times it was about updating traditions or recovering lost ones. Modernity, then—in the history of science as elsewhere—is not a teleological or linear story. The rhetoric of modernity must be teased out and contextualized in a broader history of the movement and reappearance of traditions of knowledge. This will allow historians to understand why the Chinese Communist Party sought to patronize traditional medicine or why Jomo Kenyatta, the east African nationalist, became a defender of clitoridectomy in the midst of a great debate about the practice.[20] Old traditions came to have new life in the context of nationalizing modernities, even when we might have expected their defeat.

[18] I have in mind here the work of Jorge Cañizares-Esguerra, *Nature, Empire, and Nation: Explorations of the History of Science in the Iberian World* (Stanford, Calif.: Stanford Univ. Press, 2000); Gyan Prakash, *Another Reason: Science and the Imagination of Modern India* (Princeton, N.J.: Princeton Univ. Press, 1999); and Fa-ti Fan, "Nature and Nation in Chinese Political Thought: The National Essence Circle in Early Twentieth-Century China," in *The Moral Authority of Nature*, ed. Lorraine Daston and Fernando Vidal (Chicago: Univ. Chicago Press, 2004), pp. 409–437.

[19] This is a central question of Prakash, *Another Reason.*

[20] Kim Taylor, *Chinese Medicine in Early Communist China, 1945–1963: A Medicine of Revolution* (London/New York: Routledge Curzon, 2005); and Jomo Kenyatta, *Facing Mount Kenya* (London: Secker & Warburg, 1938), pp. 130–135.

GLOBAL THEORIES

It is not only our methodology and our historiographical terms that need attention if we are to recover more globally oriented histories of science. It is also crucial to scrutinize the theoretical tools that have become the mainstay of recent scholarship and to ask whether these need to be reconsidered.[21]

The turn to practice theory, inspired by the work of Pierre Bourdieu, has been one of the most important developments in the history of science over the last few decades.[22] By seeing science as practice, scholars have viewed it as a skill that is learned and made part of tacit and bodily knowledge. Talking of science as practice also makes it possible to trace the production of knowledge in everyday social and public life, not allowing it to be the exclusive preserve of men in white coats. Turning to the global stage, however, there have been concerns as to whether "practice" is the right theoretical term to use in recovering the wide array of ways of doing science. Following David Turnbull, Michael Bravo and Sverker Sörlin, as well as David Wade Chambers and Richard Gillespie, have endorsed narrative and vectors of assemblage, respectively, in order to widen the category of practice to take account of rituals and of the social and physical environment as equally constitutive of science.[23]

Much work in the history of scientific practice over the last few years has been concerned with the practices of reading, writing, conversing, experimenting, and displaying. Yet if scholars are to advocate a view of science at work on the global stage, it is important that the remit of the category of practice is extended to radically different ways of producing knowledge, which see different relations between texts and objects, makers and materials, and ways and places of doing. For instance, the palm leaves of Sri Lanka are texts that can now be mined by a historian—but in fact some of them contain ballads to be sung, and the contents were also used in rites and ceremonies connected with courts and villages. It would be incorrect to talk in simple terms about the readers of palm-leaf manuscripts. These texts were markers of an oral culture, tied to rituals of healing, blessing, and pilgrimage.[24] Similarly, it is important to keep in view the way the monuments of the Pacific collapse the distinction between the environment and scientific artifact: for the islanders, making astral observations was not about removing themselves from the material world. These examples demonstrate that, though thinking of science as a body of work and a process is still immensely helpful, scholars may need to leave behind instinctive ways of articulating the way particular practices were ordered in relation to others or of privileging types of practice that were typical of Europe.

As far as theoretical terms are concerned, it is the idea of networks, following the influential work of Bruno Latour, that has had the most impact on studies of global science in recent years. Scholars who have utilized the idea of a network of knowledge spanning

[21] For an amplification of some of the themes of this section see Sujit Sivasundaram, "Science, Medicine, and Technology," in *Companion to Modern Empires*, ed. Philippa Levine and John Marriott (Aldershot: Ashgate, forthcoming).

[22] For more on this see James A Secord, "Knowledge in Transit," *Isis*, 2004, *95*:654–672; and Pierre Bourdieu, *Outline of a Theory of Practice*, trans. Richard Nice (Cambridge: Cambridge Univ. Press, 1977).

[23] David Turnbull, *Masons, Tricksters, and Cartographers* (Singapore: Taylor & Francis, 2000); Michael Bravo and Sverker Sörlin, "Introduction," in *Narrating the Arctic: A Cultural History of Nordic Scientific Practices*, ed. Bravo and Sörlin (Canton, Mass.: Science History Publications, 2002), pp. 3–32; and David Wade Chambers and Richard Gillespie, "Locality in the History of Science: Colonial Science, Technoscience, and Indigenous Knowledge," in *Nature and Empire: Science and the Colonial Enterprise*, ed. Roy MacLeod, *Osiris*, 2nd Ser., 2000, *15*:221–240, esp. p. 230.

[24] Gunawardana, *Palm-Leaf Manuscripts of Sri Lanka* (cit. n. 9).

the world have articulated the need to see beyond fixed centers and peripheries.[25] Rather, each locality has the capacity to become central, to act as the node of a circuit of information. Tied to this recognition is the growing interest in mediators who cross localities and who keep knowledge flowing through the network. Recent work has revealed a rich set of biographies of these people-in-between, including travelers, missionaries, mixed-ancestry observers, and local assistants. The idea of the contact zone, emerging in part out of the work of Mary Louise Pratt, has been important for exploring the character of the space occupied by these mediators who link the network up.[26] This big picture is an important one, stressing how mobility is a feature of scientific knowledge. For science to be successful it has to travel, and it must rely on mediators to take it to other places. Studying networks fits well with global history because networks cross empires, nations, and regions.

Yet there are questions that need examination. How much connection are we to assume between different types of knowledge? Some types of information have been globalized over time and repeatedly dispersed over widely flung localities, while others have had much smaller circuits of circulation that are relatively localized and have been resistant to wider geographical mobility. The contact zone is a fruitful place to consider, but is it representative? Mobility should not be stressed to the extent that immobility, disjuncture, and the workings of the local are forgotten. Related to this is a need to keep a view of resistance, anticolonialism, and antiglobalization alive in the literature on the sciences. Where do we factor in those non-European peoples who did not share their knowledge with others and, by their refusal, mounted political resistance?

AFTERWORD

I do not mean to be pessimistic about the prospects for global histories of science. There is every indication that this will be a growing concern in the discipline. Yet there are still large questions to be addressed about methodology, historiography, and theory. I am sure that the next couple of decades will allow us at long last to revisit the idea that science's history is a European or North American one. Yet for that to happen, historians of science will need to be open to changing the tools in their kit. It is especially important that methods of interpretation, questions of historical concern, and styles of theorizing that have arisen out of European and North American historiography should not be applied in a blind fashion to the rest of the world. Globalizing the history of science may change not just the geographical contours of the discipline but its cherished modes of operation as well.

[25] Chambers and Gillespie, "Locality in the History of Science" (cit. n. 23). For a sample of recent works on networks and mediators see David Arnold, *The Tropics and the Traveling Gaze: India, Landscape, and Science, 1800–1856* (Seattle: Univ. Washington Press, 2006); Kapil Raj, *Relocating Modern Science: Circulation and the Construction of Knowledge in South Asia and Europe* (Delhi: Palgrave Macmillan, 2006); and James Delbourgo and Nicholas Dew, eds., *Science and Empire in the Atlantic World* (London: Routledge, 2008).

[26] Mary Louise Pratt, *Imperial Eyes: Travel Writing and Transculturation* (London: Routledge, 1992).