

## *Introduction*

# RETHINKING DISCIPLINARY SPECIALISM IN VICTORIAN SCIENCES

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In 1847 the British physician James Cowles Prichard (1786–1848) delivered his presidential address before members of the Ethnological Society of London (f. 1843). For over three decades he had been a figurehead for the emerging research field, and his book *Researches into the Physical History of Mankind*, which was first published in 1813, was a formative text that defined both the theoretical foundation of early ethnological research and its methodological framework.<sup>1</sup> Rather than using the occasion to summarize the discipline’s major achievements during the previous year, Prichard chose instead to discuss a more pressing issue—the position of ethnological research at the British Association for the Advancement of Science (BAAS; f. 1831).<sup>2</sup> During the 1840s ethnology remained a subsection within the Department of Natural History at BAAS meetings, and for many early ethnologists, such as Prichard, this organizational structure was problematic. It was believed that so long as ethnology remained subordinate to the larger research field of natural history, its progress and findings would be stunted. For ethnology to mature and be an important scientific specialism in its own right, it needed to be independent and recognized as a distinct discipline. Ethnologists wanted to have ownership over their research program, and to achieve this goal, it was essential for its practitioners to differentiate their re-

search from that of other disciplines. Prichard therefore focused the rest of his presidential address on the relationship between ethnology and other branches of knowledge.

As he recounted in his address, ethnology may have begun as a form of natural history, but over the previous thirty years it had grown into something different. Ethnology, according to Prichard, was a historical pursuit that focused entirely on humanity's place in nature, while natural history was a contemporary study that explored the whole of the organic world. As he explained, it was "distinct from natural history, inasmuch as the object of its investigations is not *what is*, but *what has been*."<sup>3</sup> He continued to expound on how ethnology borrowed from many other "departments of knowledge," including linguistics, geography, archaeology, literature, anatomy, and history, to name a few examples. It used data from these other fields to trace the historical development of human groups over multiple generations.<sup>4</sup> Ethnology's engagement with these other departments of knowledge was, to use a somewhat anachronistic framing, "interdisciplinary" in nature.

What is striking about Prichard's address before members of the Ethnological Society of London in 1847 is how it raises questions concerning the conventional historiographical narrative about nineteenth-century disciplinary specialization. Prichard's discussion of a specific Victorian scientific discipline, ethnology, is but one of many examples that suggest the need to reassess the "specialization thesis"—the idea that nineteenth-century science fragmented into separate and specialized forms of knowledge, which led to the creation of modern disciplines. While it is certainly the case that new disciplines emerged during the nineteenth century, the intellectual landscape was far muddier, and in many cases these new forms of specialist knowledge continued to cross disciplinary boundaries while integrating ideas from other disciplines. As the Prichard example shows, his attempt to highlight ethnology's supposed expert knowledge was somewhat tenuous. Instead of showcasing the distinctive nature of ethnological research, he actually showed that the boundaries between ethnology and other newly formed disciplines were quite nebulous. The conception of ethnological expertise was actually intended to serve the rhetorical purpose of solidifying the place of the discipline within the larger scientific community. It was part of a vocational strategy for Prichard and other ethnological researchers to strengthen their authority within a dramatically transforming intellectual culture in Victorian Britain.

Prichard's story is by no means unique, even later in the century when it might be claimed that specialization had increased in importance. If we fast-forward to the mid-1870s, we see a similar rhetorical

argument in the writings of the scientific naturalist Thomas Henry Huxley (1825–1895). In his famous address “On the Study of Biology,” which he delivered in 1876 in connection with the special loan collection of scientific apparatuses to the South Kensington Museum, he framed biology as a kind of umbrella science that covered “all the phenomena which are exhibited by living things.” Biology, according to Huxley, necessarily included humans, and therefore it had authority over other disciplines, including psychology, political science, and economics. If humans, as “living things,” were responsible for its production, biologists could claim ownership of it.<sup>5</sup> It was therefore, like ethnology, a highly interdisciplinary research field.

Huxley’s broad definition of biology was significant and part of a rhetorical strategy, one that was often used by the scientific naturalists as part of their attempts to gain cultural hegemony within Victorian Britain. The construction of disciplinary parameters during the middle of the nineteenth century was as much an exercise in expanding the boundaries of human knowledge as it was a performance in cultural politics.<sup>6</sup> Getting the balance right between interdisciplinary breadth and disciplinary focus was a difficult task. This volume follows this historical narrative by exploring the history of Victorian interdisciplinarity in the sciences through a series of interconnected case studies. The term *interdisciplinarity*, as we are using it here, can be defined as the process of bringing together two or more areas of knowledge into a single research field. This volume will expose the tension between the rhetorical push for disciplinary specialization and the actual practice of interdisciplinary integration during the nineteenth century.

Using the words *interdisciplinary* and *interdisciplinarity* when discussing Victorian science may strike some scholars as controversial and anachronistic, as they were not terms that were used commonly in the nineteenth century. We have even gone so far as to use the term *interdisciplinarity* in the title for the entire volume. It is nearly impossible to define a term such as *interdisciplinarity* precisely because of its messy epistemic ambition, which runs counter to the very reasons for disciplinary boundary making in the first place. And yet there remains the important task of historicizing the term’s origin because of its continued impact on, and legacy within, academic fields today. Understanding the roots of this intellectual epistemic shift in knowledge production allows us to better appreciate the making of modern science in the broadest sense. Because the Victorian period is traditionally seen as the moment in which these very ideas of specialization formed, it is an ideal starting point for tracing the history of interdisciplinarity.

In early twentieth-century editions of James Murray’s *A New En-*

*glish Dictionary on Historical Principles*, there is no entry for *interdisciplinarity*. More recent sources confirm that this term, as well as *interdisciplinary*, were rarely used by historical actors of the nineteenth century. When searched, the digital database C19: Nineteenth Century Index lists no book titles including either of these terms. Google Ngrams for “interdisciplinary” and “interdisciplinarity,” which display graphs showing how often phrases or words have appeared in a corpus of books over time, confirm that these terms were used during the nineteenth century, though not commonly. The big jump in their usage occurs in the 1970s. So why do we persist in applying recently evolved terms to a historical period when they rarely appeared in print?

While we acknowledge the difficulties that can arise in using terms such as *interdisciplinary* and *interdisciplinarity*, it can be argued that there are several reasons for using a modern label. First, what we mean by interdisciplinarity is a fairly accurate description of how the relationship among scientific disciplines were conceived of for much of the nineteenth century. What we now refer to as physics and astronomy, for example, were a part of what historical actors termed *natural philosophy*. Scientists routinely moved between physics and astronomy when they discussed issues in natural philosophy. Second, the twentieth-century understanding of interdisciplinarity did not arise *ex nihilo*. It had its roots in nineteenth-century currents of thought. While the disciplinary landscape of the nineteenth century was transformed by the disaggregation of natural philosophy and natural history, the two primary bodies of knowledge of the early and mid-century, the process of disaggregation was messy and lengthy.

Although new disciplines were formed, often they were conditioned by the disciplines that they were to be distinguished from. The chapters in this volume deal with this complicated process of disaggregation in different ways. Some of the new disciplines can be conceived of as being composed of hybrid fields. Or they can be seen as meta-disciplines, that is, a branch of knowledge designed to discipline other disciplines. Some of the chapters even go so far as to use the term *interdisciplinary* to refer to the new sciences, as the lines of demarcation dividing them from each other were porous and blurry. However, others note that the term is anachronistic and resist using it, or adopt fuzzier expressions like “disciplinary transgression” or “cross-disciplinary work.” Rather than viewing the volume as working toward a firm consensus, it should be understood as being more of a dialogue about the viability of interdisciplinarity as a category applicable to the nineteenth century. This dialogue has generated novel insights into the complex evolution of scientific disciplines. The term *interdisciplinary*, while admittedly retrospective, nevertheless offers

scholars a heuristic tool that helps us to identify and group together a set of intellectual practices characteristic of the nineteenth century.

### SPECIALIZATION AND PROFESSIONALIZATION IN THE HISTORY OF VICTORIAN SCIENCE

To fully understand the history of interdisciplinarity, one should begin by critically reflecting on the “specialization thesis” that is dominant in the historiography on Victorian science. It is this thesis, after all, that has obscured our historical perspectives relating to disciplinary formation that emerged during the nineteenth century. Previous scholars have presented a much more straightforward narrative about the process of specialization. At the beginning of the nineteenth century what we call natural science was divided into two bodies of knowledge, natural philosophy and natural history. By the end of the century natural philosophy and natural history were no longer commonly used designations for the organization of knowledge. The terms more generally used to delineate scientific disciplines were the ones we are now more familiar with, such as *biology*, *geology*, *physics*, *astronomy*, *chemistry*, and *anthropology*. As the historian of science Jan Golinski has observed, the period from 1780 to 1850 was a time in which “new scientific disciplines such as geology, biology, and physiology were founded and existing ones (especially physics and chemistry) dramatically reconfigured. Remarkable changes in conceptual content and practice occurred in institutional settings that were themselves being transformed.”<sup>7</sup>

The question is how to interpret this reconfiguration of the scientific disciplines during the nineteenth century. According to what we have referred to as the specialization thesis, British science began to be transformed by the formation of specialist societies beginning primarily in the 1820s, and by the adoption of disciplinary sections within the BAAS. In this era of the “gentlemen of science,” the phrase used by Jack Morrell and Arnold Thackray to describe the dominant group of scientists in the first half of the century, embracing natural theology went hand in hand with specialization.<sup>8</sup> Some gentlemen of science, such as William Whewell (1794–1866) and John Herschel (1792–1871), had reservations about increasing specialization. Whewell famously coined the term *scientist* at an early meeting of the BAAS in order to counter what he saw as the fragmentation of science.<sup>9</sup> Herschel felt overwhelmed by the huge amount of information contained in the papers given at BAAS meetings. Like Whewell a polymath at heart, Herschel regretted that specialization was a necessity due to the growth of scientific knowledge. “Such is science now-a-days,” he wrote to Whewell in 1835, “no man can now hope to know more than one part of one science.”<sup>10</sup> Yet despite their

reservations, historians subsequently adopted the specialization thesis and treated specialization as an almost unstoppable force throughout the rest of the nineteenth century, as scientific institutions developed and scientific knowledge increased significantly over time.

Scholars have often dealt with disciplinary development in the Victorian period by focusing on one specific discipline. Take, for example, George Stocking's *Victorian Anthropology* (1987) or William Coleman's *Biology in the Nineteenth Century* (1971).<sup>11</sup> Inevitably this approach maintains the specialization thesis. Our aim is to break out of disciplinary silos—to challenge the older scholarship that chopped up the history of science into the history of separate disciplines. The most extensive scholarly treatments of specialization across the sciences can be found in older works like Morrell and Thackray's *Gentlemen of Science* (1981) and Colin Russell's *Science and Social Change in Britain and Europe 1700–1900* (1983). Morrell and Thackray have discussed how the establishment in 1831 in the BAAS of subcommittees on mathematical and physical science, chemistry, mineralogy, geology and geography, zoology and botany, and the mechanical arts eventually led by 1836 to the formation of seven sections with their own presidents, vice presidents, and secretaries. They emphasize how the sections of the BAAS provided “a context in which the devotees of different disciplines could fashion a sense of common identity.” They also argue that the development of sections within the BAAS was linked to the development of specialist societies. Not only did the sections work in league with existing societies, according to Morrell and Thackray, they could also lead to the formation of new disciplinary societies. Sectional activities were “symbiotic” with the work of the national societies.<sup>12</sup>

Where Morrell and Thackray focus on the disciplinary sections in the BAAS as an engine of specialization, Russell pays more attention to the development of specialist societies. In a chapter titled “The Rise of the Specialist,” Russell asserts that “the new specialist consciousness was institutionalized in a relatively large number of societies which sprang up in the early years of the nineteenth century.” The Geological Society of London, founded in 1807, was the first of these London learned societies, followed by the Astronomical (1820), Meteorological (1823), Zoological (1826), Geographical (1830), Entomological (1833), Botanical (1836), Microscopical (1839), Pharmaceutical (1841), and Chemical (1841). In focusing on the creation of scientific societies, Russell, like Morrell and Thackray, sees specialization largely in institutional, rather than intellectual, terms. He starts the chapter discussing the founding of specialized societies in the cities and in the provinces, and then moves to the founding of professorships as well as museums in specific disciplines

as further indications of the rise of the specialist.<sup>13</sup> In addition to Morrell and Thackray's and Russell's overviews of specialization writ large in the first half of the nineteenth century, there are also accounts of the way specific disciplines were becoming more narrowly defined.<sup>14</sup> However, how specialists conceived of the boundaries between their discipline and others is rarely discussed.<sup>15</sup>

Past studies have tended to link specialization with professionalization. Russell's chapter on the rise of the specialist is followed by a chapter titled "The Road to Professionalization," implying that the specialized societies came first, inevitably followed by professionalization. In other words, for Russell the road to professionalization passes through specialization. Frank Turner, in his classic article on the professional dimension of the Victorian conflict between science and religion, quotes Bernard Barber on the major features associated with nascent professionalism. One of the features is the control of behavior through voluntary associations organized and operated by the work of specialists.<sup>16</sup> Turner's article treats the scientific naturalists—figures like Huxley, John Tyndall (1820–1893), and Herbert Spencer (1820–1903)—as a group that sought to professionalize science, producing the conflict between science and religion as a by-product of their efforts. In the past this led historians to think of the scientific naturalists as important agents of specialization in the second half of the nineteenth century. More recently, in her book on the X Club, a central node of scientific naturalism, Ruth Barton has contended that its members wanted "more narrowly focused specialist journals."<sup>17</sup>

It would, however, be a mistake to take Barton's comment about their desire for specialist journals as an indication that she is in agreement with the older scholarship's emphasis on an intimate connection between professionalization and specialization. She points out that the push for specialist publishing matches only one of the three characteristics of professionalization. The X Clubbers, Barton maintains, were not concerned with specialist education and formal qualifications.<sup>18</sup> Barton, in fact, has for some time been one of the leading exponents of a reevaluation of how historians of science should think about professionalization in general. More than twenty years ago she convincingly argued that historians had neglected the importance of amateur members of the X Club, such as John Lubbock (1834–1913).<sup>19</sup> Like Barton, Adrian Desmond, Paul White, Theodore Porter, and Jim Endersby have questioned the idea that contemporary notions of professionalization are applicable to the second half of the nineteenth century. The newer scholarship has complicated the historian of science's understanding of the meaning and nature of the process of professionalization in this period.<sup>20</sup>

The reassessment of professionalization has not led to a reexamination of specialization, although they were frequently linked in the past. We now have a more sophisticated grasp of professionalization thanks to Barton and others, but we do not have anything similar when it comes to appreciating specialization in the latter half of the nineteenth century and the role that it played in the thinking of the scientific naturalists. Even in his brilliant piece on Joseph Dalton Hooker (1817–1911) as scientific naturalist, Endersby has little to say about specialization. In his “Odd Man Out: Was Joseph Dalton Hooker an Evolutionary Naturalist?,” Endersby aims to revise our understanding of scientific naturalism by questioning the role of the three “isms”—professionalism, secularism, and naturalism—in Hooker’s conception of himself as a scientist.<sup>21</sup> However, he never broaches the subject of specialism. In this volume we are proposing to remedy the situation by focusing on the way specialization functioned in conjunction with an interdisciplinary ethos, not only within the thought of scientific naturalists, but throughout different fields of science.<sup>22</sup> During the nineteenth century, at the same time that new, fluid, and malleable disciplines were created, the desire to unify science continued to inform a broader vision of what constituted knowledge.<sup>23</sup>

#### VICTORIAN INTERDISCIPLINARITY THROUGH CASE STUDIES

Interdisciplinarity during the Victorian period took on many forms, much like it still does today. There was no singular model of practice, and it is for this reason that a series of interconnected case studies that explore the history of Victorian interdisciplinarity is so useful. It allows us to consider what the historian George Stocking has described as the “multiple contextualizations” in which these ideas and activities occurred.<sup>24</sup> Such a historiographical approach offers an important pathway for cross-comparing how a diverse group of historical actors engaged with their areas of study through both competing and complementary interdisciplinary frameworks. By bringing these diverse perspectives together, it is then possible to highlight the complexities and subtleties that existed within Victorian science, thereby helping us to critically re-evaluate the specialization thesis.

The volume is divided into five thematic sections, with each focusing on a different form of Victorian interdisciplinarity. Section one, “Between Disciplines,” opens with a chapter by Bernard Lightman, who considers how a diverse group of scientific naturalists, usually seen as those scientific researchers most interested in professionalization and specialization, unexpectedly developed a rather interdisciplinary framework for investigating the natural world in a Science Primer series that was published by Macmillan during the second half of the nineteenth



century. Through an examination of the various volumes in the series, which included contributions by key figures such as Thomas Henry Huxley, H. E. Roscoe (1833–1915), and Balfour Stewart (1828–1887), Lightman exposes an example of cross-disciplinarity that was occurring within the supposed disciplinary specialization of the period.

Exploring this theme of cross-disciplinary dialogues further, chapter 2 by Geoffrey Cantor considers how investigations into electrochemistry did not fit unambiguously into a single scientific discipline, but instead straddled two main fields of study. As Cantor explains, electricity typically falls within physics (broadly construed), while chemical action, a key part of electrochemical research, is typically within the remit of chemistry. Both disciplines are concerned with the phenomena of electrochemistry, albeit in significantly different ways, therefore allowing us to examine a fascinating cross-disciplinary dialogue that emerged through this research program. Cantor anchors his investigation in a close study of Michael Faraday's electrochemical work.

In the second thematic section, "Synthesizers," Janet Browne begins chapter 3 by positioning Charles Darwin (1809–1882) as one of the great synthetic writers of the nineteenth century. Coming out of a classic naturalist tradition, typically associated with the first half of the nineteenth century, Darwin's research program covered a range of different fields, including geology, paleontology, zoology, and botany, to highlight a few examples. As Browne argues, this broad scope provides the basis for thinking of Darwin as an interdisciplinary scholar. Browne traces Darwin's interdisciplinary research activities through a close reading of several of Darwin's works on natural selection, thus exposing his interdisciplinary and synthetic approach to understanding the natural world.

In chapter 4 Ian Hesketh provides a similar analysis of another significant synthetic figure from the first half of the nineteenth century, Henry Thomas Buckle (1821–1862). Although Buckle is typically seen as one of the progenitors of a scientific discipline of history, Hesketh provides a different picture, one that shows how Buckle's historical framework was far more interdisciplinary in breadth than scholars have typically recognized. When Buckle attempted to explain the development of human civilization as resulting from natural laws and processes, he drew heavily on other specialist fields of knowledge, including philosophy, politics, classics, and statistics. Thus, much like Darwin's synthetic approach in the *Origin of Species* (1859), Buckle's main book, *History of Civilization in England* (1857), harmonized the theories and methods of multiple disciplines.

The third thematic section "Practices and Displays," provides a different perspective on Victorian interdisciplinarity. Through a detailed

study of the International Health Exhibition of 1884, Elsa Richardson in chapter 5 traces the way interdisciplinary knowledge about health and wellness was physically and spatially exhibited throughout the event. The chapter therefore fosters important discussions about Victorian interdisciplinary displays and workspaces, because the International Health Exhibition was an extremely active space of interdisciplinarity, where different forms of knowledge and expertise intersected in fascinating ways. Laboratories sat alongside working dairies, while drainpipes and cooking appliances jostled against ice cream stalls and Japanese restaurants. The design of the exhibition also blurred distinctions among disciplinary fields. Thus medicine and engineering, sanitary science and elementary education, agriculture and manufacturing all had potentially equal roles to play in shaping Victorian understandings of health and wellness.

In chapter 6 Iwan Morus explores Victorian interdisciplinarity through a study of physics. While at first one might think that such an examination would reinforce the specialization thesis, what emerges through Morus's discussion is a rather complex narrative that shows the diversity of the discipline of physics during the nineteenth century. Morus's discussion underscores the tension between the rhetorical push for disciplinary specialization and the actual practice of interdisciplinary integration during this period. Through a series of snapshots of the field of physics across the Victorian era, Morus explores some of the ways that different conceptualizations of physics practice emerged within the discipline, thus exposing how interdisciplinary the research programs of physicists were at the time. Focusing particularly on public performances of physical experiments, led by leading figures such as William Robert Grove (1811–1896) and John Tyndall, Morus, much like Richardson in the preceding chapter, demonstrates how practices of display and spatiality intersected with Victorian interdisciplinary paradigms within the sciences, creating new forms of knowledge.

The fourth thematic section, "Reluctant Collaborations," provides yet another perspective to our narrative of Victorian interdisciplinarity in the sciences. Unlike previous sections, we see instances not of harmony and syncretization, but of disunity and contestation. For example, chapter 7 by Chris Manias examines competing discourses of disciplinary theories and practices within Victorian anthropology and paleontology. With the supposed advance of increased specialization and professionalization within these two disciplines, clear divisions began to emerge as "branches" of distinct knowledge. And yet, despite the growth of these divergent disciplinary perspectives, a rhetoric persisted that argued for more dialogue among these new disciplinary specialisms. Through his detailed and thoughtful examination of anthropology and paleontology,

Manias shows how some forms of interdisciplinary knowledge during the Victorian period were contentious and resistant to intellectual and practical collaboration.

In chapter 8 we see another example of a disunified and competing interdisciplinary research program, with Nanna Katrine Lüders Kaalund's examination of Arctic science during the second half of the nineteenth century. There was no consensus on how to undertake scientific research in the Arctic during the nineteenth century, and as Kaalund shows in her chapter, questions about theory and practice were widely debated by researchers interested in the icy north. Moreover, because Arctic science was still in a nascent stage, it borrowed theories, practices, and topics from a range of disciplines, further exposing the interdisciplinary character of the research field. However, the uncertainty of the Arctic generated other problems, and much of the scientific work conducted in this harsh environment was opportunistic, which therefore resulted in a vibrant interdisciplinary research program during Arctic expeditions. These activities, more often than not, however, were conducted through reluctant collaboration. Kaalund explores all these issues through both a detailed examination of questionnaires given to travelers visiting the Arctic during the second half of the nineteenth century, and with a critical analysis of the findings generated by the British Arctic Expedition of 1875, led by George Strong Nares (1831–1915).

The final thematic section focuses on “Hybrid Fields,” and chapter 9 by Efram Sera-Shriar explores the emergence of the interdisciplinary field of psychical research during the late Victorian era. As Sera-Shriar argues, one of the more heated cultural debates of the late Victorian period was determining whether or not spirits and psychic forces were real. It was a topic that attracted researchers from all corners of the scholarly world. Yet, despite numerous attempts by believers and skeptics alike to resolve the matter once and for all, no single discipline seemed able to offer a definitive conclusion on whether there was any real weight to the possibility of the genuine existence of supernormal forces. Any verdict regarding the veracity of spiritualism or telepathy was informed by an interdisciplinary approach, and spirit investigations and psychical research more broadly were a kind of hybridized field. Sera-Shriar explores these issues through a close historical reconstruction of the supposed exposure of the medium Henry Slade (1835–1905) as a fraud by the biologist and scientific naturalist E. Ray Lankester (1847–1929) in 1876.

In chapter 10 James Stark and Richard Bellis explore how far-reaching the process of disciplinary specialization in the sciences during the nineteenth century impacted heterogeneous fields such as nutrition. Drawing on nineteenth-century medical and scientific texts, as well as

Victorian manuscript recipes, Stark and Bellis argue that the heterogeneity of nutrition and its relationships with the practice of preparing food and medicaments in the home, demonstrates two key points. First, investigators studying human nutrition drew on many different research specialties, and second, the example of nutrition provides a model for thinking about activities that functioned beyond the supposed boundaries of a nascent disciplinary framework, and that continues to dominate historiographical understandings of the structure of Victorian science today. Thus nutrition, much like spirit investigations, represents an important case study for understanding the interdisciplinary hybridization of some nineteenth-century research programs.

In the Afterword, Bennett Zon approaches the topic of Victorian interdisciplinarity as an improvised form of conversation. Zon contends that modern conceptions of disciplinary identities are formed both spatially and temporally. The problem, then, is a cognitive one, where people struggle to comprehend the “becoming of things” and instead position themselves outside of these processes as a way of coming to terms with them intellectually. Zon goes on to explore the ontology of interdisciplinarity through the lens of what the psychologist John Shotter calls “witness-thinking,” which flips the cognitive problem of engaging these processes from the outside to a model that is centered on responsive thinking from within.<sup>25</sup> Drawing together key themes from the various chapters in the collection, what emerges in Zon’s discussion is a new framework for understanding the processes of constructing disciplinary, and by extension interdisciplinary, identities, or what he terms “Victorian witness.”

#### MOVING THE DISCUSSION FORWARD

The specialization thesis has in the past been an integral part of how historians have described the changing disciplinary map of nineteenth-century British science. The lines demarcating one discipline from the other supposedly became more and more rigid, until by the end of century they were almost set in stone. This picture of the disciplinary map frames the process of specialization as if it were the product of a necessary law of nature. By contrast, this collection has encouraged historians to recognize the more fluid “nature” of Victorian science in at least three ways. First, it points to how scientific spaces were sites in which a variety of disciplines were brought together. We see this in Richardson’s International Health Exhibition, an interdisciplinary space where different registers of knowledge and diverse forms of expertise circulated. Here visitors encountered information drawn from biology, chemistry, bacteriology, epidemiology, and engineering. We also catch a glimpse of other

interdisciplinary spaces in Manias's discussion of the Manchester Museum, in some of the experimental sites of physics examined by Morus, and in the séance room explored by Sera-Shriar.

More often the chapters in this collection focus on scientific figures whose writings and research drew on a multitude of disciplines. This is the second way in which the collection moves the discussion forward. Cantor's analysis of Faraday as a powerful symbol of unity in nature who explored the quantitative interrelation between electrical and chemical forces, in addition to the connections among magnetism, heat, light, and gravity, remind us of the similar aims of important early and mid-century figures like John Herschel, William Whewell, and Mary Somerville (1780–1872). But the volume also investigates the cross-disciplinary exploits of significant late-century scientists, such as Darwin, Grove, and Huxley. Browne argues that Darwin saw himself as a naturalist who ranged across a number of different fields, including geology, paleontology, zoology, and botany. By crossing disciplines Darwin aimed to produce a synthesis that interconnected the study of living things through the application of one crucial insight—the theory of evolution by natural selection—to many fields. Yet, Browne maintains, Darwin also actively contributed to the consolidation of specialized domains such as zoology and geology. Strikingly, in his chapter Morus also emphasizes how Victorian physicists tended toward disciplinary transgression—that Grove, James Clerk Maxwell (1831–1879), and Oliver Joseph Lodge (1851–1940) had more of an interest in overstepping boundaries rather than policing them. Where Darwin attempted to perpetuate the tradition of the naturalist, Morus's physicists desired to continue the tradition of the natural philosopher. The desire to move across disciplines is evident in both the life and the physical sciences.

It is also remarkable that the group of scientists from the latter half of the century most identified with the push for specialization, the scientific naturalists, are presented in a different light in a number of chapters in this volume. As Hesketh demonstrates, Buckle's attempt to save both history and science from becoming too specialized inspired scientific naturalists in the middle of the 1860s after first being rejected by them. The scientific naturalists who were involved in producing Macmillan's Science Primers during the 1870s, which appeared to chop up science into its constituent disciplines, actually embraced a vision of unity in their volumes. Lightman shows how each of the authors of the primers insisted that the discipline being covered did not stand on its own but was part of an interconnected whole, unified by a common method, a shared purpose, or overlapping subjects. If scientific naturalism was the main force behind the production of the primers, then we need to reeval-

uate the customary picture of Huxley, Hooker, and the others as being champions of narrow specialization.

The third way that this volume moves our understanding of disciplinary specialization forward is its handling of the disciplines themselves. Many of the chapters discuss how even after the modern disciplines began to emerge during the nineteenth century and boundaries were being drawn to demarcate these disciplines from each other, the traffic between them continued to be heavy. No doubt the boundaries were continuously contested and therefore remained fuzzy, as in the case of electrochemistry and physics in the second half of the century. Add to the mix the development of nascent disciplines that drew on the more established disciplines, such as nutrition science, the study of human origins, Arctic science, or even spiritualism. The latter, as Sera-Shriar shows, was at the center of heated controversies in which both sides drew on an array of disciplines and expertise, including physics, psychology, chemistry, folklore, and anthropology. Though less controversial, as Stark and Bellis demonstrate, the nutrition sciences drew on physiology, chemistry, and physics as practitioners in the field struggled to establish a coherent disciplinary framework. In her account of the formation of a discipline focused on Arctic research, Kaalund insists that it was inherently interdisciplinary since it drew on multiple specialisms that required a division of labor between specialists and generalists. Manias also claims that the new study of human antiquity required collaborations among those working in geology, archaeology, and paleontology. These collaborations could conceal a strategy of annexing multiple fields under the umbrella of a single analytical framework, as in the case of James Hunt's (1833–1869) use of anthropology.

The more complicated story of the formation of disciplines told in this volume, which does not align with the specialization thesis, serves as a reminder that disciplines cannot be seen as unambiguous mirrors of the organization of nature into discrete bodies of knowledge. Disciplines are not actual groupings of natural phenomena. In his *Origin of Species*, Darwin asserted that in the future species would have to be treated in the same manner as naturalists treated genera: mere artificial combinations made for convenience. "This may not be a cheering prospect," Darwin declared, "but we shall at least be free from the vain search for the undiscovered and undiscoverable essence of the term species."<sup>26</sup> Like species, disciplines are not fixed. Unlike species, they are not formed through some law of evolution or specialization. Disciplines are contingent and in flux, since they are made by human beings attempting to find order in nature. This is what makes them such fascinating subjects for historical analysis.