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Scientific Publishing and the Reading of Science in Nineteenth-Century Britain: A Historiographical Survey and Guide to Sources

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> Claims to knowledge become accepted insofar as they are embodied in effective acts of communication. And the persuasiveness of particular claims is not simply a result of what was said, but also of how it was said, where, and by whom.
>
> Jan Golinski, *Science as Public Culture*[1]

> Great have been the recent revolutions in the book trade. Cheapness, combined with elegance, is the universal order of the day, and historians, poets, novelists, who used to come out in two guinea quartos, or fifteen shilling octavos, or even twelve shilling duodecimos, are now compressed into little five shilling volumes, each of which often contains nearly twice as much as was formerly sold for the same sum.
>
> *Congregational Magazine* (1837)[2]

It is now generally accepted that both the conception and practices of natural enquiry in the Western tradition underwent a series of profound developments in the late eighteenth and early nineteenth century—developments which have been variously characterized as a 'second scientific revolution' and, much more tellingly, as the 'invention of science'.[3] As several authors have argued, moreover, a crucial aspect of this change consisted in the distinctive audience relations of the new sciences. While eighteenth-century natural philosophy was distinguished by an audience relation in which, as William Whewell put it, 'a large and popular circle of spectators and amateurs [felt] themselves nearly upon a level, in the value of their trials and speculations, with more profound thinkers', the science which was

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[1]Golinski (1992), p. 3.

[2][Anon] (1837), p. 33.

[3]On the 'second scientific revolution' see Cohen (1985), pp. 91–101. For the 'invention of science' see Schaffer (1986), Cunningham (1988) and Cunningham and Williams (1993). On the changes in natural enquiry in this period see also Foucault (1974).

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invented in the late eighteenth and early nineteenth century was, as Simon Schaffer has argued, marked by the 'emergence of disciplined, trained cadres of research scientists' clearly distinguished from a wider, exoteric public.[4] Similarly, Jan Golinski argues that the 'emergence of new instrumentation and a more consolidated social structure for the specialist community' for early nineteenth-century chemistry was intimately connected with the transformation in the role of its public audience to a condition of relative passivity.[5] These moves were underpinned by crucial epistemological and rhetorical shifts—from a logic of discovery, theoretically open to all, to a more restrictive notion of discovery as the preserve of scientific 'genius', and from an open-ended philosophy of 'experience' to a far more restrictive notion of disciplined 'expertise'. Both of these moves were intended to do boundary work, restricting the community active in creating and validating scientific knowledge, and producing a passive public.[6]

Intimately connected with these changes was the creation of the familiar diffusionist notion of 'popularization' in which scientific ideas are viewed as being communicated in a basically linear process from the (expert) context of discovery and validation to the (lay) context of passive public consumption.[7] It is no coincidence that this sense of the verb 'to popularize' was developed in English at just the same time that the word 'scientist' was invented to describe the new experts who sought to develop such an audience relation.[8] Indeed, it is now increasingly recognized both that this notion of popularization was a crucial element in the self-fashioning of the emergent scientists of nineteenth-century Britain, and that it continues to do important work for present-day scientists.[9] Thus, while the diffusionist model is utterly inadequate as a characterization of the actual processes of scientific communication, its history is nevertheless central to an understanding of how such audience relations have been created and sustained, and should constitute a crucial element in the history of 'science', strictly defined. The diffusionist notion of 'popularization' has profitably become the *object* of historical study, while being rejected as a historiographical principle.

[4]Schaffer (1986), p. 407. The quotation is from Whewell (1857), vol. 3, p. 16. See also Schaffer (1983).

[5]Golinski (1992), p. 9.

[6]Schaffer (1986), pp. 406–13, and Golinski (1992), pp. 9–10 and 284–5. On the changed audience relations of the new sciences of this period, see also Secord (1985) and Yeo (1993), esp. pp. 32–8.

[7]I do not mean to imply that there has been a completely unitary and homogeneous notion of popularization within the science of the last two centuries, but merely certain common elements. On the changing nature and functions of the diffusionist notion see Whitley (1985) and Cooter and Pumfrey (1994), esp. p. 239.

[8]On 'popularization' see Green (1964), p. 33, and Williams (1988), pp. 236–8 on the changing meanings of 'popular' and 'the people' see Shiach (1989) and Joyce (1991). The earliest use of this sense of 'popularize' cited in the *OED* dates from 1836. On 'scientist' see Ross (1962).

[9]For recent valuable discussions of the uses of the 'diffusionist' model of popularisation see Hilgartner (1990), Whitley (1985) and Cooter and Pumfrey (1994). A detailed historical study of the word 'popularization', and of the associated diffusionist notion, would be extremely valuable. Its origins in nineteenth-century Britain are briefly discussed in Kitteringham (1981), pp. 1–10, and Hinton (1979), pp. 2–6.

Of course, attempts to create and maintain a large, passive, lay audience for esoterically validated scientific knowledge were by no means universal, nor were they either immediately or uniformly successful. To take only one example, Susan Sheets-Pyenson has argued that the popular science periodicals published in early nineteenth-century London embodied a form of 'low science' with an experiential, inductivist openness to non-expert involvement in science which was only gradually supplanted by a more closed form of 'popular science', intended to render audiences increasingly passive, in the second half of the century.[10] Indeed, the crucial question is how, among a plethora of competing views of the theory and practice of natural enquiry, the science which prevailed came to do so.

Yet, while historians have to some extent addressed the mechanisms by which a science characterized by the audience relations described here was created and maintained in early nineteenth-century Britain, it is striking that these transformations have not generally been related to another, equally revolutionary change which took place in the period—namely, the appearance for the first time of a mass medium of print. For it is clearly of considerable significance that the same period which witnessed the creation of specialist scientific disciplines, typified by trained cadres of 'experts' and increasingly arcane and technical vocabularies, also saw the potential readership for printed accounts of those sciences increase exponentially. While it goes without saying that print was far from being the sole medium (nor necessarily the most important) by which the new scientists sought to make their local knowledge into public knowledge, their achievement of cultural authority in the context of an ever more powerful popular press raises many important questions. As Roger Cooter and Steven Pumfrey put it: 'Since "popularizations" are communicative processes, their histories must attend to the history of communicative production.'[11]

One important area of interest concerns the involvement of the incipient scientists in managing the new print media to secure their ends, and there has been increasing historical interest in the rhetorical strategies by which practitioners sought to construct audiences and to make their science public. However, this work has tended to be carried out with little consideration either of the rapidly changing print culture through which such rhetoric was mediated to audiences, or of the nature of the new reading audiences themselves. This arguably testifies to the lingering presence in our historiography of one of the assumptions of the diffusionist model—that the communication of scientific ideas and practices operates (at least when successful) in an unmediated, unidirectional manner from the scientist to the lay public. However, as Roger Cooter and Stephen Pumfrey argued in an important recent article, the search for an alternative model by which to analyse the multidirectional, actively contested communication of scientific ideas and practices has

[10]Sheets-Pyenson (1985), pp. 547–55.
[11]Cooter and Pumfrey (1994), p. 239.

proved forbidding.[12] In this context we can benefit from the insights of the new history of the book, developed notably by Roger Chartier and Robert Darnton, which reinstates to active roles not only those involved in mediating authors' texts, but also those who read the texts thus mediated.[13] In particular, as I have argued elsewhere, Darnton's notion of a 'communication circuit' of print, in which 'messages' variously embodied in people and objects pass from authors and publishers through printers, 'shippers', booksellers and readers, and ultimately back to authors and publishers, provides a useful heuristic for exploring the multi-directional and actively contested nature of scientific communication by print.[14]

My object in this account is to discuss ways in which such an account could be developed in regard to science in early nineteenth-century Britain—identifying some of the historiographical issues, and outlining some of the available sources. This exercise seems doubly necessary. Firstly, while historians of Renaissance and early modern natural philosophy have over the last decade turned increasingly to the history of the book in dealing with the issue of scientific communication, the approach has yet to be applied to any great extent to the nineteenth century, notwithstanding the profoundly important conjunction of the invention of science and the development of a mass medium of print in this period.[15] Secondly, it is notable that nineteenth-century publishing and reading have been more generally bereft of historical attention than earlier periods, not least because scholars have understandably been daunted by the staggering increase in the scale of book production and consumption in the period.[16] Clearly, it would not be possible to provide a detailed analysis of what is a vast and largely unexplored territory within the confines of this account. Instead, my objective is to sketch out an agenda for further study, both within the history of science, and within book history.

1. The Readers for Science

> I am out of all patience with this march of mind. Here has my house been nearly burned down, by my cook taking it into her head to study hydrostatics, in a sixpenny tract, published by the Steam Intellect Society, and written by a learned friend who is for doing all the world's business as well as his own . . . My cook must read his

[12]Cooter and Pumfrey (1994).

[13]See Johns (1991), p. 8, and Johns (1998a).

[14]See Darnton (1990a), p. 111, and Topham (1998). Darnton's model purports at some level to present a 'life cycle' of the book, but he is quite clear that what is transmitted at most stages of the circuit is not the book as such, but variously embodied 'messages'. A more strictly book-centred approach is proposed in Adams and Barker (1993).

[15]This point is well made in the conclusion to Adrian Johns's magisterial *The Nature of the Book: Print and Knowledge in the Making* (Johns, 1998b), which appeared after this paper had been written.

[16]There has, however, been a growing interest in this area over the last few years, and a number of important studies have recently appeared. See Secord (2000) and Frasca-Spada and Jardine (2000), and the special section in the June 2000 issue of the *British Journal for the History of Science*, entitled 'Book History and the Sciences'.

> rubbish in bed; and as might naturally be expected, she dropped suddenly fast asleep, overturned the candle, and set the curtains in a blaze.
>
> Rev. Dr. Folliott in Thomas Love Peacock, *Crotchet Castle* (1831)[17]

In his model of the 'communication circuit' of print, Robert Darnton suggests that the reader 'completes the circuit because he influences the author both before and after the act of composition'.[18] Likewise, recent literature in the history of science has emphasized the extent to which the publics for science have sometimes had considerable impact on the scientists who sought to 'enrol' them, and ultimately on the nature of science itself.[19] These insights indicate both the value, and the legitimacy, of beginning our analysis with the readers of books on scientific subjects, rather than with the authors of such books. For, until the readers for science are brought into the foreground, and considered as actively engaging with what they read, the processes by which the authoritative audience relations of science were actually accomplished will not be adequately understood.

Clearly, one important element in attempting to understand these processes will always be a focus on the reception of those works of scientific exposition by which practitioners sought to enrol various publics. However, before such work can deliver the insights we require, it is necessary to gain an adequate understanding of the place of natural knowledge more generally in the diverse and fragmentary socio-cultural groups variously subjected to these self-conscious acts of popularization. As James Secord has argued, such an exercise must begin 'from the ground up, looking at the basic material products of cultural life', including those printed objects (books, periodicals and ephemera) relating to natural subjects.[20] Moreover, it must include not only objects which embody the science of the gentlemanly elite and such dissident sciences as phrenology, mesmerism and Scriptural geology, but also those embodying non-scientific and even anti-scientific approaches to nature—from astrological almanacs and herbals to books of Christian devotion. Thus, an important starting point is to attempt an assessment of which printed objects relating to natural subjects were actually read, and by whom.

1.1. Who read what, and where

Perhaps the most basic indicator of what was read is the pattern of production: what titles were produced, at what price, and in what quantities? The subsequent history of such publications—whether they were made available in libraries, read aloud in public houses, or allowed to moulder unread in aristocratic collections—is, of course, of considerable importance, but the basic production data nevertheless provide an important point of departure which has barely begun to be explored. It

[17]Peacock (1969), pp. 133–4.
[18]Darnton (1990a), p. 111.
[19]See Golinski (1990a), pp. 498–500, Whitley (1985) and Cooter and Pumfrey (1994), pp. 250–1.
[20]James Secord, 'Evolution for the people' (discussion paper), quoted in Cooter and Pumfrey (1994), p. 243.

has been bibliographers—more often librarians and collectors than historians—who have done most toward recording the output of books on different scientific subjects, and there exist many subject and individual bibliographies, which give some useful data, albeit of variable quality.[21] However, these sources rarely provide any assessment of the patterns and trends of the production of scientific books.[22] Moreover, they have a tendency toward a presentist focus on the 'great men' and 'great books' of science, at the expense of the many often very widely read books which subsequent history has obscured.[23]

The two most deliberate attempts to assess the patterns of production of publications on natural subjects in this period remain the unpublished doctoral theses of G. S. Kitteringham and D. A. Hinton, both of which are attempts to understand the place of science in 'popular culture' in early nineteenth-century England.[24] Lamenting the difficulty of establishing the actual views of those outside the gentlemanly elite, both authors focus primarily on communication media—books, periodicals, libraries, institutions and lectures—as being both determinants and indicators of what they call 'popular science'. Repudiating the diffusionist model of popularization, they are interested in establishing what was available to readers rather than in simply tracking the output of known gentlemanly popularizers. In particular, Kitteringham attempts to assess the prevalence of books by relying on contemporary trade lists like the *London Catalogue of Books*, rather than merely on the received canon of popular science books. As a result, his consideration of the books relating to nature which were available to working-class readers includes widely circulated chapbooks and almanacs in addition to the more familiar cheap publications of the Society for the Diffusion of Useful Knowledge.[25]

Of course, more recent work has exemplified radically new ways of exploring the place of natural knowledge in the lives of those outside the gentlemanly elite, and in this regard the work of Hinton and Kitteringham has been superseded.[26] Nevertheless, the kind of analysis of print media which they used, if developed in a rigorous manner, could still make an important contribution to an understanding of the actual experiences of contemporary readers. Moreover, while no attempt has

[21]Among the more valuable bibliographies are Freeman (1977, 1980), Cole (1988), Cooter (1989) and Wallis and Wallis (1977). Further references are given in Knight (1975).

[22]David Knight went some way toward providing an overview of patterns and trends in Knight (1972), but the intended audience and historical range of that work militated against systematic analysis, and only passing attention was given to the development of reading audiences. See also James (2000). For discussion of the changing pattern of book production in nineteenth-century natural history see Allen (1978), Barber (1980) and Merrill (1989).

[23]It is particularly striking that John Thornton's two standard works on scientific and medical books, even in their recently revised form, provide little more than annotated lists of books and authors retrospectively considered to have been important. See Thornton and Tully (1971, 1978), Thornton (1966) and Besson (1990). At the time of going to press, I have only been able to see one of the chapters from Hunter (2000), which is a marked improvement on its predecessors. See James (2000).

[24]See Kitteringham (1981) and Hinton (1979).

[25]See Kitteringham (1981), pp. 10, 20–22.

[26]See especially Secord (1994a).

been made within the history of science to advance such an analysis, developments in bibliography and book history are making it increasingly feasible. As recently as the early 1990s, when in my doctoral research on the *Bridgewater Treatises* I sought comparative data relating to edition sizes, book prices and the prevalence of different genres in the period, I had to rely on the brief account of the development of the mass medium of print given in Richard Altick's ground-breaking social history of the mass reading public, which, while more than thirty years old, was still the standard account of the changing patterns of production.[27] In the years since then, however, books historians have begun more determined efforts to assess the overall patterns of book production in the nineteenth century—attempts which have been given a tremendous fillip by the development of computerized bibliographical databases—and many potential avenues for research are beginning to emerge.

One of the most prominent scholars working in this field is Simon Eliot, who has applied the techniques of bibliometry to nineteenth-century publishing, showing how data from admittedly partial sources such as the *Publishers' Circular* and the British Museum copyright receipt books, can be used to assess the overall patterns and trends of book production. Eliot's more systematic analysis, while not fundamentally altering the overview given by Altick, is serving to flesh out a more detailed picture, not only of the headline patterns and trends of book production, but also of patterns and trends in the price structure of the book market and of subject publishing.[28] More recently, Eliot has been able to extend his analysis by using the CD-ROM edition of the *Nineteenth-Century Short Title Catalogue* (NSTC) which, despite its being a skewed sample, nonetheless provides an extremely important resource by which large-scale patterns and trends of book production can be assessed.[29] From the perspective of the history of science, Eliot's data on the subject trends in nineteenth-century publishing are particularly suggestive. The data are based on the NSTC's Dewey-decimal subject classification, which clearly imports anachronistic categories. However, while Eliot urges caution in using the results, these first approximations seem to indicate some highly significant publishing trends. Firstly, the NSTC-listed titles in the 'Pure Science' classes (500–599) show a marked proportional increase for the decade 1861–70 (5.10%) as compared with the decade 1801–10 (3.47%), one of only two subjects

[27]See Topham (1993), chapter 5, and Altick (1957), pp. 260–93.

[28]Eliot (1994a, 1995). See also Howsam (1992).

[29]Nineteenth Century Short Title Catalogue (1996). This union catalogue, begun in 1983, is intended to provide progressively more complete listings of all books published between 1801 and 1919 in Britain, its colonies and the U.S.A., together with any other books published in English or in translation from English. See Eliot (1997–8). As an indication of the relevance of such work to the history of science, it is worth noting that the fall in the number of medical periodical titles during the 1860s, identified as 'puzzling' by W. F. Bynum and Janice C. Wilson, coincides with a general plateauing in the total number of book titles in the same period. See Bynum and Wilson (1992), pp. 30–1.

to show such an increase.[30] Secondly, Eliot is able to break down the trends within the 'Pure Science' classes to show that there was a very marked increase over the same period in titles in the earth and life sciences (32.26% rising to 44.80%), relative to titles in the physical sciences (60.06% falling to 44.90%).[31]

Establishing such long-term trends is clearly of considerable importance to historians concerned with the place of science in British culture, and while such evidence requires careful handling, there will undoubtedly be growing dividends as the level of bibliographical control becomes ever greater. Indeed, literary historians are already demonstrating both the advantages and the practicality of reconstructing what James Raven describes as 'full publishing profiles'.[32] Raven argues persuasively that it is only by such means that the historian can avoid what he calls (following Darnton) 'cultropomorphic distortion', resulting from the reliance on a few canonical works as representative of the whole.[33] Raven thus bases his analysis of the literary assault on the newly wealthy in late eighteenth-century England on 'a continuing project to recover all fiction published and reprinted in Britain and Ireland from 1750 to 1800'.[34]

A similar approach to publications on natural subjects, though certainly daunting, would have radical implications for our understanding of what was available to readers, and ultimately of the place of science in the wider culture. Quite as much as in literary history, the history of science has been dominated by a canon of works which has distorted our view of the subject. The value of attempting to recover the vast body of forgotten books is clearly demonstrated by Peter and Ruth Wallis's project to 'list every book and article published in Britain or in English in the field of mathematics, and its applications', up to 1850.[35] On the appearance of the first part of their projected three-volume biobibliography in 1986, listing multiple editions and reprints of approximately 10,000 titles published between 1700 and 1760, the eminent Newton scholar D. T. Whiteside felt obliged, as one who had 'worked full time in the area for over thirty years', to 'say humbly that he ha[d] never even heard of the great majority of them'.[36] Moreover, as the Wallises' work amply demonstrates, many of the books which lie beyond the historical canon were circulated far more widely than those within. To take an example from the nineteenth century, the clerical author Ebenezer Cobham Brewer's *Guide to the Scientific Knowledge of Things Familiar* ([1841?]) is almost unknown within the history of science, yet an astonishing 113,000 copies were reported to have

[30]Eliot (1997–8), pp. 72, 80. For a similar use of the new bibliographical databases for the eighteenth century see Feather (1986). A rather more limited, but nonetheless interesting bibliometrical assessment of nineteenth-century science books is made in James (2000), pp. 259–62.
[31]Eliot (1997–8), pp. 84, 88–9.
[32]Raven (1992), p. 24.
[33]Raven (1992), p. 25.
[34]Raven (1992), p. 26. See also Raven (1987, 2000).
[35]See Wallis (1974), p. 449.
[36]Wallis and Wallis (1986) and Whiteside (1988), p. 306.

been printed by 1873, rising to 319,000 by 1905.[37] Such sales dwarf those of the 'great' books of nineteenth-century science, and while extensive circulation is by no means a reliable indicator of the importance of a book to its readers, it is only by recovering such works that the question of their significance can even be addressed.

In terms of outlining patterns of production, historians of nineteenth-century science have given much more attention to periodicals than they have to books.[38] One reason for this is undoubtedly that the problem of bibliographical control is far less complex with periodicals than it is with books: as Robert Gascoigne observes, it would be 'laborious', but not 'difficult' to compile a 'comprehensive list of [scientific] periodicals from 1665–1900'.[39] Moreover, the fact that journals played a particularly important role in defining reading audiences means that scholars working in this area have been concerned to relate the patterns of journal production to the emerging audiences with which they are associated.[40] However, much work still remains to be done in this area. One particularly striking omission is that the scientific content of the non-specialist reviews, magazines, and newspapers—which generally had much wider circulation than the specialist periodicals—until recently received almost no scholarly attention for this period.[41] An initiative to rectify this situation has recently been inaugurated at the Universities of Leeds and Sheffield, where the Science in the Nineteenth-Century Periodical (SciPer) Project, under the direction of Geoffrey Cantor and Sally Shuttleworth, is engaged in indexing and analysing the science content of nineteenth-century general periodicals.[42]

Of course, patterns of distribution were equally as important as patterns of production in determining what was available to readers. This was perhaps more than ever the case in early nineteenth-century Britain, when the growth of reading audiences combined with the continued high prices of books to make libraries and book clubs increasingly central to print culture.[43] Yet, with the exception of the studies of Hinton and Kitteringham, little work has been done to explore the preva-

[37]See Layton (1973), pp. 111–2, and Evans (1990), p. xvii.

[38]See, for instance, Meadows (1980), especially the essays by W. H. Brock and Jean G. Shaw, Sheets-Pyenson (1985), Gascoigne (1985), Bynum, Lock and Porter (1992) and Barton (1998). Important overviews of the literature on scientific and medical periodicals respectively are provided by W. H. Brock and M. Jeanne Peterson in Vann and Van Arsdel (1994).

[39]Gascoigne (1985), p. vii. The standard bibliographies of nineteenth-century scientific and medical periodicals remain Bolton (1897), Scudder (1965) and Lefanu (1984). For general periodicals see especially Wolff, North and Deering (1977), North (1986, 1989, 1997–), Sullivan (1983–4) and Altholz (1989).

[40]A notably successful use of early nineteenth-century medical periodicals in this way is found in Desmond (1989); see esp. pp. 13–16.

[41]Some consideration is given to this matter in Hinton (1979), pp. 266–340, and Kitteringham (1981), pp. 180–226. See also Cook (1976), and the use of religious periodicals in Morris (1976), ch. 7. For the later nineteenth century see, for instance, Ellegård (1990) and Broks (1996).

[42]See http://www.sciper.leeds.ac.uk.

[43]See Altick (1957), p. 260. On nineteenth-century library provision see especially Kelly (1966). A useful survey of library history literature and historiography is given in Black (1997).

lence of scientific books in contemporary libraries. Even the literary and philosophical societies and the mechanics' institutes, which have been a particular focus of scholarship in the history of science, have received strikingly little attention in regard to their library holdings.[44] Moreover, such libraries were far outnumbered both by commercial circulating libraries and by chapel libraries, which were frequented by large numbers of readers, and were clearly important determinants of reading in the early nineteenth century.[45] Other aspects of distribution are also relevant here, from the circulation of free religious literature, to the state of the second-hand book market, which was an important resource for many readers.[46]

So far I have discussed only the indirect evidence of who read what. Yet the mere production of vast numbers of copies of a book, or its appearance in many libraries, do not in themselves provide unequivocal evidence that the book was either widely read or particularly significant for its readers. Likewise, the appearance of a book in a style, and at a price, intended to make it appeal to one socio-economic class, does not in itself constitute reliable evidence of the book's actual readers. As Roger Chartier has argued, the 'fluid circulation' of books across social boundaries means that it is not possible to identify certain forms of literature with particular social groups in any decisive manner.[47] On the one hand, for instance, we find that the *Penny Magazine* of the Society for the Diffusion of Useful Knowledge and the *Saturday Magazine* of the Society for Promoting Christian Knowledge—both intended for working-class readers—constituted the 'chief reading' of the Darwin household in the months after their first production in 1832. Indeed, Susan Darwin told her brother that the *Penny Magazine* was the perfect vehicle for learning 'a little smattering' of geology.[48] On the other hand, the blacksmith's son Michael Faraday gained his first knowledge of chemistry from such fashionable fare as Jane Marcet's *Conversations on Chemistry* (1806, 14s.) and the *Encyclopaedia Britannica*—books encountered in the prosecution of his trade as an apprentice bookbinder.[49]

Given this disparity between production and consumption, the recovery of the often faint traces of individual reading habits is clearly an essential component of

[44]I give some consideration to the mechanics' institutes libraries in Topham (1992). See also Hinton (1979), pp. 221–65.

[45]See, for example, Topham (1993), which provides an account of the libraries in early nineteenth-century Leeds.

[46]A useful guide to the literature on retail bookselling, and on some other aspects of book distribution, is given in Kirsop (1998).

[47]Chartier (1989), p. 169. Chartier makes this point particularly in opposition to the older tradition in French cultural history, which relied heavily on indirect, sociometric evidence. On the dominance of exclusively sociometric analysis in the 'old' book history of the *Annales* school, and on the reconstitution of book history in the 1980s to include the 'internal' history of reading, see also Johns (1998a) and Darnton (1990b), pp. 158–63.

[48]Letters from Susan to Charles Darwin, 12–18 November 1832 and 3–6 March 1833, in Burkhardt *et al*. (1985–99), vol. 1, pp. 283–5 and 299–300, on pp. 284 and 299.

[49]Letter from Michael Faraday to A. de la Rive, 2 October 1858, in Williams (1971), vol. 2, pp. 913–4, on p. 914. Jonathan Rose (1992) presents some striking evidence of the use of the literature of 'high culture' by working-class readers in nineteenth-century Britain. See also Topham (1998).

any history of reading. Of course, such research is dauntingly time-consuming, and some historians appear doubtful of its practicability. Nevertheless, recent trends in scholarship are making evidence of individual acts of reading increasingly available. Research concerning loans from institutional libraries and the contents of private libraries has in the last few years been put on a surer footing by Robin Alston's compilation of a database of over 12,000 commercial and institutional libraries existing in the British Isles before 1850, together with information on several thousand private libraries and book owners.[50] Likewise the data from more than 1500 book subscription lists for the period 1680 to 1830 has now been collated and made electronically searchable.[51] Evidence of reading habits from more personal sources is also becoming increasingly accessible with the appearance of new editions of correspondence and with the production of bibliographies of autobiographies and diaries.[52] Indeed, such evidence is now being collected in a more concerted manner with the instigation of the Reading Experience Database (RED) at the Open University.[53] Historians have never been in a better position to identify the actual patterns of reading of historical actors, and it is only by reading the evidence of production and distribution in the light of this more direct evidence that an accurate picture can be obtained of who read what, and where.

1.2. How readers read, and why

Identifying who read what, and where, is clearly only a first step toward a history of reading: it is what Darnton calls the 'external history of reading'.[54] In addition, we obviously want to know how and why readers read what they read. Until recently, however, these questions have all too often been answered chiefly by reference to the text itself. Both in literary studies and more generally, the text's own self-definition, taken together with the textual strategies for enforcing a particular reading, have often been assumed to present an adequate account of its readers' motivations and experiences. Yet such an approach falls into what Jonathan Rose has called the 'receptive fallacy', in that it fails to acknowledge the agency of readers in subverting authorial intentions and textual strategies.[55] As I have argued elsewhere, the fact that a fashionable book of gentlemanly science like

[50]Alston's database is currently available at http://www.r-alston.co.uk/contents.htm. For references to private and public library catalogues see also Alston (1991), Pollard (1915) and Coral (1995). One of the most systematic and valuable studies of loans from an institutional library is Kaufman (1960). The Bristol Library Society's loan registers have survived for the years 1773–1857, and are now kept at Bristol Public Library. Another important library for which some loan registers have survived is the London Library. See Baker (1992). There is some discussion of other early nineteenth-century borrowing records in Topham (1993), ch. 5.

[51]*Biography Database* (1995). See also Robinson and Wallis (1975–81) and Alston, Robinson and Wadham (1983). Data from the former have been used extensively in Wallis and Wallis (1988, 1993).

[52]See, for example, Matthews (1955, 1950) and Burnett, Vincent and Mayall (1984–9). A particularly rich source for historians of science, which has been made available on microfiche, is Brock and MacLeod (1980).

[53]See Eliot (1994b, 1996).

[54]Darnton (1990b), p. 157.

[55]Rose (1992), p. 49.

William Buckland's *Bridgewater Treatise* could be read by atheist radicals as a source book for transmutation clearly indicates that a wider perspective needs to be taken.[56]

The last few years have seen the crystallization of an historical approach to reading which, while it acknowledges the relevance of more traditional theoretical approaches, seeks to relate such work to the actual practices and experiences of readers. In outlining what they consider to be the constituents of such a history of reading, Chartier and Darnton both suggest that evidence from textual analysis must be supplemented by two further sources of evidence.[57] First, they point to the evidence concerning what we might call the semiotics of the physical form of the book, arguing that the meanings encoded in the book as a physical object are sometimes quite as significant a determinant of reading experiences as the text itself. This insight comes in large measure from a chiefly Anglo-American tradition of 'analytical bibliography'—a field commonly defined as 'the study of books as material objects'—but in the context of the new book history it takes on a wider relevance. Secondly, Chartier and Darnton point to the historical evidence concerning the readers themselves and the reading practices in which they were engaged, which has been a primary focus of recent cultural history. Only by combining the evidence relating to texts with these additional sources of evidence relating to forms and readings, they argue, can a thoroughly *historical* history of reading be developed.

Inasmuch as historians of science have concerned themselves with the readers for science in early nineteenth-century Britain, they have, as we have already seen, generally done so by reference to the first type of evidence—the textual strategies of authors. However, even here it has only been relatively recently that historians have drawn significantly on literary theory in their textual analysis, and even then they have generally not drawn specifically on reading theory.[58] Such work has nevertheless demonstrated the enormous importance of textual analysis in the history of science. One particularly fruitful area of interest has been in the rhetorical nature of scientific writing—an interest which reflects a wider concern in the more sociologically informed literature to understand science as a rhetorical enterprise.[59] The textual strategies of popular science writing have also come under scrutiny—notably by Greg Myers, whose work demonstrates the manner in which the audience relations of science in nineteenth-century Britain became embodied in the very genres of scientific popularization.[60] Mary Fissell has recently gone further,

[56]See Topham (1998).

[57]See Chartier (1994), pp. 1–23, and Darnton (1990b).

[58]A useful introduction to reading theory is provided by Bennett (1995). One of the more significant applications of reading theory to the analysis of early nineteenth-century reading audiences is found in Klancher (1987).

[59]An overview of recent work is given in Golinski (1990b). Particularly notable examples are Shapin (1984a), Benjamin, Cantor and Christie (1986), Cantor (1989) and Dear (1991).

[60]Myers (1989, 1992, 1997) and Secord (1985). Also relevant in this context is Shapin and Barnes (1976).

seeking to use textual ('reader–response') analysis of a popular medical work, to elaborate a sophisticated historical account of the reading practices of its otherwise unreachable early modern readers.[61] However, as Fissell herself suggests, such textual evidence should ideally be augmented by the two other sources of evidence identified by Chartier and Darnton.

While historians of nineteenth-century science are increasingly aware that the physical form of books provides evidence not only of their intended audience, but also of their intended and actual meanings, we are still far from acquiring the highly developed sense which contemporary publishers and readers had of the meaning of the physical form of the book. The situation in early nineteenth-century Britain was more complex than ever before, as publishers increasingly sought to exploit different physical forms for different audiences, often, indeed, producing multiple editions of the same work to suit the pockets and tastes of different readers. It thus makes sense to think of the period as one in which new *formal* genres, as well as new literary genres, were developed. That these new formal genres created expectations and structured readings is obvious from contemporary accounts of reading experiences. As Leslie Howsam has recently shown, the 'familiar red covers' of the volumes of the International Scientific Series communicated to contemporary readers a sense of stability and quality somewhat independent of the actual text.[62] Yet historians of nineteenth-century science have rarely given any serious attention to the complex and changing semiotics of typography, paper, format or binding.[63] Indeed, the prevalence of library bindings, and more obviously of reprints, means that for many historians, the books they handle are in an important sense not the same books as those used by the historical actors. Just as literary theory provides the historian with the tools to understand the language of the text, so the historian must look to analytical bibliography in order to learn the 'language' of books, and thus to recover crucial aspects of historical reading experiences.[64]

Important as both the textual and formal strategies of authors and publishers were in structuring the experiences of readers, it is important not to underestimate the capacity of readers to misunderstand or subvert those strategies in producing meaning. This is not to imply that individual readers were wholly free agents. On the contrary, readers were not only greatly affected by the formal and textual strategies of the printed object, but they were also obviously constrained by the culture of the community to which they belonged. For this reason, it is necessary to read the vestiges of actual reading experiences which we find in diaries, autobiographies,

[61]Fissell (1992).
[62]Howsam (2000).
[63]Some attention is given to formal strategies in Topham (1998).
[64]The best introduction to the subject is Gaskell (1974). A ground-breaking application of bibliography to the history of reading is D. F. McKenzie's study of the effects of formal changes on the status and meaning of William Congreve's plays. See McKenzie (1981). McKenzie has been profoundly influential in the dialogue between traditional analytical bibliography and the new book history. See McKenzie (1985) and Johns (1998a), pp. 184–5.

letters and marginalia, in the light of an understanding of the concerns and the practices of the communities of readers to which their authors belonged. As Chartier explains, there is a 'paradox underlying any history of reading, which is that it must postulate the liberty of a practice that it can only grasp, massively, in its determinations'.[65] Thus, the full significance of the traces of individual reading only becomes apparent when examined in the light of the reading practices of that reader's community.

Communities of readers are distinguished by differences in reading ability, by differences in the 'norms and conventions that define the legitimate uses, ways to read, instruments and methods of interpretation', and by differences in their 'expectations and interests'.[66] The historical task, then, is to identify such differences by charting differences in educational provision, by analysing the different conceptions of reading conveyed by such guides to reading as conduct manuals, periodical reviews and sermons, by examining the different representations of reading in works of art and literature and in more personal sources like letters and autobiographies, and by considering the different spaces in which reading took place. Yet, while there is now a growing body of literature on the history of reading practices devoted to such a task, little work has been done in this area relating specifically to nineteenth-century science.[67]

The sources of evidence for reading practices which have undoubtedly received most attention from historians of science have been periodical reviews. In the early years of the nineteenth century, periodicals were an increasingly important source of advice on reading, informing readers not only about *what* but also about *how* they should read. Yet reviews have rarely been read with the practices of reading communities primarily in mind. Instead, they have generally been used—sometimes rather uncritically—as evidence for the views of certain well known 'opinion formers' who wrote such reviews. This is reflected in the typical focus on the heavyweight quarterlies and monthlies whose contributors are identified in the *Wellesley Index*, supplemented by the fashionable weeklies (the *Literary Gazette* and the *Athenæum*).[68] Nevertheless, important as such reviews undoubtedly are as indicators of individual reactions, they can also be profitably read from the point of view of their original readers. Of course, reviews were themselves subject to an active process of reading shaped by the practices of the reading community, and they must be read in that light. It is significant, however, that the vast growth both

[65]Chartier (1994), p. 23.

[66]Chartier (1994), p. 4.

[67]There are a number of excellent studies of the reading of science in earlier periods. See Sherman (1995, 1996), Johns (1996), Stewart (1996) and Walters (1997). Susan Sheets-Pyenson's pioneering study of Charles Darwin's reading of natural history periodicals does little to situate his practice in regard to a community of readers. See Sheets-Pyenson (1981a). On reading practices more generally in nineteenth-century Britain see especially Jordan and Patten (1995) and Vincent (1989).

[68]Houghton (1966–89); a CD-ROM edition was published by Routledge in 1999. The authors of reviews in the *Athenæum* can often be identified from the publisher's marked file of the journal at City University, London.

in the number and variety of periodicals in the early nineteenth century reflected a conscious move on the part of publishers to identify and codify distinct reading audiences who shared the editorial reading ideals. Moreover, this vast range of periodicals, largely unexplored by historians of science, provides important indications of the reasons why reading publications on nature seemed valuable to different reading audiences, and of the ways in which they might be read. Strikingly, for instance, the religious monthlies remain almost completely unexplored. Yet the *Wesleyan Methodist Magazine* alone reportedly sold 25,000 copies monthly in 1820—far more than either the *Edinburgh* or *Quarterly* reviews—and for many readers, these magazines provided extremely authoritative guidance both on what and how to read.[69]

Although reviews are to the historian the most obvious and accessible sources of guidance on reading, there were, of course, many others. Kate Flint, for instance, used evidence drawn from the many conduct manuals of the early nineteenth century in her study of *The Woman Reader*.[70] Other books of the period provided guidance on the choice of a library, ranging from Thomas Frognall Dibdin's *The Library Companion* (1824), designed for wealthy book-collectors, to B. F. Duppa's *Manual for Mechanics' Institutes* (1839).[71] Of course, not all sources of guidance were in published form. For many readers, sermons and lectures were crucial, as were more personal sources of advice such as conversations and letters. Indeed, it is striking how far reading remained embedded in oral culture, with a continuing emphasis on sociability. From pubs to book clubs, and from middle-class parlours to fashionable salons, talking about what one had read was an important part of social intercourse. Yet to fulfil these social functions, reading had to be practised in particular ways, and the varying, often tacit conventions of reading practice clearly generated different readings of the same physical objects. Reading itself was often oral—whether it was the radical artisan reading Cobbett's *Weekly Political Register* aloud at the pub, or the middle-class family reading together in the parlour.[72] Moreover, whether it was an oral or silent process, the *place* of reading was clearly important in shaping reading practices. Charles Dickens viewed the window tax as yet another of the 'taxes on knowledge' because it made reading so difficult in working-class and many lower middle-class homes.[73] Equally, should the artisan or shopman look to do his reading elsewhere, the differing conventions of Mechanics' Institutes, dissenting chapels and radical newspaper rooms each provided for radically different experiences of reading.[74]

Of course, another major determinant of reading practices was education, an

[69]Mineka (1944), p. 72.
[70]Flint (1993).
[71]On Duppa's *Manual* see Topham (1992), pp. 407–13.
[72]On the public reading of newspapers see Aspinall (1946), p. 38; on family reading see Davidoff and Hall (1994).
[73]Altick (1957), p. 92.
[74]See Vincent (1983), esp. p. 214.

area which saw huge transitions in early nineteenth-century Britain. Yet, while we know something about the way in which scientific reading was presented within the Broughamite context, and to some extent within the universities, we know next to nothing of many other contexts.[75] Particularly notable is our ignorance of the place of reading about nature in the elementary day and Sunday schools organized by such religious organizations as the British and Foreign School Society and the National Society for the Education of the Poor in the Principles of the Established Church in England and Wales.[76] Yet the education which they provided was the introduction to reading of a great part of the British population, and the reading habits they inculcated were pivotal to future reading experiences. Religious organisations were also, of course, responsible for flooding Britain with a tide of cheap, or even free, literature during this period. More generally, the great explosion in print culture clearly had a major impact on reading practices. It has even been suggested that a 'reading revolution' occurred at the end of the eighteenth century, in which readers, faced with the burgeoning production of printed matter, were increasingly unlikely to read and reread the same few items (intensive reading), instead reading large numbers of items, somewhat omnivorously, discarding them after use (extensive reading).[77] While it seems unlikely that the change was so unequivocal and universal as this implies, it is clear that reading practices did change radically with the burgeoning output.

The idea that the historian might be able to gain a fuller understanding of the experiences of early nineteenth-century readers of books on nature by combining evidence of the production, distribution and consumption of books with evidence relating to the textual and formal strategies of books, and to contemporary reading practices, has far-reaching consequences for the history of science. Firstly, it guides us away from the 'canon' of scientific works which embodies the agenda of contemporary scientists, and towards a more diverse body of literature reflecting widely differing and often conflicting views of nature. Secondly, it allows us to approach those books with a different set of questions. Instead of concerning ourselves primarily with the objectives and rhetoric of those who created the idea of the popularization of science, this approach provides us with an apparatus for reconstructing the mental worlds of those outside the scientific elite, and for analysing how such readers responded to the rhetoric of the new sciences. Such an approach thus problematizes the whole issue of popularization, making the audience relation which it presupposes a matter of historical contingency, and providing a means of analysing the contest for cultural authority which resulted in its achievement.

[75]On the intended role of scientific reading in the mechanics' institutes see especially Shapin and Barnes (1977). On scientific reading at the universities see especially Fyfe (1997).

[76]See Altick (1957), pp. 141–72, Layton (1973), Russell-Gebbett (1977) and Laqueur (1976).

[77]The general distinction was made independently by David Hall and Rolf Engelsing (for America and Germany respectively), although the terminology belongs to Engelsing. See Hall (1996) and (on Engelsing) Darnton (1990b), pp. 165–7.

2. The Publishers for Science

> The growth of knowledge is daily increasing in rapidity and strength. In this wonderful country, it is barely possible for those, who lead a quiet and uniform life far beyond the reach of the hum of our great Metropolis, to form a correct notion of the various channels by which knowledge is so swiftly and so widely diffused; and it is not the least instructive feature in the HISTORY OF BOOKS, to be appraised of the expenses incurred, and hazards run, in the establishment of a popular and useful work.
>
> Thomas Frognall Dibdin, *The Library Companion* (1825)[78]

In the previous section I laid considerable emphasis on the agency of readers both in choosing what to read and in the act of reading itself. Yet, as I have also emphasized, readers were unquestionably constrained in numerous ways, not least by the availability of certain kinds of books, and by the formal and textual strategies of those books. In both of these respects, readers were largely dependent on a commodity market controlled by some of the most powerful entrepreneurs of the industrial age—namely, the book trade. Indeed, as we shall see, it would be difficult to overestimate the importance of early nineteenth-century publishers as creative agents responsible for selecting and developing certain forms of scientific publication. Yet, while the romantic notion of the scientific 'genius' has been thoroughly deconstructed by historians of science, our historical narratives still arguably embody something of a legacy from the romantic notion of the scientific author as the key creative agent responsible for producing books that bear his or her name. It is only by reinstating the agency and creativity of those involved in the manufacture of books, that we can move beyond the rhetoric to understand the actual processes by which scientists and their audiences interacted.

2.1. Science and the book trade

The emergence over recent decades of the discipline of publishing history has gone some way towards rectifying our ignorance of the early nineteenth-century book trade. Yet, dominated as it is by literary historians still often greatly attached to a canon written by literary 'geniuses', publishing history has sometimes merely perpetuated the view of the publisher as a minor adjunct to the author. Moreover, there has been a tendency to shy away from the study of the commercial conditions and concerns of the literary marketplace as a whole, and to focus instead on the activities of certain publishers whose patronage of canonical authors marks them out as being of interest. Only in the last few years have attempts been made to provide a more wide-reaching analysis of the book trade in early nineteenth-century Britain, and much still remains to be done.

The book trade in the early nineteenth century was, of course, undergoing rapid and profound change. Most notably, the output of printed matter rose rapidly throughout the period, and in the second quarter of the century in particular there

[78]Dibdin (1825), vol. 1, pp. xi–xii.

was a revolutionary cheapening of books and periodicals to take in an ever wider range of potential readers. Given their tremendous importance for the history of science, the causes of these developments clearly require careful consideration. However, historians of science have tended to skirt around the question, often relating developments in an unduly determinist way to the emergence of new printing technologies, or viewing it as an inevitable consequence of the growth of literacy and the increasing cultural significance of print. While these were both clearly important causal factors, they must be understood as part of a more fundamental shift in the commercial organization and practices of the book trade.

This is not to deny that the mechanization of many aspects of book manufacture in the course of the early nineteenth century had far-reaching implications not only for pricing and edition sizes, but also for both the form and content of books. Take, for instance, one of the most ground-breaking publications of the first half of the nineteenth century—the *Penny Magazine* of the Society for the Diffusion of Useful Knowledge, which was published in eight-page weekly numbers from March 1832, and rapidly achieved previously unthinkable sales of over 200,000 copies. In the preface to the first volume of the magazine, its editor–publisher, Charles Knight, argued that such a work 'could not exist in its present state … except in a country where civilization is carried forward to very high degrees of perfection'.[79] This was so, he observed, not just because it presupposed a 'vast number' of readers, but because it was dependent on the mechanical contrivances of modern book manufacture, and on a reliable system of national transportation like that recently developed in Britain.[80] In substantiation of his claim, Knight issued, towards the end of the second volume, a series of supplements to the magazine under the title 'The Commercial History of a Penny Magazine', in which he reflected on the importance of the new technologies for his enterprise.[81] There was, the articles made clear, hardly any aspect of book manufacture that had remained unchanged in the preceding thirty years. The transformations had been fundamental—ranging from the introduction of bleaching and mechanization in paper manufacture, through the development of stereotyping and of printing machines, to the use of mass-produced cloth case bindings—and Knight demonstrated just how essential these changes in the processes of book manufacture had been in making commercially viable a work like the *Penny Magazine*.[82]

Clearly, then, an appreciation of the changing technologies of book production is essential in terms of understanding the conditions of existence of certain types of publication in the early nineteenth century. Indeed, this reiterates the importance

[79]Knight (1832), p. iii.

[80]Knight (1832), p. iv.

[81]Knight (1833). The articles have subsequently been reprinted in several forms, and are now available at http://english.cla.umn.edu/lkd/pm/CommHist.html. See Dickinson and Wadsworth (1997). For a modern introduction to the technology of early nineteenth-century book manufacture see Gaskell (1974), pp. 189–296.

[82]A helpful financial analysis of the publication of the *Penny Magazine* is provided in Bennett (1982).

of understanding the physical evidence embodied in scientific books that points to machine-made, rather than hand-made paper; stereotyped or machine-printed, rather than hand-composed or hand-printed text; and edition-bound, rather than individually bound volumes. Yet it is very easy to slip from this 'soft' form of technological determinism to a 'hard' form which make changes in print culture—particularly the rise of mass circulation publications—follow 'inexorably' from the development of paper-making machines, stereotype moulds, steam presses or binding cloth, as Lee Erickson sometimes does in his recent and controversial book, *The Economy of Literary Form*.[83] In this context, we should perhaps turn again to Charles Knight, who, notwithstanding his appreciation of the importance of the new technologies of manufacture in making new products possible, argued that their application to cheap publishing had been far from inevitable, but was crucially dependent on the actions of individual publishers.[84] Moreover, as John Feather points out, the development of these technologies was itself the result of commercial imperatives in the book trade: it was no coincidence that the mechanization of book manufacture began just as the demand for print was reaching unprecedented levels. While the kinds of products made possible by the technological innovations in turn served to generate further demand for print, this was part of what Feather calls a 'cycle of development', rather than a unidirectional causal chain.[85]

However, while technological change in book manufacture was clearly prompted by economic causes, the actions of publishers in developing and using particular technologies to specific ends cannot simply be considered as the necessary result of the operation of 'market forces'.[86] This kind of economic determinism is also found in Erickson's *Economy of Literary Form*, which presents an attempt to explain the prevalence of certain literary genres—specifically poetry, the periodical essay and the novel—in terms of their profitability within the prevailing market conditions. Erickson's approach has, indeed, much to commend it, for it serves both to mitigate the traditional overemphasis on the role of authors in determining what is published, and to grant some agency in the matter to readers. Yet he often implies that market forces necessarily called particular kinds of literary product into being without the mediation of publishers. Thus, he writes of literary forms as

[83]Erickson (1996), p. 19. For the distinction between 'soft' and 'hard' determinism see MacKenzie and Wajcman (1999), p. 4. There is, of course, a well developed body of scholarship relating to the introduction of moveable type in the West, which espouses a more or less 'hard' version of technological determinism, the best known example of which is Elizabeth Eisenstein's *Printing Press as an Agent of Change* (Eisenstein, 1979). On the technological revolution in book manufacture in the early nineteenth century see Sheets-Pyenson (1987). Sheets-Pyenson is careful to situate her analysis in the context of changes in publishing practices, rather than giving changes in technology causal primacy.

[84]See especially Knight (1854), pp. 238–59.

[85]Feather (1988), p. 130.

[86]On the failures of 'neoclassical' economics in accounting for technological change see MacKenzie and Wajcman (1999), p. 13.

'historical, aesthetic products of market forces reaching a momentary equilibrium between the aspirations of writers and the desires of their audiences'.[87]

Even a cursory glance at the development of publishing in the early nineteenth century, however, makes clear that, to a quite remarkable extent, the use of new technologies and the creation of new publishing genres was the result of historically contingent experiments by individual publishers. Indeed, as contemporary sources testify, publishers were reluctant to employ the new technologies in developing mass circulation books, relying instead on the traditional practice of producing small editions of books at high prices.[88] The book trade had long been known for its conservatism, and with elements of protection still in operation, change was far from inevitable.[89] In addition, the capacity of publishers to judge the changing state of the market was severely limited. Charles Knight, writing in 1854, clearly had in mind his losses on certain of the cheap publications of the SDUK when he reflected: 'The general cheapening of books must be gradual to be safe. The soundings of the perilous sea of publishing must be constantly taken. There is no chart for this navigation which exhibits all the sunken rocks and quicksands.'[90]

What is required, then, is an analysis which views the technical and socio-cultural changes of the period from within the commercial context of the book trade, and which takes seriously the practices and motivations (and even the ignorance) of the publishers, as well as the concerns of both authors and readers. While such an analysis has long been applied to earlier periods, it is only in the last few years that historians of publishing have made a concerted effort to develop such an analysis for nineteenth-century Britain.[91] Moreover, the difficulties experienced by Charles Knight and his contemporaries in charting the bookish ocean are as nothing to those experienced by the modern historian. For not only do we share their ignorance of the actual state of the market for print, but we are also ignorant of the tacit knowledge concerning the commercial practices of the trade that men like Knight took for granted. Publishers rarely left explicit accounts of their decision-making processes, and as historians we have to piece together the commercial practices of the trade from more indirect sources. We have to immerse ourselves in the world of share books and trade sales if we are to understand the tacit knowledge which enabled publishers to determine what they should publish and how, and which thus ultimately contributed substantially to the making of reading audiences in this period.

How, then, are we to proceed? In the first part of this paper I argued that pub-

[87]Erickson (1996), p. 8.
[88]Knight (1854). See also Altick (1957), pp. 260–93, which relies heavily on Knight's account.
[89]On publishers' protectionism in the early nineteenth century see Barnes (1964) and Fyfe (1999).
[90]Knight (1854), p. 267.
[91]The most helpful overview of the trade in the nineteenth century is Feather (1988), which provides a useful introduction to the more recent scholarship in this area. Marjorie Plant (1939) gives some consideration to the economic aspects of the early nineteenth-century book trade in her classic study *The English Book Trade*.

lishing profiles—recording on a large scale the patterns and trends of publishing output—provide valuable evidence regarding the reading matter available to readers. Ultimately, however, these profiles are a more accurate reflection of publishers' assessments of the market for books than they are of readers' desires, and as such they present an important starting point for understanding the commercial practices of early nineteenth-century publishing. Simon Eliot's work in this regard, while clearly (and explicitly) limited by the partial nature of the sources used, has nonetheless proved particularly illuminating. Thus, for instance, his analysis of the shifting price structure of British book publishing serves to flesh out the point made above concerning the cheapening of books, giving us the first tangible evidence that, at least on one sampling, the number of medium-priced titles (3s.7d.–10s.) overtook that of high-priced titles (>10s.) between 1825 and 1835, and that low-priced titles (<3s.7d.) first took the lead between 1845 and 1855.[92] Such evidence clearly provides a more systematic basis than that of contemporary anecdote for drawing conclusions about large-scale trends in nineteenth-century publishing. Moreover, Eliot and his collaborators have now moved on to the next phase of their project—a 'series of micro studies of production'—which promises further valuable evidence concerning publishing trends.[93]

While the construction and use of such publishing profiles is still in its infancy, it is already clear that they can provide very valuable data about the general patterns of decision-making within the trade. However, establishing the actual patterns of published output raises as much as it answers the question of *how* publishers went about deciding what to publish, and in what form.[94] In this context, James Raven's study of late eighteenth-century popular novels provides a useful exemplar of how evidence from publishing profiles can be combined with more direct evidence of the commercial practices of the book trade. In Raven's study, such evidence is drawn from a detailed study of the leading booksellers, from an assessment of the impact of crucial legal and commercial developments, and from a wider examination of the commodification of leisure in eighteenth-century Britain. Noting the 'virtual technological standstill in printing methods' in this period, Raven relates the large-scale changes in production revealed by his publishing profiles—most notably the very dramatic upturn in publication totals from about 1780—chiefly to the fundamental changes in the 'commercial orientation of the book trades' in the second half of the eighteenth century.[95] Although, as Raven observes, there is 'still no full study of the commercial development of the late eighteenth-century book trade', the transitions he describes are becoming increasingly well charted, and

[92]Eliot (1995), p. 39.
[93]Eliot (1997–8), p. 97.
[94]Even Richard Altick, who, in a useful paper, sought to assess the state of the mid-nineteenth-century book market, shied away from attempting to characterize the assessments of the market made by the publishers themselves. See Altick (1989).
[95]Raven (1992), p. 42.

since they provide the immediate background for the early nineteenth century trade they are worth briefly recounting here.[96]

The roots of the changes Raven describes lay in the middle years of the eighteenth century, when the commodification of middle-class leisure generated considerable demand for printed matter. The book trade developed new genres to exploit the emerging markets—most notably the novel and the magazine, but also including children's leisure books, and recreational books of natural philosophy and natural history[97]—and also developed an improved machinery for advertising and distributing books nationally. Nevertheless, the supply of books continued to be severely limited by the restrictive practices of the small coterie of leading booksellers who owned the bulk of copyrights. In an age increasingly convinced of the benefits and virtues of free trade, however, this virtual monopoly was undermined in 1774 by a crucial House of Lords ruling which denied the booksellers' long-standing claim that perpetual copyright was enshrined in common law.[98] Although the leading booksellers did what they could to protect their erstwhile monopoly, the issuing of cheap reprints of standard works, often in series, undermined their position, and contributed to a major upheaval in the book trade in which the prices of standard works plummeted, and the output of books radically increased.

The competitive commercial climate arising both from the growing demand for print and from the removal of perpetual copyright thus served to encourage booksellers to be innovative in seeking to exploit new markets. In particular, with their mainstay of relatively expensive editions of standard works removed, many booksellers sought to cultivate new works from which they could obtain the premium ensured by copyright protection. This resulted not only in the development of new publishing genres, like anthologies, but also in new departures in the physical format of books—notably a vogue for duodecimo 'pocket books'—and in their marketing and distribution. Where older booksellers showed resistance to change, there were plenty of new entrants to the trade who made fortunes by pursuing new avenues. However, with a steady move away from collaborative publishing, in which the heavy capital outlay was shared by a number of booksellers, the risks were high, and there were some spectacular failures. Indeed, many of the older booksellers foundered in the new competitive climate, and those who did survive into the nineteenth century, like Longmans and Rivingtons, did so by successfully catering for the new markets, and by transforming themselves from copy-holding retail booksellers, publishing chiefly in partnership, into publishers in the modern

[96]Raven (1992), p. 25. On the expansion of the book trade in the eighteenth century see also Feather (1988), pp. 67–125, Brewer (1997), pp. 125–97, and Raven (forthcoming).

[97]On the appearance of a new natural history genre see, for instance, Ritvo (1985) and Ritvo (1987), pp. 8–9. On the vogue for popular natural philosophical works see Rousseau (1982), Secord (1985) and Walters (1992), pp. 2–50.

[98]The ruling meant that new books could only obtain twenty-eight years' copyright protection at most, as directed by the 1710 copyright act, and a vast number of very valuable and hitherto private 'copies' thus became public property. See Feather (1988), pp. 67–83.

sense, acting largely independently and relying on specialized wholesalers and retailers to distribute their books. It is in the context of this increasingly competitive commercial climate that we must consider the activity of the publishers for science in early nineteenth-century Britain.

2.2. The publishers for science

In the book trade of early nineteenth-century Britain, then, publishers were more than ever before innovative entrepreneurs, intent on creating and exploiting new markets with an increasing range of literary products. Moreover, as several authors have demonstrated, it is no coincidence that the romantic notion of the author as creative genius was being formulated just at the moment when the publishers' creative control over the production of books was on the increase.[99] As I have already noted, literary historians have made much progress in addressing the creative role of publishers in the production of literature,[100] although much still remains to be done in regard to the publishers of popular literature, or of literature by authors not considered to be 'great'. Within the history of science, however, the agency of early nineteenth-century publishers has barely begun to be addressed, and many basic questions remain unanswered.

One important set of questions relates to the role commonly taken by the publisher as the chief architect of the book as a physical object. While a few authors took an active hand in such matters, most relied on their publishers at least to guide them, if not to be completely responsible for overseeing the manufacturing of the book. Roger Stoddard makes the point very strikingly when he states: 'Whatever they may do, authors do not write books. Books are not written at all. They are manufactured by scribes and other artisans, by mechanics and other engineers, and by printing presses and other machines.'[101] As I have already made clear, the physical nature of the book was critically important to the reading experience, both because of the implications for pricing and distribution, and because readers interpreted the semiotics of the book as well as the text. The rapid diversification in the physical forms of books and in the range of reading audiences during the first half of the nineteenth century if anything gave publishers an increased role in determining the cultural meaning of the books they produced.[102]

A more fundamental, although obviously related set of questions relates to the role of the publisher in determining what texts appeared in print. For, while private and subscription publication continued to be possibilities for authors whose manu-

[99]Some of the issues surrounding the rise of the author-genius are considered in Chartier (1994), pp. 25–59. See also Woodmansee (1984), Rose (1988, 1993) and Hesse (1990).

[100]Among more recent studies are Patten (1978) and Sutherland (1976, 1995).

[101]Stoddard (1987), p. 4.

[102]See, for example, Topham (1998). In his detailed study of the relations of authors with printers and publishers in the production of nineteenth-century books, Alan Dooley (1992) considers the extent to which changes in technology affected the control of leading authors over their texts, noting that in some ways it was increased through such innovations.

scripts were turned down by commercial publishers, the growing complexity of the book trade in the early nineteenth century made it progressively more necessary that a book should have the backing of a commercially motivated publisher if it were to succeed.[103] Denied effective access to the advertising and distribution machinery of the trade, authors generally needed a shrewd commercial assessment of their intended market in order to achieve any appreciable degree of success. Moreover, many of the more successful publishers were well ahead of their authors in determining what kinds of books were marketable in the changing conditions of the book trade, and they were quick not only to issue reprints of out-of-copyright works, but to commission authors to write new works, to translate foreign works, or to anthologize, edit or plagiarize existing works. Indeed, it was often the case that the publisher's role as literary entrepreneur effectively subsumed the role of the author: the hack writer writing on commission might easily find his or her activities utterly subservient to the editorial vision of the publisher.[104]

Such a state of affairs was perhaps most likely to prevail in the case of the most widely circulated books of all—such standard trade-books as primers, school books, cheap manuals, dictionaries and encyclopaedias. The point is well illustrated by James Secord's study of the *Newtonian System of Philosophy Adapted to the Capacities of Young Gentlemen and Ladies* (1761), a book issued anonymously by the pioneering publisher of children's literature John Newbery, which passed through many editions and became Newbery's best selling publication.[105] Newbery was almost the archetype of the new entrepreneurial publisher of the late eighteenth and early nineteenth centuries, and his success was in no small degree founded on his capacity to anticipate the products that might succeed in the changing market. In this sense, our continuing ignorance of the author of the *Newtonian System* is not the historical problem it might seem to be, for a publisher of Newbery's type employed hack writers to produce a specified product, and expected them to do so within strictly defined boundaries. Indeed, when the publishers Ogilvy and Sharpe published revised editions of the work between 1794 and 1812, the name of the writer employed in making what Secord reveals to have been quite extensive and significant revisions was also omitted from the title-page. In this case, then, it was not until 1827—when James Mitchell was identified as the editor of the cheap reprint publisher Thomas Tegg's new edition of the work—that any author's name appeared on a British edition. Such a publishing history strikingly illustrates the extent to which publishers, rather than authors, might be the primary determinants of widely distributed texts.[106]

[103]See, for example, Grant (1838), vol. 1, pp. 181ff. On the tradition of self-publishing in science see, for example, Noblett (1988).

[104]See Myers (1983) and Roldán-Vera (2000, forthcoming).

[105]Secord (1985).

[106]On two of the more important entrepreneurial publishers of the early nineteenth century, namely Richard Phillips and William Pinnock, see Issitt (1998, 2000) and Roldán-Vera (2000, forthcoming), respectively.

This emphasis on the critical creative role of publishers in the early nineteenth century is borne out by the small number of existing studies relating to early nineteenth-century science publishing. Susan Sheets-Pyenson, for instance, begins her excellent study of *The Naturalist's Library* (1833–43) by insisting that '[p]ublishers and printers merit attention not only because they acted as midwives in the creative process of bringing forth periodicals and books, but also because they made decisions about what forms of scientific literature could survive in the marketplace'.[107] They can, she claims, be seen as 'merchants or brokers in scientific ideas'. Sheets-Pyenson's study reveals that it was the Edinburgh printer and engraver William Home Lizars who was the originator of the *Naturalist's Library*, and the key agent behind its production. Sir William Jardine, whose name is most commonly associated with the venture, was brought in by Lizars as his collaborator; but it was Lizars who masterminded what was a daring experiment in adapting the new technologies and practices of book production to create a new kind of literary product, and it was his astute publishing strategy which was chiefly responsible for the success of the series—the more so as it came into competition with imitators.

The often critical role of entrepreneurial publishers in scientific publishing also emerges in Sheets-Pyenson's work on the publication of early nineteenth-century scientific periodicals.[108] This is the area of scientific publishing on which most scholarly attention has been focused. Indeed, the only scientific publisher of the early nineteenth century to receive extensive historical treatment is Richard Taylor, whose activity as a publisher (rather than as a printer) was chiefly confined to the several scientific periodicals which he issued, most notably the *Philosophical Magazine* and the *Annals and Magazine of Natural History*.[109] As W. H. Brock and A. J. Meadows show, Taylor and his illegitimate son William Francis were primarily responsible for developing these best known of Victorian science journals, cultivating their own scientific interests and their extensive scientific acquaintance in the process. Nor were they untypical in this. Brock observes that of the 535 British science periodicals listed in the *Waterloo Directory of Victorian Periodicals*, sixty-four percent were issued commercially, rather than by scientific or learned societies, and not a few were begun by publishers with at least one eye to profit.[110] Nevertheless, only a handful of these commercial speculators have received historical attention, and much work remains to be done.[111]

While science journals were clearly of considerable importance in the early nineteenth century, it is striking that with very few exceptions, the publishers respon-

[107]Sheets-Pyenson (1981b), p. 51. On the publishers behind some of the other new serialized 'libraries' of the late 1820s and early 1830s, see Peckham (1951) and Bennett (1976).

[108]Sheets-Pyenson (1981c, 1982, 1985). See also Allen (1996).

[109]Brock and Meadows (1998), esp. pp. 89–145.

[110]Brock (1980), p. 95.

[111]Although beyond the chronological scope of this paper, Roy M. MacLeod's historical contribution to the centenary number of *Nature* deserves particular mention in this context, because of his account of Alexander Macmillan's central role in the project. See MacLeod (1969).

sible for the vast output of books on scientific subjects have received no attention from historians of science.[112] Indeed, beyond a few well-known names of those responsible for publishing some of the 'great' books of early nineteenth-century science—perhaps most notably John Murray who published for both Lyell and Darwin[113]—it would be difficult even to identify the leading publishers of early nineteenth-century science books. A brief examination of the imprints of books listed in the *English Catalogue of Books* for 1837 provides a striking demonstration of this (see Table 1). The figures must be treated with caution, since the sample is skewed in several different ways. Most obviously, it is a catalogue of books published in London, and thus significantly excludes important publishers in Glasgow and Edinburgh, like William Collins and W. & R. Chambers. In addition, the *Publishers' Circular*, from which the data are drawn, did not provide either a full or a representative sample of publications.[114] Yet, even with these caveats, the analysis reveals some interesting features. Firstly, it is notable that of the eleven publishers responsible for over two-thirds of the 413 books on scientific subjects listed, not one has been the subject of extensive consideration within the history of science. Indeed, almost half the number (Samuel Highley, Simpkin, Marshall & Co., W. S. Orr & Co., James Ridgway, and Hippolyte Baillière) are not even included in the *DNB*.[115] Secondly, and perhaps more startling, is that almost one third of the books listed were published by Longman & Co. Of course, Longmans were dominant in the trade as a whole, with approximately 13% of titles listed, but it is clear that the dominance of Longmans in regard to scientific subjects was on a different scale.[116] Even allowing for sampling error, this dominance strikingly illustrates the extent to which the decision-making processes of certain of the publishing entrepreneurs of the period could have large-scale effects on the place of science in the prevailing culture. What such effects might have been is, of course, a question which awaits further study.

Perhaps contrary to expectations, the published and manuscript resources available for research relating to early nineteenth-century publishers are very extensive. In addition to contemporary accounts and reminiscences,[117] there is a growing col-

[112]The chapter on 'Scientific publishing and bookselling' in Thornton and Tully (1971), which runs to only thirteen pages in total, mentions only four science publishers for early nineteenth-century Britain: Longman, Murray, Taylor & Francis, and Macmillan. One particularly valuable study for the later nineteenth century is MacLeod (1980).

[113]On Murray see Smiles (1891) and Paston (1932).

[114]See Eliot and Sutherland (1989).

[115]Simpkin, Marshall & Co. receive attention in Bracken and Silver (1995). Orr, Ridgeway, and Baillière appear in Boase (1892–1921).

[116]On Longmans see Briggs (1974) and Cox and Chandler (1924).

[117]See, for example, Curwen (1873), Rees (1896), Marston (1904), esp. pp. 323–30, and Knight (1864–5).

Table 1 Imprints of books on scientific subjects from the English Catalogue of Books, *September 1837 to December 1838*

Publisher	Medicine & surgery		Natural history, botany, agriculture, &c.		Science, including metaphysics, physics, &c.		Total	
Longman & Co.	60	42.0%	53	36.6%	19	15.2%	132	32.0%
Samuel Highley	21	14.7%	5	3.4%	0	0.0%	26	6.3%
John Murray	2	1.4%	5	3.4%	13	10.4%	20	4.8%
Simpkin, Marshall & Co.	3	2.1%	2	1.4%	13	10.4%	18	4.4%
J. W. Parker	0	0.0%	5	3.4%	11	8.8%	16	3.9%
W. S. Orr & Co.	0	0.0%	9	6.2%	5	4.0%	14	3.4%
G. B. Whittaker & Co.	5	3.5%	2	1.4%	5	4.0%	12	2.9%
James Ridgway	0	0.0%	11	7.6%	0	0.0%	11	2.7%
John Van Voorst	0	0.0%	11	7.6%	0	0.0%	11	2.7%
John Churchill	9	6.3%	1	0.7%	0	0.0%	10	2.4%
Hippolyte Baillière	7	4.9%	1	0.7%	2	1.6%	10	2.4%
Others	36	25.2%	40	27.6%	57	45.6%	133	30.3%
Total	143	100%	145	100%	125	100%	413	100%

lection of reference works which provide important information,[118] and an invaluable finding guide to the extensive publishers' archives which exist.[119] Moreover, even without the aid of archival sources, much can still be learned about a publisher's activities from book trade sources and from bibliographical databases of the sorts discussed in this article. The problem has not been a shortage of sources, but a reluctance on the part of historians of science to allow publishers the historical significance which they undoubtedly have. Moreover, it is only as individual publishers become the subjects of historical study that we can hope to provide an assessment of the place of different kinds of science publishing in the book trade as a whole.[120] The evidence quoted above suggesting an increasing market share for books on natural subjects during the first part of the nineteenth century clearly raises an important question about the role of publishers in both reflecting and contributing to the increasing cultural authority of science.

Fully accepting the role of the book trade in creating the audience relations that are so distinctive of science has wide-reaching implications for the practice of history of science. Firstly, it contributes towards a de-centring of the leading practitioners of science, bringing into focus a far larger cast of characters on whom science depended. Thus, attention must now also be paid to the publishers, motivated by their own commercial and ideological concerns, who were chiefly responsible for devising new genres of scientific publication, and for developing and exploiting new reading audiences. Secondly, it places the development of science into its proper commercial context, serving to show that the success of science was dependent on successful marketing, as much as on successful rhetoric.

3. Scientific Authorship

> But a defence of popular science is not to be considered an argument for the mass of productions which go by that name... In nineteen cases out of twenty they are the work of persons who, having themselves learnt Natural Philosophy in six lessons, profess to teach it in half-a-dozen—who fill their small phials from another's bottle and adulterate what they steal—who render science easy by suppressing difficulties

[118]See, for example, Maxted (1977), Brown P. (1982), Todd (1972), the *Dictionary of Literary Biography*, esp. vols 106 (Anderson and Rose, 1991) and 154 (Bracken and Silver, 1995), Fraser (in press), and *ABHB: Annual Bibliography of the History of the Printed Book and Libraries*. A project to produce a comprehensive British Book Trade Index is ongoing under the direction of Peter Isaac of the University of Newcastle-upon-Tyne; it is ultimately intended to be published online. See also the Scottish Book Trade Index, which is available online at http://www.nls.ac.uk/catalogues/sbti/index.htm.

[119]Weedon and Bott (1996); a version of this list, together with lists of North American publishers' archives, is available at http://www.indiana.edu/~sharp. It is important to observe that the destruction of a publisher's archive can sometimes be compensated for by the existence of the relevant printer's archives.

[120]David Knight gives limited attention to the question in Knight (1980).

> instead of explaining them, and who keep to its shallows less from the fear of advancing beyond the pupil's depth than of being detected in wading out of their own.
>
> Whitwall Elwin, 'Popular science' (1849)[121]

I have left my discussion of the authors of scientific books until last partly because historians of science have often been concerned with authors almost to the exclusion of readers and publishers. However, approaching authors from the perspective of readers and publishers raises a whole range of questions which we have barely begun to address. For, it brings clearly into focus the fact that scientific authors were deeply embedded in a network of trade relationships which had substantial implications for the practice of authorship. This was more so in early nineteenth-century Britain than it had ever been before. The changes in the book trade which took place in the eighteenth century had served to establish for the first time a clearly defined profession of authorship, based increasingly on commercial payment, and becoming increasingly independent of the older traditions of patronage.[122] The continuing expansion of print culture in the early nineteenth century served only to increase the status and power of authors, as publishers vied for their services in creating new products. It is only by situating scientific authors and their writings within this context that we can fully explore their role in the making of science.

3.1. Authors for books on science

Thinking about scientific writing from the perspective of the emerging profession of authorship raises the important question of who was actually writing about science in early nineteenth-century Britain. Most of what has been written about scientific authors in this period has been written about scientific practitioners who for various reasons chose to write. However, only a little reflection reminds us that many of those who wrote on science were not scientific practitioners. The range of such individuals was considerable. They included hack writers, like those employed to prepare elementary and reference works, or the writers and compilers of the myriad 'improving' miscellanies which became increasingly popular from the 1820s. There were more fashionable authors employed to write science for the growing middle-class leisure market—a few well known to historians of science, like Mary Somerville and Jane Marcet, while many others remain obscure. There was also a growing band of reviewers—rarely practitioners of science—who were responsible for presenting synoptic reviews of new works on scientific subjects in the burgeoning weeklies and monthlies of the general and religious press. Increasingly, too, professional journalists came to report on science in the daily and, more particularly, the weekly press, especially after the activities of the British Association for the Advancement of Science achieved the status of news in the 1830s.

[121]Elwin (1849), p. 322.

[122]See Woodmansee (1984), Rose (1988), Hesse (1990), Brewer (1997), Collins (1928) and Bonham-Carter (1978).

The relevance of such authors to the history of science was noted many years ago by Steven Shapin and Arnold Thackray, who, in their classic article on prosopography, noted that only a 'very small proportion' of those who had published a scientific paper, book or pamphlet had hitherto concerned historians of science. Their conviction was that in seeking to identify the members of the scientific community in nineteenth-century Britain, we '*cannot* … start with names known to us through their science', but must first 'find out who published science, then assess the intellectual and cultural significance of their association with the enterprise of natural knowledge'.[123] Yet, notwithstanding an increasing number of studies of individual scientific authors, we still lack the prosopographical perspectives advocated by Shapin and Thackray. Indeed, this is not a problem peculiar to *scientific* authorship. More generally, despite a number of useful studies of nineteenth-century authorship, Richard Altick's analysis of the social origins, education and occupations of 1,100 nineteenth-century British writers remains the only significant attempt at a prosopographical study.[124] Until a more systematic survey of those involved in scientific authorship has been made, many questions will inevitably remain unanswered. One indication of how this might be achieved comes from the work of Peter and Ruth Wallis, whose biobibliography of eighteenth-century British mathematical authors includes extensive indexes of the places where authors lived or worked, their dedicatees, their occupations, and their educational institutions, together with indexes of printers and publishers and of the places of publication. Although the Wallises do not themselves carry through the prosopographical analysis which these indexes make possible, it is clear that such a study, based on their systematic bibliographical research, would yield remarkable insights into the nature of mathematical authorship in the period.[125]

Despite the lack of prosopographical perspectives, some headway in exploring the *dramatis personae* of nineteenth-century science writing is nevertheless being made. One particularly fruitful area has been the activity of women in scientific authorship. As Margaret Rossiter has pointed out, the recent attention focussed on the history of women in science has led to an increased interest in the history of scientific communication.[126] This interest has found expression in a growing number of case studies, which demonstrate not only that scientific authorship constituted an important and hitherto neglected form of women's participation in science, but, equally interesting, that women science writers were active interpreters of specialist knowledge, 'retelling the story of science' in discourses that were often different

[123]Shapin and Thackray (1974), p. 14.

[124]Altick (1962). A limited prosopographical analysis of 878 novelists is given in Sutherland (1995). Nigel Cross provides some very valuable data concerning nineteenth-century authors, drawn from the archive of the Royal Literary Fund, in Cross (1985). On authorship in the nineteenth century see also Collins (1928), Bonham-Carter (1978) and Gross (1991).

[125]Wallis and Wallis (1986). See also Fauvel (1989).

[126]Rossiter (1986).

from, or even counter to, those of the gentlemanly specialists.[127] Similar perspectives have also been developed in the well established field of 'literature and science', and there are now numerous valuable studies of the involvement of prominent literary authors in reformulating the discourse of science.[128] Yet, with a few exceptions, those working in this area have largely ignored the work of those writers on science who were not either well known literary authors or well known scientific practitioners.

There is, however, a growing recognition that the activities and concerns of a wider range of authors on scientific subjects need to be scrutinized, if the place of science in Victorian culture is to be more adequately understood. In particular, historians are increasingly aware of the importance of those historically invisible writers on science—professional writers, hacks, and journalists—who were responsible for many of the most widely circulated publications. Pointing out that '[p]rofessional scientists … account for only a small portion of the works of Victorian popularizers of science', Bernard Lightman argued in an important recent article that the non-professional scientific popularizers who wrote for a mass market in the late nineteenth century 'may have been more important than the Huxleys and Tyndalls in shaping the understanding of science in the minds of a reading public composed of children, teenagers, women and nonscientific males'.[129] Lightman himself provides a useful analysis of several late nineteenth-century authors of popular science books, demonstrating that their vision of science was by no means the same as that of the small coterie of scientific practitioners who form the chief focus of research, but he concludes by noting that we need 'to know far more about how science was popularized during the Victorian period in magazines, journals, textbooks, children's literature, encyclopaedias, and newspapers'.[130]

Of these more widely circulated publications, it is the authors, and more especially the editors, of popular scientific periodicals who have received most attention, with valuable studies by Susan Sheets-Pyenson and W. H. Brock.[131] By comparison, the authors and compilers of articles and reviews on scientific subjects in more general magazines and miscellanies have remained largely unknown. Yet, as we have seen, many of these publications had massive circulation figures, and their importance is difficult to overestimate. Indeed, while few would dispute the enormous significance of Robert Chambers's best known publication, his anonymous *Vestiges of the Natural History of Creation*, it is interesting to speculate whether his literary labours as editor for over a quarter century of *Chambers's*

[127]See Gates and Shteir (1997). See also Gates (1993), Shteir (1987, 1989–90, 1996, 1997) and Benjamin (1991).

[128]For an introduction to work in this field see Beer (1990), Schatzberg, Waite and Johnson (1987), and the bibliographical note to Paradis (1997), p. 171.

[129]Lightman (1997a), pp. 187, 188. See also Gates (1997).

[130]Lightman (1997a), p. 206. See also Lightman (1989, 1996, 1997b). Lightman's claim is taken up in Barton (1998).

[131]See, for example, Sheets-Pyenson (1985) and Brock (1980). See also Bynum and Wilson (1992) and other essays in that collection.

Edinburgh Journal did not ultimately have a greater impact on the scientific views of the Victorian reading public, more than 50,000 of whom regularly bought his journal.[132] Particularly illuminating in this regard has been Adrian Desmond's recent work on those radical artisans who engaged science in a propaganda war against religion in some of the more extreme working-class journals of the 1830s and 1840s. Yet, as Desmond himself observes, the work of the vast body of less extreme but more widely read radical journalists remains largely unconsidered.[133] More generally, the development in the early nineteenth century of scientific journalism—notably the reporting of scientific meetings and discoveries in the new weekly literary journals like the *Literary Gazette* and the *Athenaeum*—is an area where little work has yet been carried out, though its growing importance was obvious to contemporaries.[134]

In regard to the non-specialist authors of books on scientific subjects, one area which has received some attention relates to the authors of those books intended for fashionable, middle-class audiences.[135] Yet, important as these undoubtedly were, there is a pressing need to consider the authors of the often far more widely circulated books intended for increasingly large lower middle-class, working-class, and juvenile audiences. One such author, the Scottish schoolteacher and widely read scientific writer Thomas Dick, has been the subject of a recent study by W. J. Astore. Astore shows that the vision of science which Dick developed in his scientific works was profoundly shaped by a 'doxological' theology of nature distinctive of the evangelical culture to which he belonged. Strongly opposed to any separation of the practice of science from the practice of Christian piety, Dick was concerned to counteract what he considered to be a secularizing trend in contemporary gentlemanly science. Moreover, despite some censure of his more idiosyncratic views, Dick's works were widely recommended by the evangelical press, and in several cases achieved remarkable circulation figures.[136]

Rather more extreme is the case of Richard Phillips, the educational publisher and political radical who issued, and had a hand in writing or commissioning, many of the most successful elementary textbooks of the first half of the nineteenth century—books which sold in tens and even hundreds of thousands. What is striking, considering that many of these textbooks were on scientific subjects, is that Phillips was an outspoken critic of Newtonian physics, and published extensively on his own anti-Newtonian theory. Moreover, such views permeated at least some

[132]James Secord has used *Chambers's Edinburgh Journal* to chart the development of Chambers's views. See Secord (1989a). Two doctoral theses have examined the educational and improving literature issued by the Chambers brothers. See Cooney (1977) and Hutchinson (1980).

[133]Desmond (1987), p. 104. See also Topham (1993), ch. 7.

[134]Some consideration of this development is given in Ellegård (1990), pp. 62–94, Morrell and Thackray (1981), pp. 139–48, Orange (1975) and Secord (1989b).

[135]See, for example, Hays (1981), Patterson (1983) and Lindee (1991).

[136]The two parts of his *Solar System*, published in 1846 by the Religious Tract Society, had sold 30,510 and 26,890 by 1850. See Astore (1995), p. 194, and Astore (forthcoming). On Dick see also Smith (1983). On the popular science publishing of the Religious Tract Society see Fyfe (2000).

of his elementary works. His *Million of Facts* (1832), for instance, referred to gravity as a 'gratuitous hypothesis' and dismissed the gravitational theory of the tides as 'that credulous philosophy' which maintained 'the execrable gossip of the dark ages upon lunar attraction!'[137] While Phillips is undoubtedly a somewhat exceptional case, it is nonetheless clear that the authors of elementary or widely circulated scientific books in the period were very far from presenting a unified vision of science, and that a thorough going analysis of such non-specialist authors of widely distributed books would provide important new perspectives on the contested place of science in contemporary culture.

Moreover, while many early nineteenth-century authors agreed on the value of science—if diverging over the substance or meaning of its true doctrines and practices—there were clearly others who disregarded or disputed its objects and findings, in part or in whole. Viewed from the perspectives of both readers and publishers, many of these authors gain a significance which they have not hitherto been accorded. Those who compiled astrological or magical almanacs and chapbooks, for instance, like those who reworked pre-scientific herbals, or those who wrote the innumerable tracts and books of Christian devotion which developed largely non-scientific visions of nature, were responsible for some of the most widely read publications of the period. In the 1820s, approximately half a million stamped almanacs were sold annually (one for every twenty-five people), and in 1827 the Society for the Promotion of Christian Knowledge alone issued some one and a half million tracts.[138] Furthermore, such publications were taken seriously by contemporary exponents of scientific education, such as the Society for the Diffusion of Useful Knowledge, which mounted a campaign to supplant traditional 'superstitious' almanacs with its own rational and scientific *British Almanac*.[139] As this example illustrates, the development of scientific authority in the period was closely linked with the marginalization of non-scientific views. A full exploration of the development of scientific authorship in nineteenth-century Britain will thus include an exploration of such non-scientific forms of writing about nature.

3.2. Authorship and the man of science

Thus far, I have written as though the professional writers who wrote on scientific subjects were easily distinguishable from practitioners of science who were also scientific authors. This was certainly increasingly the case later in the nineteenth century, as both science and authorship became increasingly professionalized.[140] However, in the early nineteenth century, many of those who were

[137]Phillips (1832). On Phillips see Axon (1888), pp. 238–57, and Issitt (1998, 2000). I am grateful to John Issitt for providing me with several useful references.

[138]Kitteringham (1981), p. 18, and Altick (1957), pp. 101–2. On the prevalence of almanacs, chapbooks, herbals and tracts, see also Neuburg (1977), James (1976) and Vincent (1989), esp. pp. 156–95. On astrological almanacs see Anderson (1999).

[139]James (1976), pp. 53–4, and Vincent (1989), pp. 192–3.

[140]See, for instance, Lightman (1997a) and Shteir (1996).

professional writers on science were to some extent involved in scientific practice, and many of those who were scientific practitioners earned a significant part of their income from writing. This raises a second set of questions about scientific authorship. Firstly, we need to establish how financially important scientific writing was to practitioners of science at a time when the number of full-time paid positions directly or indirectly linked with the possession of scientific knowledge was very limited. Secondly, it is important to consider the effect such literary work had on their reputations as men of science, and to explore the complex interrelations between the persona of the man of letters and that of the man of science.

Recent moves away from the rather essentialist approach to scientific professionalization which gave primacy to the emergence (or non-emergence) of university and state-sponsored scientific posts have not, as yet, resulted in a thoroughgoing reassessment of the forms of financial remuneration linked with the possession of scientific knowledge in the early nineteenth century.[141] However, even a cursory glance at the lives and letters of early nineteenth-century men of science makes clear that literary work was—at least in terms of income—of considerable significance for many of them. In some cases such work was the principal source of a practitioner's income. More often, it supplemented income coming from numerous other sources, ranging from university chairs and college fellowships, to itinerant lecturing, medical practice, or various kinds of work for societies and museums. That it was nonetheless important, however, should not surprise us. Authorship had been an increasingly valuable source of income for scientific practitioners during the course of the eighteenth century, as the market for books on natural subjects expanded.[142] With the growing competition for new literary products in the late eighteenth and early nineteenth century, moreover, there was a rapid increase in the demand for able authors, and the potential rewards rose accordingly. As Walter Scott famously demonstrated, those authors whose works were most in demand began to be able to command unprecedented sums from publishers.[143] Moreover in an age which placed a premium on educational and 'improving' books, men of science were not the least beneficiaries from these developments, finding themselves in demand for a burgeoning range of writing. Nevertheless, the nature of the financial and other arrangements between men of science and their publishers remain shrouded in obscurity.

One of the few scientific authors of the early nineteenth century whose literary labours have received detailed consideration in this regard is David Brewster, whose career nicely illustrates the increasing range of scientific writing available

[141]On the essentialist approach see Morrell (1990). Historians of medicine have been somewhat quicker to examine the place of authorship in the 'occupational pluralism' which was a 'central feature of medical life in Victorian Britain'. See, for example, Bynum and Wilson (1992); the quotation is from p. 41. See also Porter (1992).

[142]See, for example, Walters (1992), ch. 1.

[143]See, for example, Collins (1928), ch. 2, and Jack (1963), pp. 31–8.

to the man of science in this period.[144] Having been obliged to abandon his intended career as a Church of Scotland minister because of his nervous disposition, Brewster supported himself over many years by writing and editing, which he combined at various times with income from private tuition, invention, services to scientific societies, occasional prizes, and (much later) a government pension.[145] Only in 1838, at the age of 56, did he finally obtain an established post at St. Andrew's University. As W. H. Brock has shown, Brewster, like many of his contemporaries, particularly benefited from the burgeoning range of early nineteenth-century periodicals, becoming a regular reviewer for the heavy quarterlies and an editor of several of the new scientific magazines. The former were a particularly important source of income for authors in the early nineteenth century, the rewards of contributing rising dramatically as the commercial importance of such journals increased. Moreover, as Richard Yeo has shown, scientific authors who could handle the specialist subject matter while still maintaining a lively and attractive reviewing style were much in demand. Even the 'heavy, clumsy' Brewster was commissioned to write 29 reviews for the *Edinburgh Review* alone between 1833 and 1844, earning himself at the lowest rate of pay more than £600, and probably at least twice that, from this one journal.[146]

Another regular source of income for Brewster was his editorial work on a number of the newly emerging commercial science journals. It was not until later in the century that the number of such journals increased beyond a handful, and, with relatively small print-runs, their rates of pay to contributors were considerably lower than the quarterlies. However, their commercial success clearly depended on the contributions of scientific specialists, and as a result they could represent a valuable source of income for scientific practitioners, both as editors and contributors. As co-editors from 1819 of the quarterly *Edinburgh Philosophical Journal*, for instance, Brewster and Robert Jameson were each paid a fee of £226 per number, out of which they had to pay contributors. When Brewster subsequently persuaded William Blackwood to produce a rival journal, the *Edinburgh Journal of Science*, he was paid £100 or £115 per number, his contributors receiving 10 guineas per sheet (that is, 16 octavo pages).[147] Medical periodicals, of course, had a potentially rather larger readership at this period, and the rewards of medical journalism could be proportionately greater. Even then, few made a living entirely

[144]Brock (1984). Although beyond the chronological scope of this paper, A. J. Meadows' study of Norman Lockyer deserves mention as considering the financial aspects of scientific authorship. See Meadows (1972), pp. 16–38.

[145]Shapin (1984b), esp. p. 19.

[146]Yeo (1993), pp. 81, 84. The quotation comes from a letter from J. G. Lockhart to John Murray, 26 October 1839, quoted in Smiles (1891), vol. 2, p. 454. The *Edinburgh Review* set new levels of remuneration when it started in 1802, offering authors an unheard-of 10 guineas per sheet (that is, for every 16 octavo pages); with rivalry from the *Quarterly Review*, the rate later rose so that 10–16 guineas per sheet represented the bare minimum, and 20–25 guineas was the average. See Erickson (1996), pp. 75, 78.

[147]Brock (1984), pp. 38, 39.

from medical journalism, although as editor of the *Lancet* Thomas Wakley demonstrated that it was possible, and the physician John Elliotson reputedly increased his annual income from £500 to £1500 by writing clinical reports for Wakley's journal.[148]

In 1808, Brewster became involved with another literary venture typical of the age, when he was appointed editor of the *Edinburgh Encyclopaedia*.[149] Encyclopaedias were works well suited to the high-priced upper middle-class book market of the early nineteenth century, a fact which encouraged several publishers to risk the high capital investment required. As well as the *Edinburgh Encyclopaedia*, Coleridge's *Encyclopaedia Metropolitana* and new editions of and supplements to the long-established *Encyclopaedia Britannica* gave work to numerous men of science. Moreover, as Richard Yeo has shown, the editors of these major British encyclopaedias of the early nineteenth century shifted their emphasis from the classification of universal knowledge to the 'presentation of detailed entries on scientific disciplines by expert contributors', a shift he associates with 'the point of transition from eighteenth-century natural philosophy to the emergence of modern scientific disciplines'.[150] This growing demand for scientific expertise was of no little significance in inflating rates of pay to startlingly high levels. When Blackwood's Edinburgh rival, Archibald Constable, bought up the copyright and stock of the *Encyclopaedia Britannica* in 1812, he commissioned articles for a supplement to bring it more up to date. Among these were princely payments of £1,000 each to the Edinburgh professors Dugald Stewart and John Playfair for articles on the progress of philosophy and of mathematics and physics.[151]

Encyclopaedias were not the only books in which the increasing value placed on scientific expertise combined with the ever more competitive market to augment the income of scientific authors. Educational works had long been one of the staples of the book trade, and the growth of the educational market in the early nineteenth century gave them an added premium.[152] The disproportionate expansion of scientific education and the rapid changes in scientific knowledge gave scientific authors a particular importance in this market. Even where new textbooks were not required, there was, as Brewster discovered, work to be done in editing standard works (like James Ferguson's texts on astronomy and mechanics) or translations of works by foreign authors (such as Euler and Legendre).[153] Brewster also benefited from the expanding market for fashionable works of science, contributing several books to Lardner's Cabinet Cyclopedia and Murray's Family Library. Pay-

[148]Bynum and Wilson (1992), pp. 36, 39, and Curwen (1873), p. 343. On Wakley see Bostetter (1985).

[149]See Yeo (1999) and Brown S. (1982), p. 51.

[150]Yeo (1991). See also Collison (1966) and Layton (1965).

[151]Jack (1963), p. 34.

[152]See, for instance, Topham (2000) and McKitterick (1998).

[153]On the importance of translation as a form of literary labour in the history of science, see Rupke (2000).

ment for such works could again be generous. Murray's average copyright payment for contributions to his Family Library, for instance, was around £220, and the standard payment for the treatises of the Society for the Diffusion of Useful Knowledge was reportedly £180.[154] Those works which were particularly popular could earn authors very considerable sums. Jane Marcet's *Conversations on chemistry* earned some £2329 for its author and her heirs between 1806 and 1865, and though Charles Darwin earned only £180 on the first edition of *Origin of Species*, by his death in 1881 the book had brought him more than £2500.[155]

Considering the many possible sources of income from scientific writing, then, there was clearly a living to be made from such work in the early nineteenth century. Nevertheless, for all but the most successful, authorship was a perilous profession at this period.[156] While Brewster was an accomplished professional author, who funded his career in science chiefly through his literary work, he was far from being enamoured of the profession of letters. It is particularly interesting to reflect on the advice he gave his young protégé, James David Forbes, as Forbes considered his future career in 1830. Forbes had suggested in a letter that he might attempt to earn his living as a scientific author. Brewster replied: 'I do not object to your making money by your writings, but I am sure that it would be injurious to your happiness to rely on such a source for a permanent portion of your income. The moment you do that you become a professional author, following the worst of professions.' Brewster thought that Forbes would do better to pursue a career in the law, as being 'perfectly compatible with the most ardent prosecution of science'.[157]

The financial insecurity of professional authorship was not its only potential pitfall. As Brewster was quick to recognize, the scientific practitioner who was dependent on income derived from scientific writing had to be particularly sensitive to the implications of such work for his or her reputation as a practitioner. Brewster feared, for instance, that Forbes's desire to make a living by writing would impel him into premature publication, and would consequently have disastrous implications for his scientific reputation. He explained: 'A first work clings to an author while he lives, and hence it is of great consequence that it be an original work worthy of the status of science which he is destined to attain.' Observing that he would 'object less to a system of meteorology than to an elementary treatise', Brewster continued: 'I have no scruple in expressing my convictions that you are destined to do something important in science, and under this conviction I am

[154]Bennett (1976), p. 161.

[155]The figures for Marcet are derived from the Longman archive at the University of Reading. See Horrocks (1987), Appendix. The figures for Darwin are derived from the Murray archive at John Murray (publishers), 51 Albermarle Street, London. See Peckham (1959), Appendix II.

[156]The perils of authorship in the nineteenth century are particularly well evidenced in Cross (1985), which gives details of the conditions of authors taken from the archives of the Royal Literary Fund. The archives, which represent an important source for those interested in the financial aspects of scientific authorship in this period, are available on microfilm. See Cross (1984).

[157]Brewster to Forbes, 11 February 1830, in Shairp, Tait and Adams-Reilly (1873), p. 59.

confident that there is no object of ambition worthy of your pursuit, but that of original discovery.'[158]

The centrality of this concept of originality of ideas to the definition of scientific genius in early nineteenth-century Britain made the position of the scientific author significantly different from that of the writer of other types of literature. The *Penny Cyclopedia* asserted that artistic genius, 'seeking to exhibit its own ideal in due and appropriate forms … realises the infinite under finite types, and so creates the beautiful'; scientific genius, it was stated, by contrast 'seizes at once those hidden affinities which otherwise do not reveal themselves, except to the most patient and rigorous application; and as it were intuitively recognising in phenomena the unalterable and eternal, it produces truth.'[159] Thus, unlike the literary author, any scientific author wishing to exhibit genius had to do so through originality of ideas (the discovery of truth), rather than originality of form (the creation of beauty).[160] Moreover, to be effective, such claims to originality had increasingly, through the first few decades of the nineteenth century, to be made through the medium of the publications of the learned societies. For the aspiring man of science, learning to write within this genre was the prerequisite of success as a scientific author. Yet, as Martin Rudwick has argued, the whole process of the writing of papers in this period—from the initial drafting to the process of revision between verbal presentation and publication—still requires much attention.[161]

Not, of course, that all the writing of the successful man of science needed to embody such originality of ideas. On the contrary, with the proliferation of different genres of scientific publication in the early nineteenth century, scientific practitioners had to learn to exploit a range of voices—to present a multi-faceted persona in which they were both original and authoritative, exhibiting both genius and expertise. At a personal level, the crucial issue was learning to employ the different facets of such a scientific persona at the appropriate time so as to cultivate one's reputation. This was a point well understood by the physiologist William Benjamin Carpenter, for whom authorship was an important source of income during the early part of his career, and for whom the tensions between cultivating a medical or scientific reputation and earning a living as a professional writer were particularly acute. When, in his late twenties, Carpenter wrote four volumes of a *Popular Cyclopaedia of Natural Science* (1841–44) and a volume for W. & R.

[158]Brewster to Forbes, [n.d.], in Shairp, Tait and Adams-Reilly (1873), p. 58.

[159]*The Penny Cyclopædia of the Society for the Diffusion of Useful Knowledge*, 27 vols (1833–44), s.v. 'Genius'.

[160]The issue of the relationship between literary and scientific genius was central to late Enlightenment discussions of the nature of literary property rights, and ultimately of the figure of the 'author'. See, for instance, Rose (1988), Hesse (1990) and Woodmansee (1984). See also Foucault (1977). On the emergence of the Romantic conception of scientific genius see Schaffer (1990). On questions of authorship and originality in early nineteenth-century political economy see Cooper and Murphy (2000).

[161]Rudwick (1985), pp. 433–5. On the processes of writing scientific papers, see also Secord (1986). Although Greg Myers's *Writing Biology* (1990) deals with modern subject matter, the approach taken is of relevance to the examination of earlier material.

Chambers's 'Educational Course', he had them published anonymously. As he explained to Robert Chambers, this was necessary since his reputation as an author was 'rather professional than general'. He was, he continued, 'apprehensive of being ranked by the public as a mere book-maker', since he had 'a large volume on Human Physiology on the eve of publication'.[162] Indeed, Carpenter had both a scientific and a medical reputation to defend. Nor were these entirely compatible. When, as a young man of 26, Carpenter had published his *Principles of General and Comparative Physiology* (1839)—intended to meet what he perceived to be the need for a work on the 'underlying principles of physiological science'—he found that his reputation as a scientific author hindered his medical practice.[163] More generally, W. F. Bynum and Janice Wilson have argued that for those pursuing a career in medicine, clinical practice was the crucial yardstick by which they were judged. Notwithstanding this, however, they found that, as a group, medical practitioners who became involved in editing medical periodicals tended to be ambitious individuals, for whom a period of editorial work in their youth served as a means of career advancement.[164]

Of course, an author whose reputation as a man of science had already been established by oral and literary performances within the closeted world of the metropolitan societies might greatly benefit by publishing in a genre accessible to a wider audience. As Richard Yeo has shown, for instance, the gentlemanly practitioners of science generally viewed the opportunity to write for the leading reviews of the period as a valuable means of disseminating and enforcing their views among a wider audience, and of increasing their corporate status and authority. Moreover, notwithstanding the putatively anonymous nature of nineteenth-century reviewing, authors of articles were often widely known, and personal reputations could be enhanced through such writing. William Whewell, in particular, is shown by Yeo to have used this forum in the early 1830s to develop his 'metascientific' voice, and to consolidate his reputation as an 'adjudicator of scientific developments'. Furthermore, articles in the quarterlies were particularly important to scientific practitioners since they had a 'dual audience': scientific books were not only being explained to a wider lay readership, but were also being assessed by their authors' peers.[165] This interplay of esoteric and exoteric forms of writing in establishing scientific reputations was perhaps most strikingly illustrated by the case of Thomas Young, the fate of whose vibration theory of light had, according to Whewell, been sealed by the critical assessment of an ill-informed (and

[162]Carpenter to Chambers, 20 January 1842, National Library of Scotland, Dep. 341/96, item 32. I am grateful to James Secord for this reference. See also Goldspink (1995), p. 24. This was not the only hack work which Carpenter was anxious to keep anonymous: as James Secord has shown, he was employed a couple of years later by the medical publisher John Churchill to advise on revisions to *Vestiges*. See Secord (1994b), pp. xxxiv, xxxvi.

[163]Carpenter (1888), pp. 27–8, and Goldspink (1995), pp. 17–19.

[164]Bynum and Wilson (1992), pp. 41–2.

[165]Yeo (1993), p. 114. See also Cannon (1960), p. 10.

anonymous) Henry Brougham, writing in the *Edinburgh Review*. Moreover, in a further twist, Brougham's ridicule of Young's *Philosophical Transactions* papers apparently so alarmed the entire book trade that the bookseller who had offered Young a princely £1000 for the copyright of his Royal Institution lectures felt obliged to withdraw.[166]

As Yeo makes clear, Whewell's contributions to the review journals were his 'first foray' into a wider readership.[167] By this date, Whewell had several Cambridge mathematical textbooks to his name, and a large number of papers in learned journals, but although he was well known as a man of science, it was his *Bridgewater Treatise* on *Astronomy and General Physics Considered with Reference to Natural Theology* (1833) which brought him to the attention of a wider public. Unlike his more specialist work, this book was widely reviewed in the general literary and religious journals, and established for him a reputation among a wider upper middle-class audience. Moreover, such a literary reputation presented, as James Secord has shown, opportunities for the man of science to enter into the social world of fashionable society.[168] During the course of the London social season, the latest fashionable books were discussed at the endless round of soirees, conversazione and dinner parties. In such a context, the successful scientific author could achieve unwonted celebrity status as a literary 'lion'. Such fashionable attention clearly served to increase the public profile both of the man of science, and of his science.

There is thus, of course, a close link between the individual reputation of scientific authors, and the reputation of science itself, a consideration which brings us full circle to the question with which we began—namely, how it was that science came to accomplish the audience relation that it did in early nineteenth-century Britain. It has been the object of this paper to show that the answer to that question must be based, at least in part, on an understanding of the communication circuit of print in the period. As the first of the mass media, print became in the nineteenth century, more than ever before, a crucial means by which cultural authority was to be both achieved and contested. Scientific practitioners realized this, and sought to use it to achieve their ends, although they were not alone in sometimes being rather slow to become aware of new developments. Richard Yeo, for instance, has argued persuasively that Robert Chambers' anonymous evolutionary work, *Vestiges of the Natural History of Creation*, alerted scientists to their failure to enforce their views among the new reading audiences, and provoked them into writing self-

[166]Whewell (1857), vol. 2, pp. 346–8, and Wood (1954), p. 174. On the reception of Young's optical work, see also Cantor (1983), pp. 140–6.

[167]Yeo (1993), p. 88.

[168]James Secord, 'Conversations on creation', paper read at a day-long conference on the *Vestiges of the Natural History of Creation*, held at the Wellcome Institute for the History of Medicine on 16 November 1994. I would like to thank the author for providing me with a copy of his paper and allowing me to refer to it. See also Secord (2000).

conscious works of 'popular science' to enforce their claims to authority.[169] Moreover, it is no surprise that the book which alerted them to their failure to reach the new audiences was written by one of the most successful popular publishers of the century.

4. Conclusion

> What is the history of the book for? A plausible answer lies in the role played by written and printed materials in the constitution of knowledge. The history of the book is consequential because it addresses the conditions in which knowledge has been made and utilized.
>
> Adrian Johns, *The Nature of the Book*[170]

My purpose in this account has been to point towards some of the new insights which would result from serious consideration of the communication circuit of print in relation to early nineteenth-century science, and to demonstrate the practicability of such research. In particular, I have argued that a new focus on what early nineteenth-century readers read about nature—starting with a ground-level examination of the printed objects available to them—would provide novel insights into the varied cultural topography in which science was situated as one competing form of knowledge about nature. Such an approach does not assume either the cultural legitimacy of science or the illegitimacy of other forms of natural knowledge, but raises the question of how, and how far, such legitimacy was achieved, as a matter of historical contingency. Focusing on the reading experiences of contemporary readers gives us a new means of gaining access to this contest for cultural authority. Instead of seeing popularization from within the diffusionist model, a focus on actual readers requires that we consider how power was exerted in enforcing and resisting knowledge claims. Readers were not wholly constrained by the textual and formal strategies of authors and publishers—they were active in making their own meanings, drawing on a wide range of beliefs and practices about the nature and object of reading. Insofar as they became the passive audience which scientists sought, therefore, they did so for complex reasons.

A new focus on the book trade also promises important new insights into the manner in which nineteenth-century science achieved its extraordinary cultural authority. This is most obviously the case because scientific authors were very heavily dependent on commercial publishers in successfully managing print culture—that is, in creating books which communicated the right messages to the

[169]Yeo (1989).

[170]Johns (1998b), p. 263. This ground-breaking book raises important issues for historians concerned with the relevance of the history of the book to history of science in all periods. Although the book relates mainly to the early modern period, the conclusion specifically draws attention to the need for detailed study of nineteenth-century book history in relation to the history of science, and to the history of 'knowledge' more generally.

right audiences. But publishers were not merely the lackeys of scientific practitioners. They were also extremely important initiators of publishing ventures in which scientific practitioners featured mostly only secondarily, and often not at all. As the creative agents behind vast numbers of popular trade books and periodicals, they were primarily responsible for a large proportion of the printed matter on natural subjects which contemporaries eagerly devoured. In a wider sense, too, the book trade was fundamental to early nineteenth-century science, for it was the book trade which developed the new mass medium publications on which the new audience relations definitive of science were based. Once again, these developments were historically contingent, and depended on the actions of individual entrepreneurs and ideologues who had particular interests at stake.

A final area for reassessment is scientific authorship, where the focus has hitherto been primarily on the authorial strategies of leading scientific practitioners. Many of those involved in writing on natural subjects, including on science, have not hitherto been considered within the history of science, but an acknowledgement of their involvement makes clear the extent to which the representation of science in early nineteenth-century culture was not effected by practitioners alone. Indeed, the views of science promulgated by many of the professional writers on the subject were far from congruent with those of the practitioners themselves. Moreover, those practitioners involved in writing on science had a far wider range of interests invested in authorship than has sometimes been supposed. A more broadly based consideration of what it meant for a scientific practitioner to be an author in the period—both in terms of the financial rewards, and in terms of personal reputation—will provide valuable new perspectives on the meaning of the texts they produced.

The invention of science in the early nineteenth century was, as we have seen, closely connected with revolutionary changes in reading audiences. The growing body of literature on the history of communication by print in this period, combined with the growing bibliographical control over the abundant primary resources, offers ample opportunity to explore this significant development. My purpose in this essay has been to draw together some of the available materials, and to suggest some possible avenues for exploration. The task ahead is both vast and daunting, but its contribution to the subject is potentially of the first importance.

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