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Introduction:
Constructing Scientific Communities

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In March 1828, Scottish landscape gardener and author, John Claudius Loudon, outlined the vision for his new *Magazine of Natural History*. First, with individuals the world over being occupied in "discovering new objects, or in explaining the nature of those already known" the periodical would assist active "students of nature" in keeping up "their state of knowledge with the progress of science". Secondly, it would "extend a taste for this … knowledge among general readers and observers, and especially among gardeners, farmers, and young persons resident in the country" by

> subjecting every part of the science to discussion, in a language in which all technicalities are explained as they occur; by inviting every reader to communicate every circumstance, even the most trivial, respecting the native habits and habitations of plants, the localities of minerals and strata, and peculiar or striking states of the atmosphere; by encouraging all who are desirous of information to propose questions, to state their doubts, the kind of information they desire, or their particular opinion, on any part of the subject.[1]

Loudon's eager hope was that his periodical would not only become a tool to make new scientific observers, but would also draw those observers together with others who were already proficient into an enlarged community of interconnected practitioners. Observations that might be thought "trivial" would be rendered "truly valuable when viewed in reference to general conclusions." Thus might "persons wholly unacquainted with Natural History as a science" learn to become valuable scientific observers. "In this way", Loudon concluded, "we hope to call forth a new and numerous class of naturalists."

Loudon's editorial vision was characteristic of many of the scientific and medical periodicals that, as part of a vast proliferation of print more generally, increasingly deluged the reading public in nineteenth-century Britain, threatening, at times, to overwhelm the postal system by which they were often distributed (fig. I.1). Whether motivated by the desire to maintain a sense of connectedness and common purpose among members of a learned society or professional body, by the intention to recruit and discipline new observers, or by the commercial imperative to maximize a market, periodicals played a key role in defining and developing communities of scientific practitioners and the new participants whom Loudon sought to encourage. While, of course, their ambitions were often not fully realized, as our fifth chapter shows was the case for Loudon's *Magazine of Natural History*, they nevertheless acted as powerful determinants of the role and form of scientific periodicals. This volume sets itself to examine these distinctive qualities in relation to the wholesale transformations in the scientific enterprise that occurred during the nineteenth century. In the course of doing so, it sheds an instructive side light on the current lively debate concerning the purpose, practices, and price of scientific journals in the twenty-first century.

For much of the last century, scientific periodicals have been thought of primarily as vehicles of certified knowledge. Underpinned by the process of peer review, scientific papers

have been seen as the embodiment of scientific discovery, and as the basis of scientific authority and reputation. So pervasive have such perspectives been, that historians have sometimes struggled to see how relatively recently these functions have developed, and to grasp how different scientific periodicals were in the past. In recent years, a concerted effort has been made to eschew this presentism and "denaturalize the scientific paper as the dominant genre of scientific life". [2] Yet as scholars have striven to show that the characteristics of scientific periodicals which are taken for granted in the late twentieth century only emerged by degrees over the course of the nineteenth and early twentieth century, a further question has arisen. If the scientific periodicals of the nineteenth century are not to be thought of in essentialist terms as the favoured genre of legitimated knowledge, what is the historian to make of them? What, in other words, was their precise function and role in the making of nineteenth-century science?

Science Periodicals in Nineteenth-Century Britain focuses on one key aspect of the larger history that is thus unlocked. Rather than thinking of scientific periodicals primarily as the favoured locus for authorized scientific discovery, our approach here is to examine the role that they played in the development and functioning of more or less coherent collectives within the sciences. One of the enduring problematics in interpreting science in nineteenth-century Britain has been to find a means of characterizing the diversity, complexity, and (often) disharmony of its unfamiliar pre-professional communities of practice. An early suggestion, in the 1970s, that scholars might use prosopography (a kind of collective biography designed to establish the common attributes of members of a group) to investigate membership of these communities, fell on deaf ears. A generation of scholarship, however, has since taken us far beyond the unhelpfully anachronistic dichotomy of professionals and amateurs to appreciate the social complexity of nineteenth-century science. Artisan botanists and mechanical technicians, we now recognize, were integral to the diversified communities of practice engaged in scientific work.[3] More recently, historians have transcended another unhelpful dichotomy – that between elite and popular – in recognizing that the communication of knowledge to a diversity of audiences plays a crucial role in its very construction.[4] Understanding how science worked in nineteenth-century Britain entails improving our grasp on its social topography and the ways that communities formed and operated.

In this context, the scientific and medical periodicals whose numbers grew dramatically in nineteenth-century Britain (see fig. 1.1) offer an especially valuable and barely touched resource. As with the proliferating forms of scientific print more generally, those who produced these periodicals sought to garner more or less sizeable groups of purchasers and readers. However, periodicals were distinctive, albeit not unique, in their serial character. This had several important consequences. To begin with, the expected continuance of the periodical required the drawing together of a group of readers with sufficient commonality of interest to sustain ongoing publication. Periodicals were thus often founded by pre-existing groups, such as societies and clubs. In any case, they were produced with the ambition of developing a relatively stable and reliable group of consumers, although the prodigiously high rate of rapid failure demonstrates that that ambition was not easy to fulfil. In addition, the serial form of the periodical – extending through time – offered many more opportunities for readers to engage with those producing it, and with other readers, than was the case with a standard book. As issue followed issue, the periodical and the group of readers it fostered were shaped by the comments and responses of readers themselves, in contributed articles, letters pages, and other interactive formats, which, appealing both to readers eager to exchange information and to proprietors with a vested interest in encouraging purchasers to

come back for each issue, were one of the characteristic features of commercial science journals. Moreover, relationships often developed between readers, whether through learning about each other's' activities in the pages of a periodical, or through the private communications that the periodical spawned.

Re-examining the scientific and medical periodicals of nineteenth-century Britain from this perspective promises radically to enhance our vision of the shifting communities and practices of science in the period. Much of the best work in this area currently focuses either on societies or on individual interactions. Martin Rudwick's classic study of Darwin in 1830s London, for instance, focused on the "social and cognitive topography of geology" very largely within the oral context of private and society discussion, especially among what Rudwick termed "gentlemanly specialists". Similarly, Anne Secord's important study of the interactions of artisanal and gentlemanly botanists offered a sophisticated analysis of correspondence as the "primary form of social interaction" within their shared community.[5] While such studies are indispensable, periodicals afford a large additional body of detailed evidence about the workings of communities of scientific practice. In particular, periodicals themselves played a crucial role in constructing, negotiating and disrupting such communities, and all the more so as the century went on. As chapters in this volume show, sciences such as geology and botany came more and more to depend on periodicals for their community-building, practice, and identity, with societies – and even scientific fields – sometimes only coming into existence once a journal had established the existence of a group of like-minded individuals.

This volume begins to address the neglect of scientific periodicals in nineteenth-century Britain from this broader perspective. Given the large numbers of such periodicals – a conservative estimate suggests something well in excess of a thousand titles were published, some of which lasted for the entire century – it is beyond the scope of such a book to offer systematic, let alone comprehensive treatment. While this introduction outlines a new historiographical orientation to the history of science periodicals, the next chapter offers something of a chart of the historical terrain. The chapters that then follow provide a series of representative examples from across the range of scientific subjects and time periods. These are not meant to add up to a tight and cohesive account, but, rather, should be taken in the spirit of "samplings and soundings" that exemplify the larger issues.[6] While subject coverage is wide, ranging across natural history, the physical sciences, and medicine, inevitably some areas (for example, chemistry) do not receive treatment. The emphasis on Britain is also, in part, pragmatic, allowing for a more focused exploration. The highly entrepreneurial character of British publishing, the population's high degree of literacy, and the notably voluntarist character of British science, all make the British case an especially suggestive one.[7] Never have scientific periodicals been more important in constructing scientific communities than they were in nineteenth-century Britain.

This having been said, the focus on scientific communities developed in this volume has much wider relevance – both for other countries, and also for other time periods. Of course, much will be gained by further developing the analysis within a larger international perspective. While broadly similar concerns relating to the construction of scientific communities recur in different national and regional contexts, the manifold variations exhibited splendidly point up the national and regional differences in the organization of both scientific communities and scientific work. In the German lands of the late Enlightenment, for instance, the distinctively rapid expansion of specialist science periodicals reflected an interest in consolidating distinctive communities of knowledge in the universities of separate

and to some extent competing states.[8] In the early American republic, by contrast, it was a single periodical, Benjamin Silliman's *American Journal of Science and Arts* (1818–), published from New Haven but distributed across the Eastern seaboard, that enabled the rival scientific groups in the urban centres of Philadelphia, New York and Boston to transcend their local enmities and come together, for the first time, as a unified national community, a process subsequently consolidated by the formation of the American Association for the Advancement of Science in 1848.[9] Moreover, periodicals have played a key role not only in enabling readers to imagine and engage with national communities of practice, but also in enabling them to imagine transcending such limitations in the construction of transnational communities.[10] The approach developed in this volume thus invites further development in relation both to other national and to supranational settings.

The historical perspectives offered here also cast important new light on other time periods, including the early twenty-first century debates concerning the future of the scientific journal. As scientists, universities, and funders become ever more radical in questioning the dominating role of modern scientific periodicals as vehicles of authorized knowledge that authenticate the expertise of scientists, so the alternative vision developed here of their role in constructing scientific communities becomes useful in offering conceptual tools to assist in that re-evaluation. For instance, just as Loudon sought to use his new magazine to expand the community of scientific practitioners, so modern scientists are questioning what forms of communication can facilitate the involvement of "citizen scientists" and others beyond the academy. Likewise, as in the nineteenth century, changes in communication technology and the economics of publishing are now seen as opportunities to expand the communities of practitioners. Moreover, such changes are again being understood in relation to concerns about securing accountability for scientific knowledge among a wider public, comprising increasingly well-educated citizens. As several participants observed at a recent Royal Society symposium on the future of the scientific journal, the "centrality of communities" is a key strand linking discussions of journals in the nineteenth and twenty-first centuries.[11] Thus, while *Science Periodicals in Nineteenth-Century Britain* is entirely historical in focus and approach, the themes it explores are highly topical and its findings have bearings for contemporary science.

The remainder of this introduction offers a historical and historiographical overview of science periodicals in nineteenth-century Britain that serves to situate the more detailed studies in the individual chapters and elaborates on the larger analytical framework. We begin with a review of the existing literature, situating our approach in relation to the "communication turn" in the history of science and to the recent growth of interest in the distinctiveness of nineteenth-century science periodicals. The following section then offers a more developed account of the volume's approach to such science periodicals, outlining some of the key themes. Finally, we provide an overview of the book's contents, showing how the various chapters exemplify and explore those themes in further depth.

From Publishers and Editors to Scientific Communities

British periodicals of the nineteenth century first became the subject of sustained scholarly attention from the late 1950s, with the inception of the *Wellesley Index to Victorian Periodicals* (1966–89), the founding of the Research Society for Victorian Periodicals (1968), and the commencement of the *Waterloo Directory of Victorian Periodicals* (1970).[12] However, it was not until the late 1970s that scientific and medical periodicals became a distinct focus of scholarship.[13] A number of this first generation of studies by historians of science and medicine were naturally designed to chart and survey the historical output of

periodicals, characterizing and enumerating different types and the patterns of their production.[14] Especially useful, though, were studies that pushed beyond this to consider the role of editors and publishers in producing and managing scientific periodicals. Encouraged by Roy MacLeod's historical centenary supplement to *Nature* in 1969, Jack Meadows and Bill Brock were prominent in opening up the practical, commercial, and strategic world of scientific periodical production. Meadows had written a biography of *Nature*'s founding editor, Norman Lockyer, while Brock became interested in the importance of commercial science journals in nineteenth-century Britain, which accounted for almost two-thirds of the 535 scientific titles listed in the first phase of the *Waterloo Directory*. In 1984, the two completed a study of the leading Victorian printers and publishers of scientific periodicals, Taylor and Francis, which still serves as the most useful overview of scientific periodical publishing in the period.[15]

Brock and Meadows' study of Taylor and Francis drew attention to many of the practical and commercial issues involved in scientific periodical publishing, but proved especially informative regarding the role of publishers and printers, who acted "as midwives in the creative process of bringing forth periodicals" making "decisions about which forms of scientific literature could survive in the market place", as well as the work of scientific editors, including Richard Taylor and William Francis themselves.[16] In placing such emphasis on the practical aspects of publishing, Brock and Meadows drew on the work of Susan Sheets-Pyenson, who in the early 1980s completed two ground-breaking studies of the publication of natural history periodicals in the 1830s, showing what could be learned from careful attention to publishing records.[17] These works also underpinned a valuable and distinctive study by David Allen offering an account of how natural history periodicals became economically viable during the first half of the nineteenth century.[18] Meanwhile, historians of medicine began to attend to periodicals more seriously, not only charting the output and sampling the content, but also seeking to expose the important role of editors in shaping and producing them.[19]

While this first cluster of studies began to delineate some of the terrain and highlight the methodological issues involved in getting to grips with the great efflorescence of scientific and medical periodicals in nineteenth-century Britain, it did little to offer a larger historiographical vision. It is striking, indeed, that the introduction to W. F. Bynum, Stephen Lock and Roy Porter's collection, *Medical Journals and Medical Knowledge* (1992), ran to just five pages, with the editors noting that it was "remarkable", in view of their "vast importance", how little "the history of scientific, technical, and medical journals" had been studied.[20] What larger historiographical visions there were, notably that offered by Robert M. Young, actually cast scientific periodicals as deleterious agents of the "fragmentation of the common intellectual context", with Young arguing that it was the "popularity of *Nature* among increasingly professional scientists", along with the emergence of other similarly specialised journals, that shattered the "rich interdisciplinary culture" established by general periodicals earlier in the nineteenth century.[21] Another large-scale perspective came from those interested in exploring the rhetorical history of the scientific "article", but, as historians have shown more recently, such work has sometimes lacked historical nuance and needs to be re-evaluated in the light of the growing awareness of the historical variability in scientific periodicals.[22] From the perspective of this volume, however, the most suggestive of these earlier studies was Sheets-Pyenson's examination of "popular science periodicals in Paris and London", with its innovative analysis of how such periodicals fostered the development of distinctive communities of scientific practice.

Focusing on popular periodicals in early nineteenth-century London, Sheets-Pyenson came face to face with the ways in which such publications encouraged as one of their primary goals the active involvement of readers in the scientific enterprise, with workers being invited to contribute their own findings in the context of an open-ended vision of inductive science. Moreover, she found in many of these periodicals a divergent vision of the "canons of scientific investigation, criticism, and explanation", terming this scientific activity "low" science, in contradistinction to the "high" science of the "scientific establishment". For Sheets-Pyenson, these "low" periodicals served an important part of the "pyramid" of British scientific readers who expected to be able to contribute to the work of science. [23] She also explored the importance of such contributions to science in her innovative study of Darwin's reading of natural history journals. That such an important philosophical naturalist should be engrossed by the observations and comments of readers in the *Magazine of Natural History* helps to situate such individuals within the larger scientific domain, in which observations by "An Admirer of Nature, Ipswich" and "Miss Kent" sat cheek by jowl with those by such learned naturalists as William Kirby and William Swainson (fig. I.2). Indeed, what Darwin most valued in the *Magazine of Natural History* was its willingness to publish what he termed "discussions & observations on what the world would call trifling points in Natural History", and, as Sheets-Pyenson showed, these ostensibly trifling points, which were a distinctive facet of many commercial scientific journals eager for cheap copy, were a vital source of descriptive information and detailed data in the period when Darwin was initially formulating the theory of natural selection.[24] While Sheets-Pyenson suggested that the open ethos of her early journals was later supplanted by a professionalizing ethos in the 1860s, chapters in this volume show that the story was not as linear as that suggests.[25]

Sheets-Pyenson's interest in periodical readers, communities of practice, and the social topography of science has been developed further in more recent studies. One major impetus for this has been the publications of the Science in the Nineteenth Century (SciPer) Project at the Universities of Leeds and Sheffield. This project, which ran from 1999 to 2004, was devoted to examining the representation of science, medicine and technology, and the interpenetration of scientific and literary discourse, in the *general* periodicals of nineteenth-century Britain, but the project brought the insights of periodical studies to bear on the history of science more generally. In particular, it highlighted the importance of even general periodicals in scientific communication and debate, drawing out their role in developing and defining audiences, and in facilitating discussion and interaction over time. Periodicals were, SciPer suggested, publications in which new communities of readers could be developed, sharing certain interests in and attitudes towards the sciences, negotiated in an ongoing conversation between editors, publishers, writers, and readers. In such publications, the participants in a new community of enquiry could learn to recognize each other as sharing a common enterprise, shaping their ideas into a scientific discipline, as was the case, for instance, with so-called "baby science" between the 1860s and 1890s.[26]

This work on science in general periodicals reflected a more general turn among historians of science towards the role of communication processes in the making of scientific knowledge.[27] James Secord's seminal 2004 article, "Knowledge in Transit", reviewed the growing interest in the "movement, translation, and transmission" of scientific knowledge, suggesting that the underpinning historiography needed to be more systematic and ambitious. His inspirational vision of a systematic focus on communication as constitutive of scientific knowledge placed a new emphasis on moving beyond the "what" of scientific communication to the "how", "where", "when", and "for whom". Moreover, as Secord and others have suggested, such a reorientation offers a helpful way out of the sterile and often anachronistic

distinction between "popular" science and science proper. Rather than thinking of certain forms of communication as merely popular, Secord's framework makes the full range of scientific communication of relevance in the making of science.[28] From the perspective of this volume, such a view is clearly valuable in suggesting to the historian that the communication that took place through the whole range of scientific periodicals, from the costly transactions of prestigious specialist societies to the cheapest of commercial journals, should be taken seriously as part of the work of science.

Perhaps partly in consequence of the new scholarly focus on communication, the last decade has witnessed a great resurgence of interest in scientific periodicals in nineteenth-century Britain. A common feature of this work has been a growing sense of the extent to which such periodicals were markedly different from the early twenty-first century conception of the scientific journal as the prime location for making accredited contributions to the sciences and building reputation and careers. As Secord pointed out in an important overview of scientific print in the nineteenth century, "what it meant for something to be a scientific periodical, and the role of periodical publication regimes within the sciences, was radically uncertain right through the middle years of the nineteenth century".[29] This point has been developed in a number of more detailed studies. Jonathan Topham and Iain Watts have explored the distinctiveness of the first British commercial science journals, the purposes, uses, and readerships of which were notably different from modern journals.[30] At the other end of the century, Melinda Baldwin's important history of the journal *Nature* shows that it was founded with a strikingly unfamiliar vision of what a scientific periodical should be, and describes the long process of transformation by which it came to have its more familiar character. Indeed, the journal that is now the international benchmark for modern science publishing was initially intended to appeal to both scientific practitioners and the general public; only subsequently, with the increasing specialization of science and the journal's growing emphasis on news of the latest research, did the journal come to be directed more narrowly to specialist practitioners. A similar series of changes and transformations is currently being brought to light by the longue durée history of the *Philosophical Transactions of the Royal Society* undertaken by Aileen Fyfe and her collaborators.[31] Equally significant is the recent work of Alex Csiszar, which offers an overarching view of the vigorous process of experimentation with scientific periodicals in nineteenth-century London and Paris, and the developments that resulted in many of the familiar characteristics of the modern scientific journal.[32]

These studies have put the history of scientific periodicals in the nineteenth century on a new footing. By more consciously historicizing the form of the scientific journal, they have drawn attention to new questions about the changing purposes of such periodicals over this key transitional period. The introduction to Baldwin's study of *Nature* argues that the journal "came to define a scientific community", whose boundaries were "constantly shifting, constantly being renegotiated and redefined". The *Philosophical Transactions* project team also emphasize the role of periodicals in enabling "geographically dispersed scholars to communicate, and sometimes to coordinate, their research" and in helping to "establish and police knowledge communities".[33] In a related way, Csiszar has laid great emphasis on changing conceptions of the publics for science in a post-Enlightenment world, drawing on Thomas Broman's important study of periodicals in eighteenth-century German medicine. As Csiszar points out, the discursive category of the public became key in the Enlightenment in securing legitimacy, and the new periodicals of the nineteenth century wrestled with how to use the notion to this end.[34] Nonetheless, the distinctive role of scientific periodicals in the creation and management of scientific and medical communities remains little explored.

Fyfe points out in her recent survey of the field that, "We know far too little about the distribution, circulation and readership of scientific journals".[35] More than that, historians have much to gain by learning about how those involved – from editors and publishers to readers and contributors – used scientific periodicals to shape communities of practice. It is this research agenda that the current volume sets out to address.

Rethinking the Role of the Scientific Periodical

As the historical review in the following chapter shows, scientific, medical, and technical periodicals were not only extremely numerous in nineteenth-century Britain, but were also extremely diverse. Few resembled the peer-reviewed scientific journals familiar in the early twenty-first century, manifesting instead a wide variety of characteristics, purposes, and practices. This returns us to the key historiographical question with which we began. What framework can the historian bring to bear on the scientific periodicals of nineteenth-century Britain that provides a means of navigating this complicated terrain? The central claim of this volume – that scientific periodicals had a significant role to play in the development and operation of communities of scientific practice – certainly has much to offer in this context. The individual chapters that follow explore a number of the implications of that perspective in more detail, but in this introduction we now turn to consider some of the core historiographical themes in a more focused way. What does it mean to say that periodicals were involved in the development of scientific communities? How was the form of the periodical exploited and developed to facilitate such processes, and what constraints came into play? And, finally, how did these processes relate to the vexed question of who could be involved in the practice of the sciences, and who had the right to exert control over them? We focus on each of these questions in turn.

Scientific Communities

We have suggested in this introduction that periodicals have much to offer the historian in understanding "communities of scientific practice". However, as David Cahan has observed, the topic of "communities" is one that historians have been slow to pursue systematically or to examine conceptually. Cahan offers a working characterization of scientific communities as "Populations of individuals who share similar cognitive interests and values that serve to provide them with a collective social identity and to advance individual scientific careers and group needs." Vital to such populations functioning as communities, Cahan suggests, is their engaging in concerted action over time and sharing a distinctive sense of social cohesion. But Cahan also observes that the notion of community can operate at a more abstract level in science, generating a sense of common identity and belonging at disciplinary, national, or international scale, independently of personal interaction.[36] In this regard, scientific communities are like the "imagined communities," sustained especially by newspapers, that Benedict Anderson suggests underpin the rise of nationalism in his landmark study of the subject. However, while, for Anderson, the abstract sense of being part of a nation that is cultivated by newspapers is the product of what he terms "print capitalism", in the case of science periodicals, such imagined communities were as much the creation of readers, for whom a feeling of authentic connection with other readers was forged through the altruistic exchange of letters and information in interactive formats, such as the notes and queries column, as they were of editors and publishers who, among other motives, often had a vested commercial interest in generating a sense of community that ensured a sufficient number of recurrent purchasers.[37]

Cahan's characterization of scientific communities is extremely helpful from the perspective of this volume, and it is easy to see that scientific periodicals played a key role in their formation and functioning. Sometimes, scientific periodicals were established with a clear intention to cultivate a working assemblage of readers who shared a strongly cohesive sense of common purpose and identity and from whom they could obtain scientific observations and contributions. Such might be the case with a periodical established by a club or society, the key object of which was to continue and develop a conversation begun within the confines of a meeting room, often expanding it to a national or even international scale, drawing individuals who rarely or never met into a cohesive imagined community. It was also the case with more speculative ventures, such as the ground-breaking cheap weekly, the *Mechanics' Magazine* (1823–72), where the editorial imagining of a geographically dispersed community of artisans sharing common interests in mechanical knowledge, only partially mapped onto the emerging social infrastructure of artisanal life in the clubs and political gatherings of 1820s Britain. The producers of some other periodicals never expected their readers to form so cohesive a group, and the commercial failure and brief duration of so many science periodicals suggests that, even when there was such an expectation, the cohesion of a community of readers could never be taken for granted and required careful cultivation. In order to achieve a viable market for their product, editors and publishers accepted the need to combine multiple groups of readers, who might typically share certain cognitive interests – say botany or astronomy – while having very different cognitive values and sharing little in the way of social identity. When, for instance, John Loudon established his *Magazine of Natural History*, he was quite clear that active "students of nature" and "general readers and observers" were both to be interested by the new product, despite their very different senses of themselves and their rather different needs.

Of course, both types of readers would themselves have simultaneously belonged to other, often overlapping, communities, and those whom Loudon designated "students of nature" would, depending on their standing and social class, have been members of institutions such as the prestigious Royal Society or the peripatetic British Association for the Advancement of Science. They may also have belonged to smaller, more exclusive groups predicated on sociability, such as the Red Lion Club, made up of younger members of the British Association who held raucous tavern dinners where they could indulge in boisterous behaviour not acceptable at the stuffy formal banquets of the parent organization, or the X Club, an informal dining group whose strategic collaboration and institutional manoeuvrings helped them to become the spokesmen for science to much of the nineteenth-century public.[38] In addition, however, they would almost certainly have participated in communities beyond the strictly scientific — for instance, reading and contributing to general or literary periodicals alongside members of other intellectual and occupational groups. Prominent men of science such as Thomas Henry Huxley, as Paul White has argued, even helped to "create and sustain a single community of diverse, but complementary, élites" in mid-Victorian Britain, whose varied members, whether Anglicans or agnostics, novelists or naturalists, were brought together by their adherence to liberal views of culture and reform.[39] The communities forged by science periodicals must be viewed in relation to this broader context of community formation in the nineteenth century, but there is still considerable value in emphasising, as this volume does, the specific ways that specialist journals fostered a sense of collective identity amongst their contributors and readers.

One of the benefits of approaching scientific periodicals from this kind of perspective is precisely that it brings into focus the diversity of communities and of their interaction, in a

way that is easily lost when focusing on particular institutions or on such inchoate social categories as "amateur", "philosophical", "practical", "popular", and "professional". Periodicals addressed to multiple imagined audiences allow the historian to gain a clearer sense of how contemporaries understood what Rudwick talks about as the different zones in the social topography of science. For Rudwick, the main distinction between the zones is in terms of levels of "ascribed competence", and this was certainly a consideration for journal editors. Scottish natural philosopher David Brewster's vision of the *Edinburgh Philosophical Journal* (1819–64), for instance, encompassed "men of Genius" and "General Readers" with a view to maximizing the market for a new kind of authoritative but fashionable scientific monthly. But the question was not merely one of "ascribed competence". Periodical editors often perceived that a population of purchasers could be generated by addressing individuals with different cognitive values. For example, journalist Alexander Tilloch's *Philosophical Magazine* (1798–) was aimed at both "philosophers" and "mechanics", and was thus meant to advance both theoretical knowledge and practical improvements, often entailing a common subject focus, albeit with distinct objects in scientific and technical innovation. Of course, the readers envisaged by Brewster and Tilloch, whether "men of Genius" or merely "mechanics", were almost exclusively male, and science periodicals that aimed to include women amongst their audiences were generally confined to certain fields such as botany and horticulture, with the opening number of Loudon's *Gardener's Magazine* (1826–44) urging that its subject was "agreeable …especially to the female sex".[40] Only later in the nineteenth century did female contributors begin to make their mark in science journalism, with, for instance, Phebe Lankester, who often wrote under the pseudonym "Penelope", contributing regular articles to the *Popular Science Review* (1862–81) on both botany and public health.[41] As the chapters by Sally Shuttleworth and Sally Frampton in this volume show, public health and medicine continued to be topics in which female contributors and readers played an important, if frequently contested, role.

At one end of the spectrum, therefore, periodicals offer insights into the overlapping nature of different communities of practice that had related but distinguishing interests. Indeed, publishers, editors, writers, and readers were often obliged to set out explicitly how they saw the differences and similarities among the diverse groups of readers. This sometimes occurred in forthright and controversial exchanges, but it also occurred in more programmatic statements about how editors and others viewed the scientific division of labour. At the other end of the spectrum, however, periodicals played a key role in developing tightly bound communities of practice with shared epistemic goals and a strong corporate identity. Such journals might emerge out of pre-existing face-to-face interactions in clubs, societies, professional bodies, or academic institutions, although they might as easily lead to such interactions. It was, for instance, the activities of the *Mechanics' Magazine* that led to the formation of the London Mechanics' Institution, rather than the reverse. Having founded their new journal, the editors used its pages to invite the mechanics of London to associate for the purpose of establishing their own institution, and to organize and report on the subsequent meetings (fig. I.3).[42] Periodicals could offer an opportunity for an individual or group to explore the viability of an "imagined community". Did the editor's vision of a new scientific discipline, medical specialism, or professional identity find an answering call from a coherent body of readers that might lead to a growing social consolidation? While many editors missed their mark, many others had a key role to play in developing the social topography of nineteenth-century science.

Periodical Formats and Finances

Given the important role that periodicals played in the growth and management of scientific communities, it is important to examine further the relevance of their distinctive characteristics in that process. Of course, the serial character of the periodical is at the core in this regard. The regular, date-stamped, and open-ended character of periodical publication allows editors, writers, and readers alike to imagine an ongoing relationship, based around scientific practice, the desire to communicate, and a sense of the unfolding work of science. These are all aspects of seriality recently emphasized by Nick Hopwood, Simon Schaffer and James Secord. They also reflect that, "More than anything else, the experience of sequential reading of printed paper tied groups together", noting "it was often said that a political group or religious sect did not really exist until it issued a periodical or newspaper".[43] As this makes clear, however, scientific periodicals were not unique in having a role in building communities. Indeed, the natural sciences were by no means the only field of knowledge considered to have a progressive character, suited to serial publication, and the intimate connection between progress and periodicals had long been a source of anxiety and satire among conservative commentators.

This raises the question whether the producers of scientific periodicals exploited the form in distinctive ways, adapted to scientific purposes.[44] To what extent were scientific periodicals the same as or different from other periodicals, and did that change over time? Of course, the variety is such that no very general answer can be offered, and science journals were published in myriad periodical formats including, but not restricted to, society transactions and proceedings, weekly and monthly magazines, reviews, annuals and digests of abstracts. It is clear that on many occasions, the publishers and editors of journals looked to existing periodicals, non-scientific as well as scientific, in conceiving the format of their new productions. Yet, with the passage of time, aspects of format were adapted to what were seen to be the distinctive demands of scientific work. For instance, the manner in which Loudon encouraged "persons wholly unacquainted with Natural History as a science" to offer observations in the pages of the *Magazine of Natural History* reflected a sense of the distinctive character of natural history as a field science, dependent upon the observations of a large body. Moreover, this active encouragement of small-scale observations by readers became a notable feature of a large array of scientific periodicals in the nineteenth century, including, as is seen in the chapters in this volume, those focused on natural history, geology, and astronomy, but also extending to public health. Often, such initiatives involved making space in the pages of the periodical for readers to contribute queries, requests for information, and offers of help with specimens and observations – activities which were likely to enhance readers' sense of being part of a community of practice. Similarly, in the late nineteenth century the new periodical format of the digest of abstracts was closely adapted to more recent developments in scientific practice, particularly the massive growth in the number of professional scientific workers, based in institutional laboratories and universities, who, in order to validate and advance their own experimental studies, required rapid access to relevant information in different specialist disciplines. The particular types of scientific work undertaken by these two very different communities – casual observers in the field and professional "scientists" (a designation, of course, that only came into widespread use at the close of the nineteenth century) – were both actively shaped by the formats of the journals that they read and to which they contributed.

Of course, such facets as readers' contributions also appeared in some non-scientific periodicals, which in itself offers the historian an opportunity to explore the extent to which scientific communities were different from those with other interests. Yet for historians of science increasingly interested in the quotidian practice of science, understanding the choices

made by those producing periodicals in relation to the organization of scientific work promises valuable insights. This, indeed, is the main focus of a recent volume on "scholarly journals in early modern Europe", where the editors' core question is "has the creation and development of a periodical form changed the nature not only of scientific communication but also of scientific and indeed of scholarly practice?"[45] Here, recent work on the use of "paper technologies" in the sciences offers a fertile approach.[46] The editor's management of the format and contents of the periodical can usefully be thought of as the deployment of such a technology in organizing scientific work, including through organizing a division of scientific labour. Thus, for instance, just as interpersonal correspondence networks are attracting increasing scholarly attention as "scientific tools", Matthew Wale's chapter in this volume shows that the mediated correspondence networks of periodicals can also be understood in these terms.[47]

It is important to appreciate, however, that these decisions about format were never entirely motivated by editorial ambitions in regard to the practice of science. Anyone familiar with the history of periodicals will recognize that concerns about finances were rarely far from the minds of editors, and that was undoubtedly the case with scientific periodicals, too. It is interesting to speculate what Robert Jameson and David Brewster's *Edinburgh Philosophical Journal* or Norman Lockyer's *Nature* might have looked like, if the editors and publishers had felt convinced that they might publish a periodical without concerning themselves with a "popular" audience beyond the active "philosophers" or "men of science" like themselves. As several of the chapters in this volume show, moreover, even the ostensibly non-commercial transactions and proceedings produced by scientific societies, who underwrote the costs of publication through the patronage of their members, generally found it necessary to shift to more commercial business models after mid-century, even if they found the requirements of the marketplace distasteful and endeavoured to retain the prestige associated with being privately subsidized. The point here, of course, is that the financial considerations that troubled most producers of periodicals had substantial consequences for the character of the scientific communities that were produced and the scientific work that was undertaken through their pages. In seeking to maximize a market by selling a magazine both to manufacturers and to learned philosophers, for instance, Alexander Tilloch committed himself to a distinctive mélange in terms both of form and contents. Of course, readers did not see themselves merely as consumers, and instead the sense of community created by journals often relied on a sentiment of shared work and participation that was inspired by values of mutuality, or more old fashioned paternalism, rather than mercantile competition. The story of scientific periodicals in nineteenth-century Britain is nevertheless in part a story of the changing economics of periodical publication, and the continuing necessity of turning a profit or at least breaking even, which endlessly redounded on editorial visions and practices.

Legitimacy and Control

While they were often made in response to financial considerations, decisions about the intended readership of scientific periodicals were often also highly political. Attempts to broaden and open out the communities of scientific practice, whether financially or ideologically motivated, were frequently perceived to be a challenge to established bodies. In particular, the growing multitude of learned societies were often alarmed, wary, or dictatorial about periodicals that seemed likely to undermine their authority by appealing to larger and more diverse constitutencies of readers. Iain Watts's recent study of William Nicholson's *Journal of Natural Philosophy* (1797–1813), for instance, draws attention to the manner in

which the Royal Society perceived Nicholson's editorial activities as an encroachment on their management of the community of scientific practitioners.[48] And, as Alex Csiszar's chapter in this volume shows, it was in this context that scientific societies sought to claim back their control by addressing an imagined general public through "proceedings" that would serve to secure their public authority. Moreover, as Csiszar has shown elsewhere, the development of processes of refereeing and the establishment of the scientific paper as a distinctive form of publication of record also need to be read in relation to such concerns. These can be viewed as some of the "ways in which received boundaries between experts and non-experts – and the values and standards that come with them – were erected in the first place."[49]

The perception of elite institutions – especially the metropolitan learned societies – that certain scientific periodicals represented a threat in their deliberate attempts to widen participation in scientific practice was not, of course, mere paranoia. Many periodicals were founded with precisely such ends in view, as is clear in the case of the *Magazine of Natural History* with which we began, and in many other cases explored in this volume. As James Secord has perceptively observed, the imagined "futures of science" were always multiple, and it was not simply the case that the learned societies did not have a monopoly on such imaginings; they also disagreed within their own ranks about how science should operate.[50] The growing range of scientific periodicals in nineteenth-century Britain can thus be read as a contest regarding the shape of the communities of science and concerning who had the authority to adjudicate what went on within them. As Geoffrey Belknap's chapter in this volume shows, the *Magazine of Natural History* prompted a range of new editors to enter the field with periodicals seeking to define and control alternative visions of the natural history community. Competition between commercial journals was often not merely a matter of financial success or failure: it represented a battle for control within the communities of scientific practice. This continued to be the case throughout the nineteenth century, even as the machinery of scientific expertise described by Csiszar developed, with new kinds of alternative communities emerging, notably including new professional and trade groups, such as architects and telegraph engineers.

This reference to professional groups leads us naturally to the medical press, where issues concerning legitimacy and control were arguably most strongly felt. As the following chapter shows, it is striking that it was in medicine, where a clearly defined market for print was known to exist, that the earliest of the new specialized commercial periodicals of the eighteenth century were produced. Unlike either the *Philosophical Transactions* (1665–) or the *Gentleman's Magazine* (1731–), such publications addressed clearly defined imagined constituencies, encompassing various combinations of physicians, surgeons and apothecaries. In the early nineteenth century, however, periodicals were commenced with more contentious alignments, whether addressing a wide public audience alongside medical practitioners, like the *Monthly Gazette of Health* (1816–32), a diverse constituency of supporters of an unorthodox medical doctrine, like the *Phrenological Journal* (1823–47), or, indeed, a politically charged section of the medical profession, like the *Lancet* (1823–). Such diversification of medical periodicals and the communities that they supported and represented only increased as the century progressed. As Sally Shuttleworth shows in her chapter, periodicals helped to forge communities interested in public health that went far beyond physicians and surgeons, without too much controversy. Yet, as Sally Frampton demonstrates, other periodicals prompted the ire of medical authorities when they targeted readers who were not doctors, including nurses and medical administrators, as well as others not employed in medicine. As medical communities themselves became more specialized

toward the end of the century, the desire of leading doctors to control and delimit those engaged with medical knowledge was met with a continuing defiance from dissenting editors and readers.

Altogether, therefore, we have to think of scientific and medical periodicals as key sites in which, and between which, the power structures of science and medicine were developed and negotiated. As Csiszar's chapter shows, the history of such periodicals takes us to the heart of "an enduring problem of science and democracy". Just as in other aspects of social and cultural life, so in the sciences the expansion of print media and the diversification of readers and contributors left members of elites who sought to establish privileged claims to authority needing to do extra work in order to gain public legitimacy. In a world in which a coal-heaver might have an opinion on the proceedings of scientific societies, as caricatured by Robert Seymour in a famous series of lithographed sketches (fig. I.4), periodicals were not only used to build boundaries to demarcate and legitimate privileged knowledge communities, but also frequently functioned to challenge such communities. Moreover, the situation was, if anything, all the more keenly felt in medicine, where livelihoods were very evidently at stake in the contests concerning the divergent ways that periodicals defined communities of medical knowledge and practice.

The historiographical reflections offered here are intended to flesh out the vision of a new way of exploring the importance of scientific periodicals in nineteenth-century science. For too long, the study of scientific periodicals has been limited by a misconception of their diverse history, rooted in the perspective of the present, when they have become primarily understood as certifying vehicles of authoritative scientific knowledge. Taking seriously the role of scientific periodicals in the development and operation of scientific communities in the nineteenth century takes us to the heart of key questions in the history of nineteenth-century science, concerning the changing and interlocking character of communities of scientific practice, the organization of scientific work, and the struggle for authority and control. Such an approach puts scientific periodicals where they belong, at the heart of the story of nineteenth-century science.

By the end of the century, science was increasingly associated with academically employed professionals in a way that, in the new century, came increasingly to supplant nineteenth-century ambitions for more inclusive scientific communities. However, recent developments make it easier to appreciate the ongoing importance of the perspectives brought to bear in this volume. For instance, "citizen science" initiatives, supported and encouraged by the flexibility of digital communication technologies, have again placed the question of the character, limits, and management of scientific communities centre stage. Similarly, the inception of the internet and the spiralling costs of journal publication have led to a vigorous debate concerning how the format and finances of scientific periodicals affect scientific work practices and the management of working communities. At the same time, principled concerns about public access to the results of publicly funded research in an era in which public engagement has become a policy watchword, link these debates to issues of public accountability and legitimacy. Underlying current discussions of the future of the scientific journal lies the question, so central to nineteenth-century debates, of how knowledge claims can be rendered authoritative, through "defining boundaries and validating membership" of knowledge communities, without making those boundaries impermeable. While twenty-first science periodicals are significantly different from those of the nineteenth century, they continue to "define and support communities," with many of the same issues at stake.[51]

Samplings and Soundings

Science Periodicals in Nineteenth-Century Britain is divided into three sections which examine different aspects of how scientific and medical periodicals created and negotiated a variety of communities of practice across the period. In the first section, *New Formats for New Readers*, the chapters examine some of the constraints and new possibilities surrounding how scientific communities could be conceived, especially during the earlier years of the century. The first chapter offers an overview of the new kinds of science periodicals that were produced in nineteenth-century Britain, charting some of the most significant patterns and trends, and providing a somewhat tentative map of the terrain. The next chapter, Jonathan Topham's "Redrawing the Image of Science: Technologies of Illustration and the Audiences for Scientific Periodicals in Britain, 1790–1840", examines how the changing technologies of scientific illustration had important consequences for the readership of early nineteenth-century journals and thus the sense of how science should be configured. The following chapter, Alex Csiszar's "Proceedings and the Public: How a Commercial Genre Transformed Scientific Publishing", examines the emergence of "proceedings" as a new format of periodical publication, with learned societies responding to the early nineteenth-century emergence of commercial journals and their demands for public accountability. Recognizing "proceedings" as a distinct periodical genre demonstrates the intimate connection between commercial journalism and the consolidation of specialized scientific publishing, which is a theme that runs through many of the chapters in the following section.

The second section, *Defining the Communities of Science*, examines how developments in periodicals in five scientific fields—geology, natural history, entomology, physics, and astronomy—served to shape, but also responded to, changing communities. The chapters explore the changing notions of who was properly involved in scientific practice, as well as tensions and contests over who should exert control. The picture that emerges is one in which fellows of learned societies and professionalizing academics were continually engaging with larger public and, indeed, professional constituencies. Gowan Dawson's "'An Independent Publication for Geologists': The Geological Society, Commercial Journals, and the Remaking of Nineteenth-Century Geology" shows how the Geological Society found itself constantly responding to a commercial press that often subverted both its authority and its hierarchical conception of the earth sciences and instead harnessed the field observations of an army of enthusiasts. It was in natural history that specialist commercial journals first found a sizeable community of readers, but here, as Geoffrey Belknap argues in his chapter "Natural History Periodicals and Changing Conceptions of the Naturalist Community, 1828–65", there were competing visions of how such a community should be managed. Like geology, entomology was another of the sub-fields of natural history that, by mid-century, increasingly had their own specialist commercial journals, and, as with the earth sciences discussed in Dawson's chapter, it too attracted practitioners from across the social spectrum. Matthew Wale's chapter, "'The Sympathy of a Crowd': Entomology Periodicals and the Construction of Scientific Communities," explores how the application of print publication to older forms of scientific correspondence had important implications for the social and geographic makeup of the communities of entomological practice.

The last two chapters in the *Defining the Communities of Science* section focus on the physical sciences – specifically physics and astronomy – in the final decades of the nineteenth century, and there are both continuities and differences from how the journals in the life sciences considered in the first three chapters forged and reacted to new forms of

scientific community. Graeme Gooday's chapter, "Periodical Physics in Britain: Institutional and Industrial Contexts, 1870–1900", examines how in physics, perhaps surprisingly, the number of interested constituencies grew rapidly in the late nineteenth century, with the rise of industry, technical professions, and school science, so that, as in Csiszar's and Dawson's chapters, learned societies found themselves responding to commercial journals with different conceptions of what the science should look like. Without the same industrial and technical applications, astronomy was much closer to natural history in attracting amateur practitioners from across the social spectrum, albeit that their exclusion from the increasingly mathematical professional forms of the science gave a distinctive role to the new astronomical journals established toward the end of the nineteenth century. In "Late Victorian Astronomical Society Journals: Creating Scientific Communities on Paper", Bernard Lightman surveys a series of society-based astronomical periodicals appealing to amateurs that, in the 1880s and 1890s, helped to motivate and manage a large and various community of observers.

The rich sense of the diverse visions and practices of communities engaged in the sciences that comes from the first two sections is echoed in a distinctive way in the final section of the volume, *Managing the Boundaries of Medicine*, which focuses on medical periodicals. Unlike the natural sciences, medicine had a distinct and increasingly consolidated professional community in nineteenth-century Britain, and, as was discussed earlier, previous histories have often emphasized the role of journals in the emergence of intra-professional specialisms. At the same time, however, new periodicals became pivotal in developing and managing larger communities of practice, as the two chapters in this section both show. In "'A Borderland in Ethics': Medical Journals, the Public and the Medical Profession" Sally Frampton examines how a range of new journals in the 1880s enabled different groups of people other than medical professionals to participate in debates over healthcare. Sally Shuttleworth's chapter, "'National Health is National Wealth': Publics, Professions, and the Rise of the Public Health Journal", shows how, in the increasingly important field of sanitary science, periodicals were central to the organization of groups involved in campaigning and in gathering information about public health, communicating sanitary science to their audiences and encouraging citizens to self-manage their health and the health of their communities.

As Shuttleworth suggests in her chapter, the communities of active and committed participants cultivated by public health periodicals in the late nineteenth century helped lay the foundations for the environmental campaigning of the present day. Such modern campaigning is often facilitated by the internet and associated digital technologies, which, as with the nineteenth-century information revolution inaugurated by steam-powered machine printing and new methods of stereotyping and distribution, have helped create distributed communities interested in and engaged with the sciences extending far beyond the confines of the academy. In their analysis of the ways in which print and its associated technologies fostered the development and operation of communities of scientific practice, the chapters in *Science Periodicals in Nineteenth-Century Britain* thus together shed important new light on a theme that is of enduring significance. For, as we have seen above, the relations between print, technology and community are as significant for science in the digital age as they were two centuries ago.

List of Illustrations

ENDNOTES

[1] [John Claudius Loudon], [*Prospectus for the "Gardener's Magazine"*] ([London: Longman, Hurst, Rees, Orme, Brown and Green, 1826]), 2–3. There is a copy of the prospectus, annotated with the March date, in the John Johnson Collection, Bodleian Library, Oxford.

[2] Alex Csiszar, "How Lives became Lists and Scientific Papers became Data: Cataloguing Authorship during the Nineteenth Century", *British Journal for the History of Science* 50 (2017), 23–60, on p. 23. See also, e.g., James A. Secord, "Science, Technology, and Mathematics," in *The History of the Book in Britain*, vol. 6, *1830–1914*, ed. David McKitterick (Cambridge: Cambridge University Press, 2009), 443–74, Jonathan R. Topham, "Anthologizing the Book of Nature: The Circulation of Knowledge and the Origins of the Scientific Journal in Late Georgian Britain," in *The Circulation of Knowledge Between Britain, India and China: The Early-Modern World to the Twentieth Century*, ed. Bernard Lightman, Gordon McOuat, and Larry Stewart (Leiden and Boston: Brill, 2013), 119–52, Melinda Baldwin, *Making "Nature": The History of a Scientific Journal* (Chicago: Chicago University Press, 2015), Aileen Fyfe, Julie McDougall-Waters, and Noah Moxham, "350 Years of Scientific Periodicals", *Notes and Records of the Royal Society* 69 (2015): 227–39, and Alex Csiszar, *The Scientific Journal: Authorship and the Politics of Knowledge in the Nineteenth Century* (Chicago: University of Chicago Press, 2018).

[3] Steven Shapin and Arnold Thackray, "Prosopography as a Research Tool in History of Science: The British Scientific Community 1700–1900," *History of Science* 12 (1974): 1–28, Anne Secord, "Science in the Pub: Artisan Botanists in Early Nineteenth-century Lancashire', *History of Science* 32 (1994): 269–315, Iwan Rhys Morus, *Frankenstein's Children: Electricity, Exhibition, and Experiment in Early-Nineteenth-Century London* (Princeton, N.J.: Princeton University Press, 1998), Alison Winter, "The Construction of Orthodoxies and Heterodoxies in the Early Victorian Life Sciences," in *Victorian Science in Context*, ed. Bernard Lightman (Chicago: University of Chicago Press, 1997), 24–50.

[4] See, e.g., James A. Secord, "Knowledge in Transit", *Isis* 95 (2004): 654–72, Jonathan R. Topham, "Rethinking the History of Science Popularization/Popular Science," in *Popularizing Science and Technology in the European Periphery, 1800–2000*, ed. Faidra Papanelopoulou, Agusti Nieto-Galan, and Enrique Perdiguero (Aldershot: Ashgate, 2009), 1–10; and Gowan Dawson, *Show Me the Bone: Reconstructing Prehistoric Monsters in Nineteenth-Century Britain and America* (Chicago: University of Chicago Press, 2016).

[5] See, e.g. Martin Rudwick, "Charles Darwin in London: The Integration of Public and Private Science", *Isis* 73 (1982): 186–206, on p. 191, and Anne Secord "Corresponding Interests: Artisans and Gentlemen in Nineteenth-Century Natural History," *British Journal for the History of Science* 27 (1994): 383–408.

[6] We owe this phrase to a classic article on periodical history, Michael Wolff, "Charting the Golden Stream: Thoughts on a Directory of Victorian Periodicals," *Victorian Periodicals Newsletter* 4 (1971): 23–38.

[7] For interesting discussions on the book in international perspective, see Michael Suarez and H. R. Woudhuysen, eds., *The Book: A Global History* (Oxford: Oxford University Press, 2013).

[8] See Martin Gierl, "The *Gelehrte Zeitung*: The Presentation of Knowledge, the Representation of Göttingen University, and the Praxis of Self-Reviews in the

Göttingische Gelehrte Anzeigen," *Archives internationales d'histoire des sciences* 63 (2013): 321–41.

[9] See Simon Baatz, "'Squinting at Silliman': Scientific Periodicals in the Early American Republic, 1810–1833," *Isis* 82 (1991): 223–44.

[10] See, for instance, Csiszar, *Scientific Journal*.

[11] Cameron Neylon, "Communities Need Journals," *Notes and Records of the Royal Society* 70 (2016): 383–85. See also Jason Potts, John Hartley, Lucy Montgomery, Cameron Neylon, and Ellie Rennie "A Journal is a Club: A New Economic Model for Scholarly Publishing," *Prometheus* 35 (2017): 75–92. Neylon's paper appears in a special issue of *Notes and Records* entitled "Science Periodicals in the Nineteenth and Twenty-First Centuries" and based on papers delivered at the symposium "The End of the Scientific Journal? Transformations in Publishing," which took place at the Royal Society on 27 November 2015. See especially the editorial, Sally Shuttleworth and Berris Charnley, "Science Periodicals in the Nineteenth and Twenty-First Centuries," *Notes and Records of the Royal Society* 70 (2016): 297–304.

[12] Walter Houghton et al., eds., *The Wellesley Index to Victorian Periodicals*, 1824–1900 (Toronto: University of Toronto Press, 1966–85), Michael Wolff, John S. North and Dorothy Deering, *The Waterloo Directory of Victorian Periodicals, 1824–1900*, Phase I (Waterloo, Ontario: University of Waterloo, [1970]); John S. North, ed., *The Waterloo Directory of Irish Newspapers and Periodicals, 1800–1900* (Waterloo, Ontario: North Waterloo Academic Press, 1986), idem., *The Waterloo Directory of Scottish Newspapers and Periodicals, 1800–1900*, 2 vols (Waterloo, Ontario: North Waterloo Academic Press, 1989), and idem., *The Waterloo Directory of English Newspapers and Periodicals, 1800–1900*, Series 2, 50 vols, (1994–). For the early literature in the field, see William S. Ward, *British Periodicals and Newspapers, 1789–1832: A Bibliography of Secondary Sources* (Lexington: University Press of Kentucky, 1973), Lionel Madden, *The Nineteenth-Century Periodical Press in Britain: A Bibliography of Modern Studies 1901–1971* (New York and London: Garland, 1976), Larry K. Uffelman, *The Nineteenth-Century Periodical Press in Britain: A Bibliography of Modern Studies, 1972–1987* (Edwardsville: Southern Illinois University, 1992), J. Don Vann and Rosemary T. VanArsdel, eds., *Victorian Periodicals: A Guide to Research*, 2 vols (New York: Modern Language Association of America, 1978–89), and J. Don Vann and Rosemary T. VanArsdel, eds., *Victorian Periodicals and Victorian Society* (Toronto: University of Toronto Press [1994]). More recent surveys include Laurel Brake and Marysa Demoor, eds., *Dictionary of Nineteenth-Century Journalism in Great Britain and Ireland* (Gent: Academia Press and London: British Library, 2009), and Andrew King, Alexis Easley, and John Morton, eds., *The Routledge Handbook to Nineteenth-Century British Periodicals and Newspapers* (London and New York: Routledge, 2016).

[13] Various attempts had been made to list and enumerate nineteenth-century scientific and medical journals. See, for instance, Samuel H. Scudder, *Catalogue of Scientific Serials of All Countries Including the Transactions of Learned Societies in the Natural, Physical and Mathematical Sciences, 1633–1876*, reprint (New York: Kraus Reprint Corp., 1965 [1879]), Henry Carrington Bolton, *A Catalogue of Scientific and Technical Periodicals, 1665–1895, Together with Chronological Tables and a Library Check-List*, 2nd ed. (Washington: Smithsonian Institution, 1897), and William R. LeFanu, *British Periodicals of Medicine: A Chronological List, 1640–1899*, revised edn., ed. Jean Loudon (Oxford: Wellcome Unit for the History of Medicine, 1984). An important early application of bibliometrics to scientific periodicals is found in Derek J. de Solla Price, *Little Science,*

Big Science (New York & London: Columbia University Press, 1963). A number of in-house histories had been produced by journals and societies. See, for example, Robert J. Rowlette, *The Medical Press and Circular, 1839–1939: A Hundred Years in the Life of a Medical Journal* (London: [The Medical Press and Circular], 1939), R. Fish, "The Library and Scientific Publications of the Zoological Society of London", in *The Zoological Society of London, 1826–1976 and Beyond*, ed. Solly Zuckermann (London: Academic Press, 1976), 233–52, and *"The Economist", 1843–1943: A Centenary Volume* (London: Oxford University Press, 1943). One notable early study of the functioning of a scientific periodical was S. Lilley, "'Nicholson's Journal', 1797–1813", *Annals of Science* 6 (1948–50): 78–101.

[14] See, for instance, the essays by Manten, Meadows, Shaw, and Katzen in A. J. Meadows, ed., *The Development of Science Publishing in Europe* (Amsterdam: Elsevier, 1980), R. M. Gascoigne, *A Historical Catalogue of Scientific Periodicals, 1665–1900: With a Survey of their Development* (New York: Garland, 1985), and Bruce M. Manzer *The Abstract Journal, 1792–1920: Origin, Development and Diffusion* (Metuchen, N.J.: Scarecrow Press, 1977).

[15] Roy MacLeod, et al., 'Centenary Supplement', *Nature* 224 (1969), 417–76, A. J. Meadows, *Science and Controversy: A Biography of Sir Norman Lockyer, Founder of "Nature"* (London and Basingstoke: Macmillan, 1972) and *Communication in Science* (London: Butterworths, 1974), ch. 3, W. H. Brock, "The Development of Commercial Science Journals in Victorian Britain", in Meadows, *Development of Science Publishing*, 95–122, W. H. Brock and A. J. Meadows, *The Lamp of Learning: Taylor & Francis and the Development of Science Publishing*, 2nd edn (London: Taylor and Francis, 1998 [1984]), and W. H. Brock, "Brewster as a Scientific Journalist," in *Martyr of Science: Sir David Brewster, 1781–1868*, ed. A. D Morrison-Low and J. R. R. Christie (Edinburgh: Royal Scottish Museum, 1984), 37–42.

[16] Brock and Meadows, *Lamp of Learning*, xii, quoted from Susan Sheets-Pyenson, "Popular Science Periodicals in Paris and London: The Emergence of a Low Scientific Culture, 1820–1875," *Annals of Science* 42 (1985): 549–72, on p. 549. See the commentary on Brock and Meadows' contribution in Jonathan R. Topham, "Technicians of Print and the Making of Natural Knowledge," *Studies in History and Philosophy of Science* 35 (2004): 391–400.

[17] Susan Sheets-Pyenson, "A Measure of Success: The Publication of Natural History Journals in Early Victorian Britain", *Publishing History* 9 (1981), 21–36, and "From the North to Red Lion Court: The Creation and Early Years of the Annals of Natural History," *Archives of Natural History* 10 (1981), 221–49.

[18] David E. Allen, "The Struggle for Specialist Journals: Natural History in the British Periodicals Market in the First Half of the Nineteenth Century," *Archives of Natural History* 23 (1996), 107–23. See also Ray Desmond, "Loudon and Nineteenth-Century Horticultural Journalism", in *John Claudius Loudon and the Early Nineteenth Century in Great Britain,* ed. Elisabeth B. MacDougall (Washington, D.C.: Dumbarton Oaks Trustees for Harvard University, 1980), 77–97 and Sarah Dewis, *The Loudons and the Gardening Press: A Victorian Cultural Industry* (Farnham: Ashgate, 2014).

[19] W. F. Bynum, S. Lock, and R. Porter, eds, *Medical Journals and Medical Knowledge: Historical Essays*, (London and New York: Routledge, 1992), and P. W. J. Bartrip, *Mirror of Medicine: A History of the "British Medical Journal"* (Oxford: British Medical Journal and Clarendon Press, 1990).

[20] Bynum, Lock and Porter, *Medical Journals*, 2.

[21] Robert M. Young, 'Natural Theology, Victorian Periodicals, and the Fragmentation of a Common Context', in *Darwin's Metaphor: Nature's Place in Victorian Culture*, (Cambridge: Cambridge University Press, 1985), 126–63, on pp. 155–56. For a critique of Young's claims, see Geoffrey Cantor et al., *Science in the Nineteenth-Century Periodical: Reading the Magazine of Nature* (Cambridge: Cambridge University Press, 2004), Introduction.

[22] Charles Bazerman, *Shaping Written Knowledge: The Genre and Activity of the Experimental Article in Science* (Madison: University of Wisconsin Press, 1988), Dwight Atkinson, *Scientific Discourse in Sociohistorical Context: The "Philosophical Transactions of the Royal Society of London", 1675–1975* (London: Routledge, 1998), and Alan G. Gross, Joseph E. Harmon, and Michael S. Reidy, *Communicating Science: The Scientific Article from the Seventeenth Century to the Present* (New York: Oxford University Press, 2002). For critical perspectives on the genre of the scientific article see, e.g., Csiszar, *Scientific Journal*, and Thomas Broman, "J. C. Reil and the 'Journalization' of Physiology", in *The Literary Structure of Scientific Argument: Historical Studies*, ed. Peter Dear (Philadelphia: University of Pennsylvania Press, 1991), 13–42.

[23] Sheets-Pyenson, "Popular Science Periodicals," 551, 554.

[24] Sheets-Pyenson, "Darwin's Data: His Reading of Natural History Journals, 1837–1842," *Journal of the History of Biology* 14 (1981): 231–48.

[25] Sheets-Pyenson, "Popular Science Periodicals," 555; see also Ruth Barton, "Just Before *Nature*: The Purposes of Science and the Purposes of Popularization in some English Popular Science Journals of the 1860s," *Annals of Science* 55 (1998): 1–33.

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[49] Csiszar, "How Lives became Lists", 58. See also Csiszar, *Scientific Journal*, and Moxham and Fyfe, "The Royal Society".

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