I

INTRODUCTION

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The main objective of this volume of the Cambridge History of Science is to explore modern science using different frames of reference: national, transnational, international, and global. The chapters in the volume primarily analyze the history of modern science during the late eighteenth, nineteenth, twentieth, and early twenty-first centuries. However, authors were encouraged to explore earlier periods where appropriate, especially when necessary as background. Chapters in Part II of the volume focus on particular national and regional contexts covering all parts of the world. They are grouped together in separate sections that represent larger regions: Europe; Africa, the Middle East, and South Asia; East and Southeast Asia; the United States, Canada, Australia, New Zealand, and Oceania; and Latin America. Each of these regional groupings ends with a separate essay reflecting on the analysis in the preceding chapters. The different chapters in this section of the volume also include comparative analysis where appropriate. Part I mainly focuses on transnational, international, and global themes, although authors of chapters in Part II were also encouraged to address these issues when necessary.

A major theme in this volume reflects a recent emphasis by historians of science to explore the "situatedness of science," placing activities, practices, and knowledge in their proper local context.[1] A tightly focused contextual analysis helps explain such problems as the role of particular local circumstances in the production of scientific knowledge and practice, how local conditions and value systems shape scientists' decisions to pursue specific areas of research and modes of practice, the reasons why specific disciplines

[1] James A. Secord, "Knowledge in Transit," *Isis*, 95 (2004), 654–72, on 657; David N. Livingstone, *Putting Science in Its Place: Geographies of Scientific Knowledge* (Chicago, Ill.: University of Chicago Press, 2003); David N. Livingstone and Charles W. J. Withers, eds., *Geographies of Nineteenth-Century Science* (Chicago, Ill.: University of Chicago Press, 2011). It is also important to recognize that place and space are not static, but dynamic. See, for example, Doreen Massey, *For Space* (London: Sage, 2005) and John Agnew, "Space and Place" in *The Sage Handbook of Geographical Knowledge*, eds. John A. Agnew and David N. Livingstone (London: Sage, 2011), pp. 316–30.

rather than others develop at a particular time and place, and why the reception of scientific theories differs in separate locations around the world. Thus, Chapter 34 partly explains the emphasis on geographical sciences in the United States in the nineteenth century based on the preoccupation of American scientists with the large natural laboratory of the American West. And Chapter 15 discusses the local conditions that help explain why Russia's enthusiastic reception of Darwin was distinctive, especially compared to Western Europe.

As the above two examples indicate, the recent emphasis on exploring the local context of science has particularly stressed the importance of analyzing science using national frameworks. One of the biggest interest groups within the History of Science Society during the late twentieth and early twenty-first centuries has specialized in the history of science in the United States. Modern science has become integral to nation-building activities, and scientists, engineers, and medical experts have played central roles creating the modern institutions of nation-states. These institutions, in turn – including government surveys, the armed forces, agricultural bureaus, and state-supported universities – have provided some of the most important employment opportunities for all types of scientists and technical experts. State funding has been a key driver of scientific research and helps explain the development of specific scientific disciplines in different countries. Finally, scientists in specific countries often measure their performance relative to the perceived national performance of other countries. Public expression of weakness and decline relative to the growing scientific prowess of Germany was one of the most important themes for both France and Great Britain during the nineteenth century (Chapters 12 and 14).

This effort to evaluate or measure scientific achievements relative to other countries or based on global standards is clear in a number of chapters in this volume. There is great value in wanting to know how well different countries created institutions that succeeded in producing world-class research, evaluated based on such measurements as the number of Nobel Prizes different countries have won. For countries that have dominated these measures, in particular the United States in recent decades, this analysis can illuminate factors that explain national scientific achievements. Besides satisfying a need for deeper historical understandings, this analysis has significant value in informing decisions about national science policy.

But the chapters on specific countries also try to understand national developments on their own terms. The accounts are concerned, for example, with exploring the meaning of science for different national groups and how science functioned within different national contexts. In the Philippines, for example (Chapter 33), patriotism and citizenship became closely linked with a general scientific outlook. Similarly, in nineteenth-century France (Chapter 12), supporters of liberal democracy valued science for its perceived ability to promote civic virtues.

Although many of the chapters focus on nation-states, a number also evaluate modern scientific developments using regional frameworks. For instance, regional science-supporting institutions have emerged in the Middle East and sub-Saharan Africa (Chapters 23 and 26). In Scandinavia, distinctive regional organizations connected with the Nordic Council have funded key institutions, including the Nordic Institute for Theoretical Physics in Copenhagen. Chapter 21 argues that the history of modern science in Portugal can only be appreciated if placed in its proper regional context. Rather than only evaluating the country's contributions using standard measures of world-class scientific research, the authors emphasize the significant role of Portuguese scientists, medical experts, and engineers in social and intellectual networks in European and imperial contexts, "playing the role of go-betweens, bridging different worldviews, and shaping the evolving European identity."

This last point underscores the need to analyze the history of modern science not only in particular local, national, and regional contexts but also with respect to the flow or circulation of knowledge, tools, methods, people, and artifacts across national borders.[2] Such transnational analysis is important in different chapters in both Parts I and II. Chakrabarti and Worboys emphasize in Chapter 2 that historians of science have replaced older models employing notions of center and periphery to explain the spread of Western science around the world with new histories that take into account complex flows crossing national and regional boundaries. In these accounts, movement can go in different directions, including from non-Western regions to the West. These new stories also emphasize the important role of go-betweens or brokers who have mediated between traditional producers and users of scientific knowledge.[3] Chapter 7, for example, analyzes the

[2] Secord, "Knowledge in Transit"; Stuart McCook, "Focus: Global Currents in National Histories of Science: The 'Global Turn' and the History of Science in Latin America," *Isis*, 104 (2013), 773–6; Carla Nappi, "The Global and Beyond: Adventures in the Local Historiographies of Science," *Isis*, 104 (2013), 102–10; Harold J. Cook, *Matters of Exchange: Commerce, Medicine, and Science in the Dutch Golden Age* (New Haven, Conn.: Yale University Press, 2007); Fa-ti Fan, "The Global Turn in the History of Science," *East Asian Science, Technology, and Society: An International Journal*, 6 (2012), 249–58; Neil Safier, "Global Knowledge on the Move: Itineraries, Amerindian Narratives, and Deep Histories of Science," *Isis*, 101 (2010), 133–45; Kapil Raj, *Relocating Modern Science: Circulation and the Construction of Scientific Knowledge in South Asia and Europe, 1650–1900* (Basingstoke: Palgrave Macmillan, 2007); Kapil Raj, "Go-Betweens, Travelers, and Cultural Translators," in *A Companion to the History of Science*, ed. Bernard Lightman (Chichester, UK: John Wiley & Sons, 2016), pp. 39–57; Lissa Roberts, "Situating Science in Global History: Local Exchanges and Networks of Circulation," *Itinerario*, 33 (2009), 9–30; Sebestian Kroupa, Stephanie J. Mawson, and Dorit Brixius, "Science and Islands in Indo-Pacific Worlds," *British Journal of the History of Science*, 51 (2018), 541–48.

[3] Also see Fa-ti Fan, *British Naturalists in Qing China: Science, Empire, and Cultural Encounter* (Cambridge, Mass.: Harvard University Press, 2004); Simon Schaffer et al., eds., *The Brokered World: Go-Betweens and Global Intelligence 1770–1820* (Sagamore Beach, Mass.: Science History Publications, 2009); Londa Schiebinger, *Plants and Empire: Colonial Bioprospecting in the Atlantic World* (Cambridge, Mass.: Harvard University Press, 2004); James Delbourgo and Nicholas Dew, eds., *Science and Empire in the Atlantic World* (London: Routledge, 2008); Florence Hsia, *Sojourners in a Strange Land: Jesuits and their Scientific Missions in Late Imperial China* (Chicago, Ill.: University of Chicago Press, 2009).

important role of missionaries who assisted in the translation of Western science to other parts of the world.

The movement of scientists and technical experts has been especially significant in the modern era, and a number of chapters expand on this crucial theme. Chapter 18 details the important phenomenon of the temporary or permanent movement of many Italian researchers to other countries and back again. The author points out that these migrations have shaped not only host countries but also the Italian homeland. Similarly, Wu and Fan argue that the history of Chinese science looks very different if our understanding of China is extended to include the Chinese diaspora (Chapter 28). The focus on measuring the performance of different countries in producing Nobel Prize winners also becomes more complex if diasporas are taken into account. In a number of cases, the Nobel Prize does not clearly fit nationally oriented analytical frameworks since the movement of scientists between countries makes it difficult to pin down clear national identities.

Key chapters in Part I also explore the historical development of internationalism in science, including the growth of large-scale cooperative efforts involving different nations from the early-nineteenth-century collaborative study of the Earth's magnetic field (the "magnetic crusade") to the Geophysical Year of 1957–8 and the signing of the Antarctic Treaty in 1959. The universalist scientific ethos that helped nurture these endeavors included a commitment to science as a body of knowledge generated and validated regardless of national boundaries and a belief in the dispassionate objectivity of science. But the different chapters emphasize the tension between these ideals and scientists' national commitments. Paradoxically, the authors also argue that a strong commitment to scientific internationalism has existed at the same time as increasing nationalism during eras of intense rivalry between major nations.

Finally, a global orientation is important in the entire volume. By including discussions of all the major countries and regions of the world, the volume seeks to decenter history of science from purely Western-centered accounts. Non-Western regions of the world are not marginal to modern science; all regions and nations are interconnected on a global scale.[4] As

[4] Francesca Bray, "Only Connect: Comparative, National, and Global History as Frameworks for the History of Science and Technology in Asia," *East Asian Science, Technology and Society: An International Journal*, 6 (2012), 233–41; Warwick Anderson, "Racial Conceptions in the Global South," *Isis*, 105 (2014), 782–92; Benjamin A. Elman, "New Directions in the History of Modern Science in China: Global Science and Comparative History," *Isis*, 98 (2007), 517–23; Marwa Elshakry, "When Science Became Western: Historiographic Reflections," *Isis*, 101 (2010), 98–109; Nappi, "The Global and Beyond"; Sujit Sivasundaram, "Focus: Global Histories of Science – Introduction," *Isis*, 101 (2010), 95–7; Sujit Sivasundaram, "Sciences and the Global: On Methods, Questions, and Theory," *Isis*, 101 (2010), 146–58; Helen Tilley, "Global Histories, Vernacular Science, and African Genealogies; or, Is the History of Science Ready for the World," *Isis*, 101 (2010), 110–19.

Chakrabarti and Worboys argue (Chapter 2), "modern science is neither western nor colonial, but global." Although the volume discusses modern science's historically important role supporting imperialism, colonial rule, and postcolonial economic inequalities, different chapters also emphasize the active involvement of local people in all parts of the world and the complex exchanges and negotiations between various groups across the globe that have shaped modern science.