



SCIENCE IN THE MARKETPLACE

Nineteenth-Century Sites and Experiences

Edited by
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- . 2004. *Phrenology and the Origins of Victorian Scientific Naturalism*. Aldershot, UK: Ashgate.
- Wallace, Alfred Russel. 1905. *My Life: A Record of Events and Opinions*. 2 vols. London: Chapman and Hall.
- Watson, H. C. 1836. *Statistics of Phrenology: Being a Sketch of the Progress and Present State of that Science in the British Islands*. London: Longman.
- Wells, Charlotte Fowler. 1896. *Some Account of the Life and Labours of Dr. François Joseph Gall: Founder of Phrenology and his disciple Dr. John Gaspar Spurzheim*. New York: Fowler and Wells.
- Winter, Alison. 1994. "Mesmerism and Popular Culture in Early Victorian England." *History of Science* 32:317–43.
- . 1998. *Mesmerized: Powers of Mind in Victorian Britain*. Chicago: University of Chicago Press.
- [Yelloly, John.] 1802. "Lettre de Charles Villers, etc. i.e., A letter from Charles Villers to George Cuvier, of the National Institute of France, on a new theory of the brain by Dr. Gall, in which that viscus is considered as the immediate organ of the moral faculties." *Monthly Review* 39:487–90.



CHAPTER FOUR

Lecturing in the Spatial
Economy of Science

BERNARD LIGHTMAN

When he arrived in Boston in 1884 to present the prestigious Lowell Lectures, Robert Ball, then astronomer royal of Ireland, was already a seasoned science lecturer with ten years of experience under his belt.¹ But a reporter for the *Boston Herald* observed that Ball "suffered from a slight impediment in his speech" and that "he has a smooth, clear voice, with a use of it, at times, quite clergymanic" ("Modern Astronomy" 1884). Ball's response to the report is revealing. "The Boston Herald says that I have a hesitation in my speech and that my style is sometimes clergymanic," he wrote. "I must try and correct these trifles" (as quoted in Wayman 1986, 192). Ball resolved to eliminate any trace of the sermon in his oral style, and not just because he was a confirmed scientific naturalist. He realized that a successful scientific lecturer needed to entertain as well as to instruct. Three years earlier he had given his first lecture at the illustrious Royal Institution on "The Distance of the Stars." Honored by the invitation, he "took great pains with the lecture which was to be delivered in such a place and before such an audience" (Ball 1915, 203–4). The Royal Institution was famous for its lecturers, among whom were Humphry Davy, Michael Faraday, and John Tyndall. Ball had frequently heard Tyndall lecture at the Royal Institution, acknowledged his special genius as an entertaining public speaker, and learned a great deal from him about communicating effectively with an audience. As he prepared for his lecture, he recollected how James Clerk Maxwell, when about to speak in public, was in the habit of "Tyndallising" his imagination up to the point of being able to devise picturesque phraseology and to accompany it with effective experiments" (Ball 1915, 203–4).

Ball delivered his lectures during a period when there was a veritable explosion of books and periodicals devoted to conveying science to a broad

audience of interested readers. The growth of an educated middle class and of literacy among members of the working class combined with the invention of new printing technologies gave birth to an unprecedented mass market that provided new opportunities for careers in science journalism and writing. Dawson, Noakes, and Topham have pointed out that new ways of presenting the sciences to general audiences were being developed in established and new serial forms in periodicals during the middle of the century (Dawson, Noakes, and Topham 2004, 16–17). Similarly, Gates and Shteir have argued that during this period, science writers invented a new literary narrative to meet the needs of the mass reading public eager to understand the larger significance of recent scientific discoveries (Gates and Shteir 1997, 12). But the increased interest in science was not limited to the realm of print culture, as other public spaces for the exchange of knowledge, such as museums, exhibitions, zoos, aquaria, gardens, lecture halls, and conversaciones, multiplied and diversified. Just as scientific authors sought in their books to forge a new style of writing, those who engaged in public speaking tried to create innovative lecturing styles that would attract an audience with high expectations when it came to entertainment. The popularity of the Crystal Palace and the spectacular shows of London had raised the bar.

David Livingstone has stressed how place is not a neutral container but rather “constitutive of systems of human interaction” (Livingstone 2003, 7). He distinguishes public from elite spaces and asserts that a recognition of how science has been “practiced in a variety of popular arenas” should help “widen our awareness of the range of spaces in which scientific knowledge has been produced and propagated” (Livingstone 2003, 85). If place is to be considered as an important factor in our understanding of the communication of scientific ideas to the public, then we must think about how lecturing was experienced differently by audiences depending on the sites of delivery. Here I will examine how science lecturers refashioned the sites in which they lectured and how they hoped thereby to provide their audiences with a different experience—one that was entertaining as well as instructive. I will begin with a discussion of the widespread demand for science lecturers in the second half of the nineteenth century, concentrating on the most active speakers, their extensive tours, their earning power, their mode of delivery, and their use of visual aids. Like Ball, they avoided using the traditional sermon, didactic and serious in nature, as a model for lecturing as in their efforts to draw large audiences they were competing with a wide range of mass-cultural forms.² Then I will focus on one representative from each important type of science lecturer, those like John Henry Pepper who operated from within institutions devoted to exhibiting science in an

established public space, and those like Frank Buckland who had to fashion a scientific space for themselves every time they lectured. Humphry Davy had been applauded for blending entertainment with instruction, through his reproduction of experiments during lectures, but Pepper and Buckland went a step further. They drew upon cultural forms connected to the world of entertainment to refashion sites of knowledge-production and learning and by doing so provided their audiences with a new experience of public science more akin to that of visitors to the museum or the theater. While Pepper is perhaps best remembered for his optical illusions that featured ghostly apparitions and Buckland for his contributions to British fisheries, they both drew on cultural forms connected to the world of entertainment. Their distinctive blend of instruction and amusement became a hallmark of lecturing in this period. They were indicative of the expansive force of public science in the second half of the nineteenth century, as its sites multiplied endlessly and it transformed the spatial economy of science.³

The Scientific Lecturing Scene

In his will, the wealthy philologist John Borthwick Gilchrist (1759–1841) had left a considerable amount of money in an educational trust. During his life he had been involved in various projects to boost popular education. In 1823, he had helped George Birkbeck found the London Mechanics' Institution, and he had also been involved in the establishment of the University of London. Part of the Gilchrist Trust was to go toward funding an annual series of public lectures in British industrial centers. But the money was tied up in litigation for more than twenty-five years, and the lectures were put on hold until the issue was resolved (Prior 2004, 219). When the Gilchrist Trust began to plan to send science lecturers throughout the country, there were doubts that they would be a success. Ball, who began his twenty-year connection with the trust in 1880, recalled one of his earliest experiences lecturing at Blackburn. The heavy rains had led the mayor to worry that attendance would be low. As they reached the hall they saw no crowds, except for the policemen standing outside the door. The mayor was about to declare the lecture a “total failure” when the policemen informed him that the hall was filled to capacity and that they had turned away two hundred people half an hour ago. Ball asserted that the general experience of those who gave the Gilchrist lectures was “house packed and every inch of standing room occupied” (Ball 1915, 217).

Ball and the other successful science lectures of the latter half of the nineteenth century were able to take advantage of the institutionalization

of scientific lecturing earlier in the century. Hays has argued that a scientific lecturing empire was established in London by the 1820s and 1830s that contributed to the support and professionalization of "men of science." During this period scientific lecturing had become formalized when scientific societies and institutions began to concentrate their activities into a season between November and June. The Royal Institution and the London Institution presented a series of lecture courses through the season. Lectures were also offered by the Russell Institution in Bloomsbury, by the Surrey Institution near Blackfriars Bridge, and by a number of Mechanics' Institutes centered in London. University College and King's College offered scientific instruction as well. Hays asserts that by the 1830s it was Michael Faraday who was seen as the model lecturer due to his clarity, neatness, arrangement, and concentration on the subject under discussion, while Humphry Davy's appeal to moral elevation, poetic inspiration, mental cultivation, business profit, and amusement was no longer in vogue.⁴ Among the important lecturers were John Millington, Charles Frederick Partington, Edward William Brayley, William Thomas Brande, William Ritchie, and Dionysius Lardner. Some of the London lecturers, such as Ritchie and Lardner, were in great demand in the provinces (Hays 1983, 91-97, 101-2).⁵

In the latter half of the nineteenth century, those who were hired to lecture to the public on a regular basis by formal institutions were in a more secure situation than those who were independent—as long as they maintained good relations with the directors. John Henry Pepper (1821-1900) was appointed lecturer and analytical chemist at the Royal Polytechnic Institution in 1848. A colorful showman who could draw in the crowds, he lectured daily at the Polytechnic until 1872 on such topics as electricity, chemistry, and optical illusions. But those without institutional positions were also much in demand as public lecturers, and they had the freedom to accept or reject whatever invitations came their way. Frank Buckland (1826-1880) and John George Wood (1827-1889) were well-known lecturers on natural history, while Robert Stawell Ball (1840-1913) specialized in astronomical topics. The number of science lectures that these men delivered during their lives is staggering, and the punishing demands of the lecturing circuit could often take a physical toll. By 1884, Ball had already delivered more than seven hundred lectures (Ball 1915, 224). Wood reportedly gave an average of ninety lectures each season (Upton [1910], 171). According to his son, his best season was that of 1881-1882, when he delivered more than 120 lectures (Wood [1890], 254). Eventually the stress of lecturing caught up to Wood. The *Times* reported in 1889 that he died "while in

harness." He caught a severe chill while on a lecturing tour, "took to his bed at Coventry on Saturday, and died on Sunday" (Whitehead 1889, 15).

Many lecturers traveled extensively throughout Britain, and several undertook lecture tours of the United States and other parts of the world. Buckland's lecturing engagements were limited primarily to Britain. He spoke in London at the Royal Institution, the London Institution, and the South Kensington Museum, and he also delivered lectures at Brecon, Nottingham, Oxford, Sheffield, Windsor, and Witney. Wood began his lecturing career in the mid-1860s and by 1879 had engaged the services of a booking agent because he was traveling all over England (Wells 1990, 58). He went to the United States twice, once in 1883-84 to deliver the Lowell Lectures and a second time in the fall of 1884. Pepper ultimately became the most cosmopolitan of the group. After twenty-four years based at the Royal Polytechnic Institute in London, he resigned and took his optical illusions to Canada, the United States, and Australia. As astronomer royal of Ireland, Ball was centered in Dublin before he was appointed Lowndean Professor of Astronomy at Cambridge in 1892, but he often made winter visits to England. By 1887 he was limiting himself to two trips, one in November and another in January. He managed the November trip himself, accepting invitations that came during the summer. He planned the lecture tour so that he would begin in the north and work his way gradually southward. The Gilchrist Trust managed the January trip, and he dutifully followed the itinerary laid out for him. He visited mostly small towns. In his first set of Gilchrist lectures in 1880, he went to Rochdale, Accrington, Huddersfield, Preston, and Bury (Ball 1915, 223, 217). Ball came to the United States to deliver lectures three times, in 1884, 1887, and 1901. He apparently left a lasting impression. The *Boston Evening Transcript* obituary asserted that "since the days of the great and only Huxley, no one has put more of natural science into the minds of men through the medium of the tongue" (Collins and Smith 1915, 5). Extensive lecturing allowed these popularizers to become widely known throughout Britain and sometimes beyond.

Successful science lecturers could earn significant sums through their speaking engagements. Ball was an astute businessman, whose lecturing and books earned him a personal fortune (Wayman 1986, 187). He charged between £25 and £40 per lecture (Wayman 1987, 124). He cleared £165 when he gave the Lowell Lectures in 1884 and was convinced that he could make £100 a week if he stayed (Wayman 1986, 194-95). In 1892, when Ball was weighing whether to accept the Lowndean chair, he drew up a budgetary scheme for living in Cambridge. He estimated that he could earn £600 annually from his lecturing, which was equal to the salary he was to receive

as Lowndean chair. In contrast, he expected to receive only £440 from his books and literary projects (County Record Office 1892). In a letter to a friend in 1897, he stated why he preferred lecturing to writing. "Lecturing is a more permanent source of income than writing," Ball wrote, "for the same lecture will be available scores of times, while there is (or ought to be) a limit to the number of times the same thing can be written." Ball also enjoyed lecturing—it was a rest and a change of pace from his duties as Lowndean Professor—and found writing articles to be "an awful grind" (Ball 1915, 221). Wood had also taken up extensive lecturing tours as a means of augmenting his income, prompted by the depression in the publishing trade in 1879 (Upton [1910], 165). However, he was not nearly as financially successful as Ball. His son claimed that he cleared about £300 per year, but his trips to the United States were financial failures due to mismanagement (Upton [1910], 171; Wood [1890], 170–71, 234, 249–52). When Wood died, he left his family in dire financial straits.

To be successful, science lecturers needed to exploit every possible angle, including the perfection of their own speaking skills and their use of visual aids. Though they offered instruction, scientific lecturers were also expected to be entertaining, especially in the post-Crystal Palace era. In London, they were competing for audiences with the theaters, museums, panoramas, and other spectacles. Lecturers became comfortable with diverse modes of delivery. Up until 1884, Ball had been delivering his lectures without a set text. In the middle of delivering the Lowell Lectures in October 1884—after a lecture in which he had "stammered and hesitated horribly"—he decided to experiment by writing and then reading his paper. He resolved in the future to write the lectures ahead of time and either memorize or read them, allowing for some improvisations along the way (Wayman 1986, 193–94). By contrast, Wood did not use a prepared manuscript and relied on rapid impromptu sketches to illustrate key points in his lectures (Wood [1890], 145). Although one critic implied that his use of "freehand diagrams" was actually to draw attention away from his "ineffective" delivery, Wood's sketches were usually considered the highlight of his lectures ("Rev. J. G. Wood" 1890). "One of his best," his son wrote, "was that of two ants fighting, in which jaws, limbs, and antennae were hopelessly interlocked, and yet the individuality of each insect was clearly preserved." He was also known for his drawing of a sperm whale and a male stickleback (Wood [1890], 159; Lightman 2000, 657–61). For his visual aids, Buckland relied on masses of specimens of bones and skin of exotic animals from around the world.

Visual aids were a crucial dimension of the presentation for public sci-

ence lecturers, and Buckland and Wood, the natural historians, made little use of the magic lantern in comparison to most speakers. Ball was more typical in his reliance on the oxyhydrogen lantern. He was using photographs in 1881, charts and the stereopticon in 1884, and the oxyhydrogen lantern in 1890 ("Lecture at the Midland Institute on Tides" 1881; "Modern Astronomy" 1884; "Gilchrist Lectures at Goole" 1890). Pepper's use of expensive technological apparatuses to illustrate his lectures was typical of those who worked at science museums, though, as well shall see, his spectacular optical ghost illusions were far more sophisticated than most.

Successful science lecturers were well traveled, well paid, and innovative. One key to their success was their degree of sensitivity to the nature of the sites in which they delivered their lectures. For those who worked in scientific institutions that contained places designed to reach out to the public, it was not necessary to create a new space for their activities. But for those, like Frank Buckland, who labored in spaces not specifically designated as scientific, more work had to be put into fashioning an appropriate site.

Frank Buckland and the Culture of Display

On the evening of October 24, 1861, Frank Buckland presented a lecture on "Curiosities of Natural History" at the town hall in Witney, Oxfordshire. The enthusiastic account of the lecture in *Jackson's Oxford Journal* emphasized that Buckland had "by the simple force of his style and the sterling value of his matter, so fully realized all the great things that were expected of him" as the son of the famous Oxford geologist and dean of Westminster William Buckland, reputed to be one of the most popular lecturers at Oxford in his day. "That power of thought," the anonymous reviewer declared, "that faculty of observation, which so greatly distinguished the father, have descended unimpaired to the son." The report also highlighted the younger Buckland's orthodoxy. It described Buckland's remarks on how nature "always has a most cogent reason for working in a particular manner." Buckland then "compared the works of the Almighty with the mightiest of man's works—the *Great Eastern*, for example,—and designated them puny and weak." Finally, the anonymous author discussed how Buckland illustrated his main theme, the universal law pervading the whole of nature of "eat and be eaten." Buckland's lecture "consisted of a series of observations, original, clearly explained, and embodying great scientific truths. These truths were illustrated and demonstrated by numerous diagrams and specimens, forming of themselves quite a museum"

("Witney" 1861). If only for a single evening, Buckland had transformed Witney Town Hall into a museum of science.

Like Ball and Wood, men without a permanent public institution in which to present their lectures, Buckland delivered his addresses in town halls, churches, assembly halls, and coffeehouses—sites that were not specifically scientific. Buckland had the daunting task of turning diverse sites into ephemeral scientific ones. Through his use of specimens and his appeal to the tactile senses of his audience, he attempted to refashion these sites, temporarily, into museums. Buckland's lecturing style was shaped by the culture of display to be found within existing scientific traditions in museums. He was influenced by the medical tradition of using specimens to illustrate lectures, as established by John Hunter. In his fascination with "curiosities"—the bizarre and unusual—Buckland also drew on the natural history tradition and its love of the exotic, which he combined with his interest in zoos, circuses, and freak shows. Buckland's lecturing was therefore shaped by a variety of scientific and cultural forms.

After completing a Bachelor of Arts degree at Christ Church, Oxford, in 1848, and then medical training at St. George's Hospital from 1848 to 1851, Buckland combined natural history writing and lecturing with a career as a surgeon, first at St. George's Hospital (1852–1853) and then in the Second Life Guards (1854–1863). He began lecturing in 1853 and wrote numerous articles for various periodicals, including, on a regular basis beginning in 1856, the *Field* newspaper. He collected many of his articles together and published them in 1857 in his *Curiosities of Natural History*, and he later produced three more series with the same title. In 1863, he resigned from the Second Life Guards in order to pursue his interests in natural history. After a quarrel, he severed his relationship with the *Field* in 1865 and the following year started his own weekly journal, *Land and Water*, devoted to sport and natural history. But Buckland's new passion was fish hatching, which later led to his appointment as inspector of fisheries in 1867. His duties included the submission of annual reports to the Home Office based on extensive inspections of English rivers and their stock of fish. The books he produced during this time reflected his work on fish, including his *Fish Hatching*, published in 1863; *Logbook of a Fisherman and Zoologist*, published in 1875; and *Natural History of British Fishes*, published in 1881. Buckland remained, to the end of his life, a devout Christian and a determined opponent of Darwin's evolutionary theory. He carried on the natural theology tradition of his father, preparing a revised edition of William's Bridgewater Treatise in 1858.⁶

Buckland spoke on a variety of natural history topics (though he had

a set repertoire like other lecturers), at a number of different institutions, and to diverse audiences. Early on, he lectured primarily to members of the working class. His first lecture on "The House We Live In," given in December 1853, was delivered at a workingmen's coffeehouse and institute in Westminster established by his mother (Bompas 1909, 79). In this lecture, he drew an analogy between the human body and a house, with its doors, windows, pumping apparatus, pipes, and telegraph wires, in order to teach elementary facts of physiology and hygiene as well as demonstrate how animal bodies were examples of divine handiwork (Bompas 1909, 80; Upton [1910], 85).⁷ In 1858, he repeated this lecture at the Mechanics' Institutes of Abington, Newbury, and Wantage (Bompas 1909, 90; see also figure 4.1.) In that same year, he gave his first lecture at the South Kensington Museum on "Horn, Hair and Bristles," one of a series of six lectures addressed to workingmen (Bompas 1909, 88). The other speakers included Richard Owen, Lyon Playfair, and Thomas Huxley. A year later, he was lecturing at Windsor and Burnham to an audience of "working men, their wives and babies" (as quoted in Bompas 1909, 95).

For this audience, Buckland developed a light, entertaining style with plenty of humor. Even though Buckland's message was heavily inflected with natural theology themes, he, like Ball, avoided the sermonizing style. Buckland did not feel comfortable until he was able to draw laughter from the crowd. According to Bompas, who was his brother-in-law, he used to say, "I can't get on . . . until I make them laugh; then we are all right" (as quoted in Bompas 1909, 79). Buckland was known to have a collection of comical stories on hand for every speaking engagement (Walpole 1881, 306). A sample from a report on a lecture in 1863 was presented to the audience as a conundrum of natural history: "It is known to many of our readers that the Platipus is a something between a bird and an animal, but more of the latter; the witty speaker therefore asked why is the Platipus like a Tailor? Because it is a BEAST with a BILL" ("St. John's School" 1863). According to reports in contemporary periodicals, Buckland's audiences appreciated his sense of humor. Reporting on a lecture on "Fish and Oyster Culture" given at the Mechanics' Hall in Nottingham in 1865, the *Nottingham and Counties Daily Express* referred to his "racy, amusing style" as being "much enjoyed by the audience" ("Fish and Oyster Culture" 1865, 8).

Accounts of Buckland's lectures in the periodical press often noted that his specimens, used for illustrative purposes, left a marked impression on his audience. Buckland drew on his own private collections (he frequented auctions and kept a large menagerie of live exotic animals in his home) as well as specimens that he had obtained from friends. In 1859, Buckland was

ABINGDON MECHANICS' INSTITUTE

REVERSION OF LECTURE.

ON
TUESDAY, November 30, 1858,

F. T. BUCKLANDEsq., M.A.,

Assistant Surgeon, Second Life Guards,

WILL DELIVER A

LECTURE

IN THE

Council Chamber,

Subject:

"THE HOUSE I LIVE IN"

SYLLABUS—The Human frame the house. The soul the tenant. Complicated but beautiful structure of the human body. Its composition—Compared to the houses of inferior animals. Bone—Use, structure—Design of Creator evinced by the structure of its form. The skull, its contents. The vertebrae. The internal parts of the body. The Heart. The Lungs. The Stomach. Practical deductions from knowledge of use of parts. The skin. Hair. Nails. Solomon's portraiture of old age (Gimnastis) explained. Conclusion.

The CHAIR will be taken at Half-past Eight o'clock, by

E. J. TRENDELL, Esq., MAYOR.

Reserved Seats ONE SHILLING. Back Seats SIXPENCE.

Tickets may be had of Mr. Johnson Bridge-street; Mr. Bezant, Market-place;
Mr. E. J. Gubb Ock-street. Members Free. (Tickets not transferable)

A. W. BEZANT, PRINTER, ABINGDON.

Figure 4.1. Poster for Buckland's lecture on "The House I Live In." Reprinted by kind permission of the president and council of the Royal College of Surgeons of England from *Frank Buckland, Records of My Life* [Commonplace Book], vol. 1, p. 159. Library, Royal College of Surgeons, London.

delivering his lecture on "The House I Live In" at Windsor to the Working Men's Association. He emphasized how the human body was like a movable or walking house: eyes are like windows, mouths resemble a door, and heads are comparable to a cupola. Just as a house is designed, so is the human body. The reporter from the *Windsor and Eton Express* was struck by how "the action and object of the skull, brain, teeth, lungs, stomach, hair, and skin, and all the more prominent and important members of the body were clearly explained and illustrated by the most curious and interesting specimens" ("Working Men's Association Lecture" 1859). Among Buckland's specimens were a New Zealander's tattooed head, a large shell from the China Seas, a rat with huge teeth, the vertebrae of a boa constrictor, the thighbone of a lion, and a monkey's skeleton (Burgess 1968, 73). After giving his presentation, Buckland wrote, "I lectured pretty well, but, as usual, had too many things to show" (as quoted in Bompas 1909, 95). Two years later Buckland was back in Windsor, when he spoke on "Curiosities of Natural History" in the Town Hall. The lecture was illustrated, in the words of the *John Bull* reporter, "with an exceedingly large and valuable collection of specimens, drawings, diagrams, and views." Among the drawings were life-size colored pictures of the great gorilla, magnified sketches of human hair and skin, and depictions of extinct British animals. "The specimens, however," *John Bull* declared, "were the most remarkable; they comprised exquisitely stuffed heads of the lion and bison, with parts of their articulation and structure, the eland, walrus, hippopotamus, elephant's skull and bones, rhinoceros, wild boar, beaver, polar bear, giraffe; skins of the bison, black, white and grisly bears, the platypus, hyena, gavial, and many others too numerous to mention" (*John Bull* 1861). Buckland's vast collection of specimens must have turned the lecture hall into a museum-like exhibition of stuffed animal parts, skulls, bones, and skins. Unlike other science lecturers, Buckland did not make extensive use of the magic lantern. By 1864 he was using the oxyhydrogen microscope when he lectured on "Fish Hatching," but he continued to use diagrams and specimens ("Reading Room and Library" [1864]).

At the Windsor and Eton Literary, Scientific, and Mechanics' Institute in 1861, Buckland reportedly brought with him "notes on the subject, but he preferred to lecture upon the objects and specimens before him, as if they saw a thing they could hang on other facts to it, and arrive at a great result" ("Mr. Buckland on Natural History" 1861). Buckland's rejection of the prepared script, his use of anecdotes (a common convention in written natural history) and humor, and his reliance on his specimens to move the lecture forward gave his public presentations a casual quality

that allowed him to establish a strong rapport with his audience. One reporter referred to his lecture at St. John's School in Hammersmith in 1863 as "an illustrated conversation from Natural History, which he kept up for more than an hour without the slightest interval, excepting the necessary repose consequent upon cheers and laughter, produced by pointed anecdotes." The reporter was aware that the conventional term to describe Buckland's speech was *lecture*. "We have adopted the term conversation in preference to lecture," he asserted, "from the peculiarly sincere and friendly manner in which Mr. Buckland addressed his audience." The "conversation" was an illustrated one due to Buckland's use of an artist, who drew freehand sketches as Wood did, in addition to all of his other visual aids. "The word illustrated must be taken in its fullest sense," the reporter insisted, for "a great portion of the walls of the building [were] covered with diagrams and pictures, artistically representing microscopic sections of birds, animals, and fish, and [there was] a collection of preparations, which almost made the Lecture Table groan beneath its weight." This time Buckland had brought with him poisoned arrows from Central Africa, a whale harpoon used by South Sea whalers, elephant and giraffe tails, heads of poisonous snakes, the skin of a sixteen-foot-long African boa, lion skulls, and the shoes of a seven-foot-tall French giant ("St. John's School" 1863).

Due to his adoption of a culture of display coupled with a racy speaking style, Buckland was often criticized for delivering superficial lectures and writing ill-informed books. In his obituary in *Nature*, it was asserted that "he was in no sense of the word a profound naturalist; he could seize with alacrity the popular side of a scientific question, but he seldom went deeper" ("Frank Buckland" 1880, 175). But Buckland was a well-educated Oxford man and the son of an eminent geologist who had taught him extensively about natural history. He self-consciously designed his lectures and writings for a popular audience. When he lectured to a more educated audience, he was quite capable of adopting a different style. Buckland's later interest in fish culture brought him a few invitations to venues that catered to more-genteel audiences. On April 17, 1863, he lectured on fish culture at the Royal Institution, with the Duke of Northumberland in the chair and an audience that included Roderick Murchison, Michael Faraday, John Tyndall, and Edward Frankland (Burgess 1968, 99). Later published in book form as *Fish Hatching*, this work bears little resemblance to his *Curiosities of Natural History*, with its humorous, first person, anecdotal style. Instead, Buckland presents a sustained argument for the public utility of

studying the breeding of fish scientifically. Buckland altered his lecturing style for such a distinguished audience. When he lectured on fish culture in other venues, such as the Mechanics' Hall in Nottingham, he continued to adopt a "racing, amusing style" and to illustrate his talk "by many diagrams and specimens of natural history" ("Fish and Oyster Culture" 1865, 8). One contemporary asserted that Buckland was at ease with both working-class and with more-educated audiences, though less successful with the latter. "If he had been a politician," the *Popular Science Monthly* obituary proclaimed, "he would have been a greater mob orator than Parliamentary debater" (Walpole 1881, 306).

Two key sources for the culture of display embodied in Buckland's extensive use of specimens in his lectures may have been the zoo and the freak show. Buckland frequented the Zoological Gardens in London and wrote extensively about zoo animals in the third series of his *Curiosities of Natural History*. Among others, articles covered giraffes, hippopotamuses, and lions at the Zoological Gardens. Human freaks and exotics also fascinated Buckland. According to Burgess, Buckland could never resist a sideshow. Buckland wrote numerous articles on freaks and carnival acts, many of them in the fourth series of *Curiosities of Natural History*, including such topics as giants, bearded ladies, fire-eaters, sword-swallowers, human cannonballs, and mermaids. As a result, promoters of unusual shows hoping for publicity often invited him to special sessions (Burgess 1968, 181-82). Buckland's interest led him to become friendly with Joseph Brice, the over eight-foot-tall French giant, whom he first met in 1862, Miss Swan the giantess, and the two-headed Mademoiselle Millie-Christine. He was known to throw parties for these friends "with the Chinamen, Aztecs, Esquimaux, Zooloos, Siamese twins, tattooed New-Zealanders, and whatever queer specimens of mankind happened to be on exhibition at the time, as fellow-guests" ("Sketch of Frank Buckland" 1885-86, 406; Upton [1910], 108; Burgess 1968, 110, 185). From the freak show and the zoo, Buckland drew on the display of the exotic in order to entertain, particularly when lecturing to his working-class audiences.

When Buckland wished to provide a genteel audience with a more learned, educational experience, or when he wished to edify a lower-class audience, he could draw upon the surgical tradition of John Hunter and its emphasis on specimens and hands-on experience. Buckland's identification with Hunter was not unusual. Jacyna has examined the various ways in which nineteenth-century British biomedical investigators could "consecrate a particular cause" if they presented themselves as belonging

to the Hunterian tradition (Jacyna 1983, 102–3). Buckland would have been exposed to the Hunterian tradition through his medical training, his father, and his friendship with Richard Owen. From 1756 until his death in 1793, Hunter had been surgeon to St. George's Hospital, where the elder Buckland had been a medical student. The younger Buckland had been taught by his father to regard Hunter's memory with enormous respect (Burgess 1968, 42–43). In the preface to the first edition of his *Curiosities of Natural History*, Buckland referred to Hunter as a "great man" and considered himself one of his "followers" in stressing the "necessity of studying comparative as well as human anatomy" (Buckland 1860, vi).⁸ Richard Owen, a correspondent, adviser, and one of his father's close friends, had had a long association with the Hunterian Museum at the Royal College of Surgeons, having been appointed assistant curator in 1827 and then curator in 1842, resigning in 1856 to take up a post at the British Museum. As the most eminent anatomist in Britain, Owen was widely regarded as having inherited Hunter's mantle. Yanni asserts that under Owen, the Hunterian was widely considered to be a "landmark in the display of natural history specimens" (Yanni 1999, 49). Through Owen, Buckland would have grasped the connection between the Hunterian emphasis on close observation and hands-on experience and the specimen as part of a museum exhibit (Rupke 1994, 297).

After Buckland became interested in fish culture, he set up a small fish hatching apparatus at the South Kensington Museum in 1863. Adding plaster casts of fish and other specimens over the years, the hatching apparatus evolved into a museum, which moved several times before being established in its final location at South Kensington in 1872 (Burgess 1968, opposite 116). The Museum of Economic Fish Culture was meant to educate the public on the natural history of fish, their commercial uses, and the development of English fisheries (figure 4.2). But it was not designed to impart information about systematics or anatomy. The specimens were arranged haphazardly. The visitor was meant to be entertained, not just instructed. Casts of fish were mounted on the wall. Various specimens were put on platforms on the floor. Small fish swam up a model salmon ladder. The museum attracted visitors of all kinds, including members of the royal family. In 1876, Queen Victoria herself visited it (Burgess 1968, 125; Bompas 1909, 279). According to Bompas, Buckland lectured there in the early 1870s (Bompas 1909, 257). It was fitting that a public speaker who had tried to construct ephemeral sites for science all over England by drawing upon the culture of display should go on to build his own museum and lecture in it.

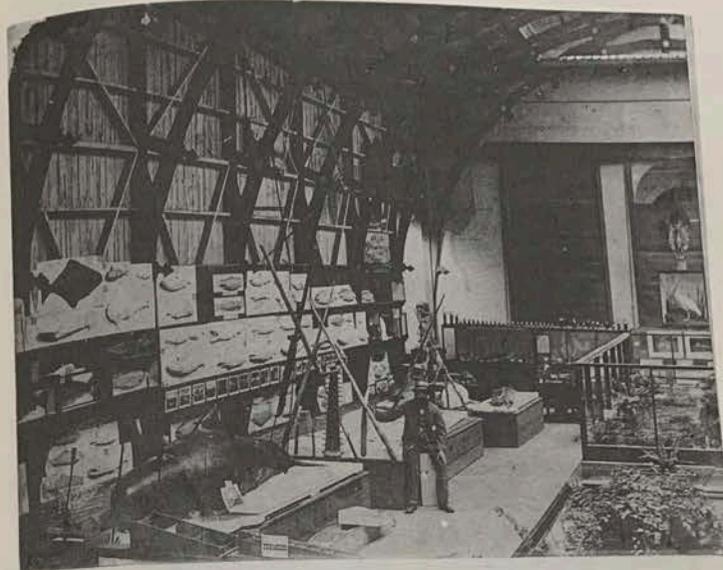


Figure 4.2. Photograph of Buckland in his Fish Museum at South Kensington. Reprinted by kind permission of the president and council of the Royal College of Surgeons of England from *Frank Buckland, Records of My Life* [Commonplace Book], vol. 2, p. 282, Library, Royal College of Surgeons, London.

Pepper, Theater, and the Polytechnic

During the 1860s, a humorous song about John Henry Pepper and the Royal Polytechnic Institution began to circulate. It was titled "Laughing Gas or A Night at the Polytechnic." The song tells a story about a young man from rural England, Humphrey Brown, who has come to London to visit all of the popular London entertainments, including Pepper's own establishment. Exhausted by his busy day, Brown falls asleep in the Polytechnic lecture room and awakens to find that he is locked in for the night. Afraid of meeting one of Pepper's famous ghost illusions, he shores up his courage by swallowing the contents of a container marked "Improved Laughing Gas." He begins to feel light headed, as if he were drunk, and laughs uncontrollably. Then he explores the Polytechnic in this peculiar condition, playing with all of the exhibits (Nash [1860?]). The composer and singer of the song, John Nash (1830–1901), was a well-known music-hall artist and comedian (figure 4.3). An iron smelter as a youth, he was billed as "The



Figure 4.3. Illustration of John Nash, frontispiece, John Nash, *Laughing Gas or a Night at the Polytechnic*. Reprinted from Nash [1860?], courtesy of the Wellcome Library, London.

Laughing Blacksmith" when he became an entertainer in the Midlands. He performed at the South London Music Hall in 1860 and then at the Oxford Music Hall the following year. He toured the United States in 1874 and in 1876 and later formed his own touring company that he took across the Atlantic in 1886. He was the first music-hall artist to perform at royal command. In the *Cambridge Guide to Theatre*, Nash is described as "a spe-

cialist in silly walks" and in the *Oxford Companion to Popular Music* as one who "pioneered the laughing song" (Gammond 1991, 415–16; Banham 1995, 777–78). Nash liked to refer to himself as "Jolly John Nash," and to prove he deserved the nickname, he composed and published a song in the 1890s titled "I'm such a jolly Man."

Nash's selection of Pepper and the Polytechnic as an appropriate topic for a music-hall song is indicative of their popularity in the 1860s.⁹ Though Altick, in his *Shows of London*, treats the Polytechnic Institution as an integral part of the London entertainment scene, he criticizes the inclusion of more-popular entertainment in the programs of the galleries of practical science. In the case of the Adelaide Gallery, it failed because it "became indistinguishable from the miscellaneous shows not far away in Leicester Square." Similarly, the Polytechnic, Altick claims, incorporated popular performances from the London amusement circuit in reaction to public pressure to entertain, and this action took it away from its "announced serious purpose" (Altick 1978, 382, 386). Pepper would have disagreed. As manager of the Polytechnic, he chose to include more-popular entertainment features and did not perceive them to be inconsistent with the goal of scientific instruction. Moreover, Pepper would have looked at Nash's song as evidence of the expanding force of science into popular culture and as proof of the success of his strategy to link instruction more closely to entertainment. Pepper was particularly interested in capitalizing on the theater as a vehicle for reaching out to general audiences, both in his lectures and in the Polytechnic. In his position as manager of the Polytechnic, Pepper had the opportunity to refashion an influential institution of science that could serve as a friendly home for his theatrical lecturing activities. Later in this volume, Morus discusses the Polytechnic and Pepper's role within this institution. Whereas Morus has focused on Pepper's use of technological display in his ghost illusion in this volume, I will discuss his lecturing in general and how it combined entertainment and instruction.

Born on June 17, 1821, in Westminster, to Charles Bailey Pepper, a civil engineer, John Henry Pepper (figure 4.4) was educated at King's College School and then later studied analytic chemistry at the Russell Institution with J. T. Cooper. In 1840, Pepper was appointed assistant chemical lecturer at a private school of medicine run by R. D. Grainger. He was hired at the Polytechnic as lecturer and analytic chemist in 1848 and then as manager in 1854. He continued in this role, with some short interruptions, until 1872, when he resigned for good after a quarrel with the board of directors over the extent of his autonomy. During his time at the Polytechnic, he published five science books for the public, including *The Boy's Playbook of*

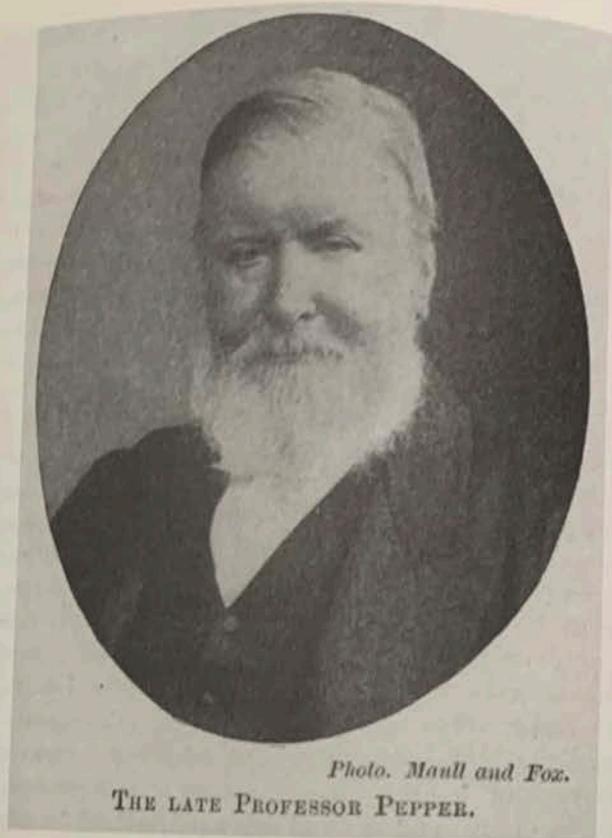


Figure 4.4. Illustration of John Henry Pepper. Reprinted from "Personal," *Illustrated London News* 116 (April 14, 1900), 503.

Science in 1860, and established himself as one of the premier showmen of science.¹⁰ He tried to re-create his successful form of science entertainment at the Egyptian Hall in Piccadilly but lost money on the venture, and he went on tour in the United States, Canada, and Australia from 1874 to 1881. He accepted the post of public analyst in Brisbane, Australia, in 1881, stayed there until 1889, and then returned to England, where he remained until his death in 1900 (Boase 1965, 386–87; Cane 1974–75, 116–28; *Second* 2002, 1648–49; Brock 2004, 1572–73).

Pepper had a reputation for being a lively speaker. Up until the early 1860s, he lectured on various topics, mostly in the physical sciences (figure 4.5). In 1850, he was lecturing on the chemistry of hydrogen, in 1851

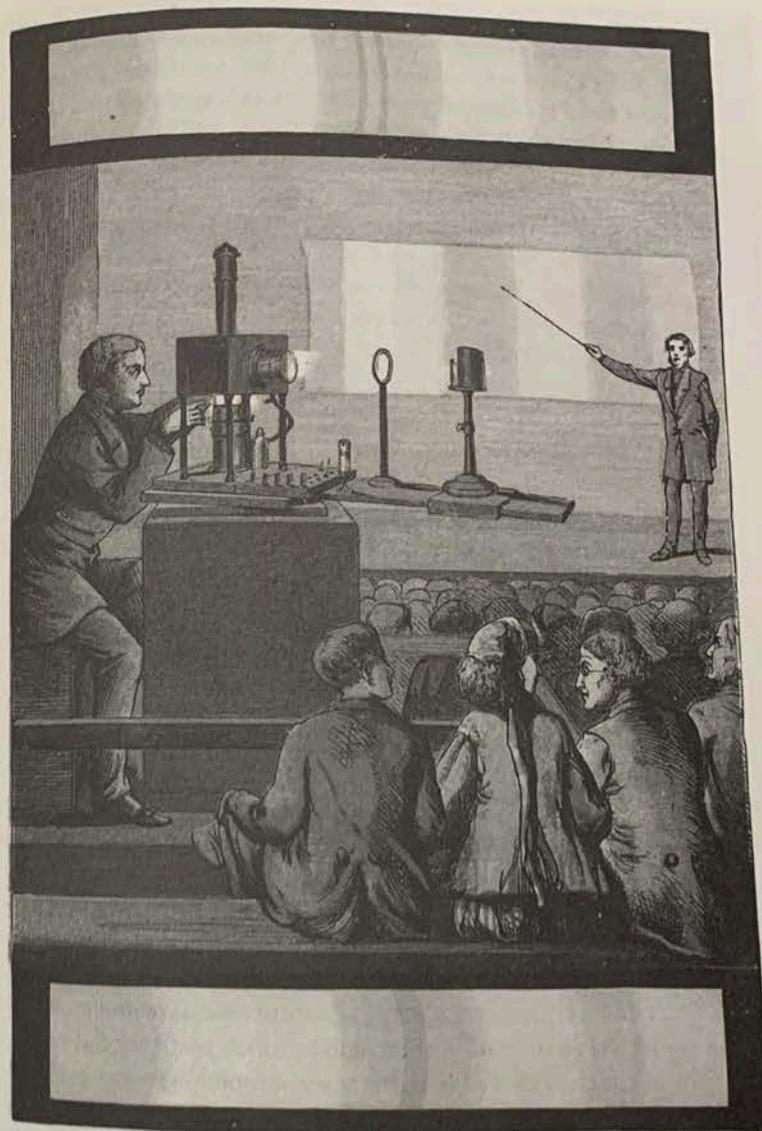


Figure 4.5. Illustration of Pepper lecturing at the Royal Polytechnic Institute on spectrum analysis. Reprinted from J. H. Pepper, *Cyclopaedic Science Simplified* (London: Frederick Warne, 1869), frontispiece.

on the chemistry of the minerals and crystals at the Great Exhibition, in 1854 on the Crimea and "Munitions of War," and in 1857 on "A Scuttle of Coals" (Press Cuttings n.d.; "Royal Polytechnic Institution" 1854b, 335). Audiences found his lectures vastly entertaining. The *Illustrated London News* reported on a lecture given by Pepper in 1854 to "a large audience" on the chemistry of nonmetallic elements "in his usual popular and interesting style" ("Royal Polytechnic Institute" 1854, 179). Even the *Fun* reporter, who remarked that Pepper "goes into ecstasies a little too often," judged that his lecture was "well worth hearing" (Our Special Sightseer 1870, 223). According to Layton, Pepper's lectures deserve an important place in the history of science education, and they had an impact on such important scientists as Sir Henry Roscoe, Sir Ambrose Fleming, and H. E. Armstrong (Layton 1977, 538).

The Royal Polytechnic Institution, founded in 1838, was an unusual institution even before Pepper arrived on the scene (Morris 1998, 82). Though it served multiple purposes like other institutions of science—the Royal Institution, for example, contained both a laboratory and a lecture hall—the Polytechnic was even more diverse. It was equipped with industrial tools and machines, a laboratory, a lecture theater, and a large display room, known as the Great Hall, where the main exhibits were housed (figure 4.6). Among the main exhibits were the diving bell and diver, an oxyhydrogen microscope, large electrical machines, and model boats floating in a long canal. The diving bell, one of the feature attractions, provided a unique experience for visitors. Four to five persons could fit inside while it was submerged. In light of the wide range of activities, what, exactly, was the Polytechnic? Was it a museum, or a laboratory, or a lecture theater, or an exhibition hall, or even an amusement park? A contemporary guide to London placed it under the heading of "Miscellaneous Exhibitions," along with the Colosseum, Egyptian Hall, the Royal Panopticon of Science and Art, Wyld's Model of the Globe, Madame Tussaud and Son's Exhibition, and exhibits of dioramas and panoramas, rather than with the Royal Institution under "Educational and Scientific Institutions" (*London as it is to-day* 1850, 268). As an indication of the Polytechnic's institutional novelty, Gerard Turner referred to it as "the first science center" (Turner 1987, 397). Even before Pepper took over as manager, the Polytechnic served multiple purposes and drew together in one hybrid location multiple sites of science open to the public. But Pepper transformed the Polytechnic into a hybrid site in a second sense by adding cultural spaces associated with the shows of London to the mix. When Pepper took over the reins of the Polytechnic in 1854, the big question for the manager of this institution was how to at-



Figure 4.6. Illustration of the Great Hall. From University of Westminster Archive, 8 (b), n.d., courtesy of University of Westminster Archive Services.

tract customers whose expectations had been raised by their experiences exploring the Crystal Palace on shilling days. The Polytechnic's offerings must have seemed meager in comparison (Altick 1978, 472–73).

In 1850, *Household Words* recommended that the Polytechnic offer the public more than exhibitions of industrial machinery. "There is a range of imagination in most of us," the anonymous writer stated, "which no amount of steam-engines will satisfy." Though the Polytechnic was a "wonderful place," the author was of the opinion that "a people formed entirely in their hours of leisure by Polytechnic Institutions would be an uncomfortable community." Since it is probable "that nothing will ever root out entertainment in some form or other," the Polytechnic, and institutions like it, had to offer some type of dramatic amusements ("Amusements of the People" 1850, 13). Whether Pepper ever read the *Household Words* article is not clear, but shortly after he became director of the Polytechnic, he began experimenting with theatrical entertainments. In 1854, the *Athenaeum* announced that "GOOD DRAMATIC READINGS are now added to the other attractions of the Institution" ("Royal Polytechnic Institution" 1854a, 1306). Pepper stuck mainly to Shakespeare, introducing dramatic readings from *The Merchant of Venice*, *Hamlet*, and *Romeo and Juliet*. It was but a short step to experiment with scenes of plays and then entire plays. A jokester in *Punch* noted in 1854 that "the proprietors of the Polytechnic and Panopticon are about to introduce dramatic readings and singsongs as part of their attractions" and claimed to see no reason why plays shouldn't be used to further scientific education. But then the journalist poked fun at Pepper's innovation by offering some light-hearted suggestions, such as the creation of new plays set in the laboratory where "scenes of thrilling interest might easily be got up with the voltaic battery" ("Philosophical Drama" 1854).

In the early 1860s, Pepper increasingly exploited the relationship between the Polytechnic and the London entertainment scene (Secord 2002, 1648). Theater and, to some extent, music were the forms of popular entertainment that best suited his mix of instruction and entertainment (Brooker 2005). Panoramic and dioramic spectacle had begun to be widely used in some forms of dramatic production in London in the 1820s, contributing to the popularity of theater (Mayer 1969, 69–70; Meisel 1983, 33–62, 380–84). Allen argues that the Victorians' insatiable appetite for novels was matched only by their voracious hunger for theatrical entertainment in all its forms, including Shakespeare, melodrama, pantomime, music hall, freak show, dancing dogs, and pyrodrama (Allen 2003, 5). Victorians flocked to the London theaters in the 1850s when Pepper first became manager

of the Polytechnic, attracted by the Shakespearean revivals by Charles Kean and Samuel Phelps. Not only did they offer magnificent spectacles, which aimed to outdo the panoramas that had inspired them, but they also sought to make theater more respectable in order to draw in a higher class of clientele (Allen 2003, 20–21; Altick 1978, 473; Booth 1981, 2–3). Pepper would have realized that both the theater and public science were forms of mass-cultural entertainment, reliant on the steadily increasing number of consumers with money and leisure (Allen 2003, 6). The popularity of theater may have made it more difficult for the Polytechnic to compete in the London entertainment scene, as Altick asserts, but it also provided Pepper with a model of a successful public cultural form that inspired his redefinition of the practice of public science at the Polytechnic, including the nature of his lectures (Altick 1978, 473). Pepper's self-fashioning as a lecturer and his institution fashioning of the Polytechnic as an appropriate scene for his lecturing activities were intimately connected.

Pepper took the theatrics of science to a whole new level when he came across a new scientific principle for generating surprisingly realistic optical illusions suggested by the inventor Henry Dircks. Pepper had already been lecturing on "Optical Illusions" in 1856 and on "Remarkable Optical Illusions" in 1857 and saw this as an area that could attract a substantial audience ("Royal Polytechnic" 1856, 1612; "Royal Polytechnic Institution" 1857, 35). But just before Christmas Day in 1862, Dircks's invention, vastly improved by Pepper, was used to produce a ghost illusion that stunned a small audience of scientific friends and members of the press previewing a performance of Edward Bulwer-Lytton's "A Strange Story" at the Polytechnic. Instead of explaining how the illusion worked, as he had intended, the following day he hurriedly took out a provisional patent, sensing its almost unlimited potential (Pepper 1890, 3). Pepper prepared a companion lecture for the play, "A Strange Lecture," where he explained the wonders produced by the "Photodrome," an optical apparatus that caused phantoms to appear at will ("Polytechnic Institution" 1863a, 19). At some point, Pepper began to tell a story in his "Strange Lecture," about a student who sees the apparition of a skeleton late at night and whose sword swings right through it (Pepper 1890, 29). By February, Pepper had introduced a new lecture, "Burning to Death, and Saving from Death," followed by the still popular ghost scenes from the "Strange Lecture." The "Spectre Drama" (figure 4.7) was playing in the morning and the evening, except on Tuesdays and Wednesdays ("Polytechnic" 1863a, 218). By Easter, the play had become so popular that it was moved into the larger theater of the Polytechnic where the dissolving views were usually exhibited. "Special

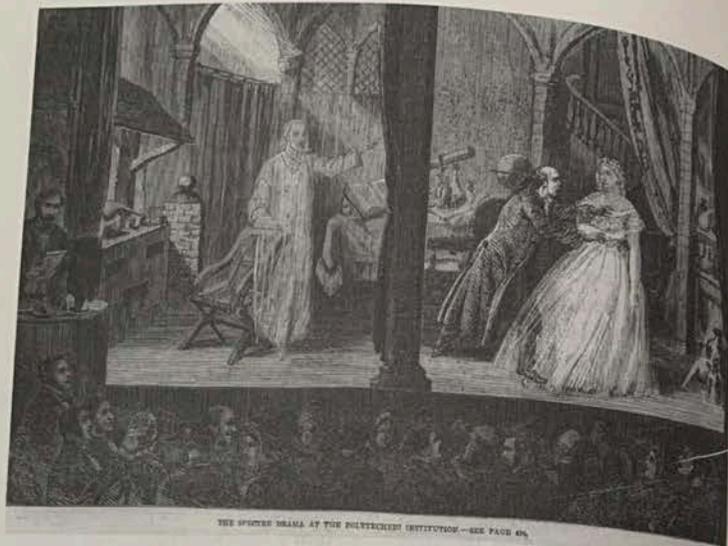


Figure 4.7. Illustration of "The Spectre Drama at the Polytechnic Institution."
Reprinted from "Spectre Drama at the Polytechnic Institution" 1863.

written permission" was obtained from Dickens to mount a production of his "The Haunted Man" as a vehicle for exhibiting the ghost illusion, and it ran for fifteen months (Pepper 1890, 12). In the years that followed, more plays were mounted featuring the ghost illusion, and they became a regular part of the Polytechnic's program. In December 1864, two new spectral tableaux were announced, entitled "The Indian Widow's Suttee" and "Snow White and Rosy Red" ("Royal Polytechnic" 1864, 666). In 1865, the *Times* announced that "Mr. Pepper's ghost is put to new uses in a dramatic entertainment, devised by Mr. Pepper himself and entitled the 'Poor Author Tested'" ("Polytechnic Institution" 1865a, 12).

Pepper also continued to lecture on ghosts and optical illusions and to mount new exhibits. On May 20, 1863, he delivered his ghost lecture to the queen and the royal family ("Polytechnic" 1863c, 9). The following month he was giving his ghost lecture twice a day ("Polytechnic" 1863b, 610). To keep the interest of his audiences, Pepper began to modify the illusion in order to present a variety of startling effects. In 1865, visitors to the Polytechnic could see the disembodied head of Socrates deliver a rhymed speech and Sir Joshua Reynolds's cherubs, or at least their heads, singing a choral song ("Polytechnic Institution" 1865b, 10). The following

year, the *Art-Journal* pointed out that Pepper, the Polytechnic, and optical illusions were inextricably connected in the public's mind. According to the *Art-Journal*, "Mr. Pepper is true to himself and to the optical phenomena which he has associated as well with his own name as with the institution that is identified with him; and so, . . . he passes . . . to fresh applications of the optical illusive impersonations that now are expected to be displayed at the Polytechnic." To the disembodied head of Socrates he had added Shakespearean creations, including the floating and speaking heads of Hamlet and Lear ("Polytechnic Institution" 1866a, 256). As a result of Pepper's innovations, the public never seemed to tire of his optical illusions.¹¹ In 1866, an advertisement in the *Illustrated London News* claimed that 109,000 visitors had already seen them ("Royal Polytechnic" 1866, 511). Pepper's ghost had become such a fixture in the Polytechnic that a notice in November 1870 listing the attractions at the Polytechnic announced "the explanation of the Ghost as usual" ("Royal Polytechnic" 1870, 538).

Pepper's theatrical use of the ghost in his lectures and the dramatic productions at the Polytechnic was, to him, completely in line with the scientific aims of his institution, and it was seen by the press in this light as well. The *Illustrated London News* presented an engraving of the strange optical effects in May 1863, shortly after their first appearance, "as produced on their original stage—the boards of the Polytechnic for purposes purely scientific" ("Spectre Drama at the Polytechnic Institution" 1863, 486). The *Times* of London recognized that illusions were used by Pepper to educate the public on the principles of optics. "Optics," the *Times* declared in 1866, "still predominate at the Polytechnic, reflection and refraction." Whereas the principle of reflection was illustrated in Pepper's lecture on Brewster's discoveries, in the appearance of the disembodied heads of Hamlet and Macbeth, and in the exhibition of the floating cherubs of Sir Joshua Reynolds, refraction was demonstrated in a series of dissolving views of the "Lady of the Lake" ("Polytechnic Institution" 1866b, 10). Entertaining and spectacular, his lectures were nevertheless intended to be instructive.

In lectures delivered in the late 1860s, Pepper also drew on his optical illusions to expose the fraudulence of spiritualists. The *Times* reported on a series of lectures by Pepper in 1867 and 1868 that dealt with spiritualism. On December 23, 1867, Pepper lectured on the frauds who claimed to produce spiritual manifestations ("Polytechnic Institution" 1867, 6). On March 9, 1868, he presented another lecture on spiritual manifestations, arguing that, in the words of the reporter, "effects vulgarly supposed to indicate supernatural causes are admirably produced by natural means"

("Polytechnic Institution" 1868a, 7). A *Times* article on his lecture on April 14, 1868, reported that he "denounced the utter absurdity of table-turning and spirit-rapping. He endeavoured to show that on his platform, fitted up as an ordinary drawing-room, he could exhibit the most striking of the spiritual manifestations with which Mr. Home and others a few seasons ago startled the London public." Pepper then mesmerized a few medium and seemingly levitated her, chairs, and tables ("Polytechnic Institution" 1868b, 9). Fearing that the spiritualists were seducing uninformed audiences, Pepper was willing to be as dramatic as his opponents.

Pepper's increased emphasis on entertainment in his lectures and in the Polytechnic in general transformed it into one of the leading London entertainment venues in the 1860s.¹² One periodical described the Christmas program at the Polytechnic for 1862, with particular reference to Pepper's optical illusions, as "unusually varied and interesting," so much so that the institution was now "in a position it has not enjoyed for several years at least—namely, in a highly prosperous and paying position" ("Polytechnic Institution" 1863b). The *Illustrated London News* judged in 1865 that the lineup of attractions offered during the Christmas season, including Pepper's ghost, placed the Polytechnic at the top of the list of best holiday amusements. There is "nothing similar in the metropolis that can compete," the newspaper announced ("Christmas Amusements" 1865, 19). However Pepper allowed the ghost to haunt other London theaters. The Haymarket, the Britannia, the Adelphi, and Drury Lane were among those theaters that took out licenses to use the illusion (Pepper 1890, 30). Pepper's ghost became so omnipresent in London at one point that *Punch* complained in October 1863 that "there is now a glut of ghosts everywhere" ("Ghosts without Spirit" 1863, 146). The ghost and some of Pepper's other illusions were later shown outside London, appearing at Leatherhead (just south of London) and Norwich (Magic and Mystery Box 2 n.d.). The adventures of young Humphrey Brown in "Jolly" Jack Nash's ditty, "Laughing Gas," is another reminder of Pepper's success. Nash mentions many of the feature attractions in his song, and the humor assumes that his audience is familiar with them. Under the influence of the laughing gas he has swallowed, Nash's country bumpkin wanders around the Polytechnic as if in a dream. "He saw Cherubs floating about in the air," put on the diver's suit and "made love to the diving Bell," turned on the "dissolving views," and, after bumping into the induction coil, received the shock of his life [Nash [1860?], 5]. Pepper's incorporation of the theatrical into his lectures and the general program of the Polytechnic led to a remolding of this crucial site of public science. A self-fashioned theatrical

lecturer par excellence, Pepper simultaneously embarked on an ambitious project of institution fashioning. It not only changed the terms on which science could be defined as "popular," it also gave science a prominent place in the London entertainment scene. In the process, Pepper created a new public space for science that, unlike the Royal Institution, was open to an audience composed of a more diverse social composition.

Pepper's bid to reenvision the spaces of public science by incorporating more theater led to a debate in the periodical press about whether the Polytechnic had gone too far in the direction of entertainment. This debate went to the heart of the questions: What kind of science should be provided for the general public? What was the appropriate mixture of entertainment and instruction in such science? Pepper's approach had led to a definition of "popular" science that was not universally accepted. Some periodicals praised the Polytechnic's measured balance of entertainment and instruction both before and during the time when Pepper was in control. In 1844, the *Pictorial Times* declared that "in no exhibition in London are amusement and instruction so thoroughly combined" ("Easter Monday and Its Amusements" 1844, 233). Later, similar expressions of satisfaction were expressed. One journal stated in 1862 that "at the Polytechnic Institution, science and fun will hold joint festival," another asserted that "the Polytechnic makes science amusing, and amusement it causes to become scientific," while a third affirmed that in combining "no little instruction with a good deal of amusement" the Polytechnic's attractions "are just suited therefore to the taste of that large section of sightseers who care little for theatre or wish to vary their amusements" (Press Cuttings n.d.; "Polytechnic Institution" 1866a, 256; "Polytechnic" 1869, 10). In 1880, eight years after Pepper had resigned from the Polytechnic for good, *Punch* compared his accomplishments with those of the new directors, who "did not seek to disguise the fact that in their opinion chemistry had been unduly sacrificed to comic entertainments, and that mechanical engineering had been altogether put on one side to make room for 'ghosts' and optical illusions." Not only did the reporter find that entertainment remained on the program, in acts such as the singing Adeson Family and a ventriloquist, but their unimpressive performances led him to recall "the past glories of the old place" ("Round About Town" 1880, 133). The ideal goal for public science institutions was to strive toward a perfect mix between instruction and entertainment, and for these periodicals, the Polytechnic under Pepper's regime had provided a model of how to achieve the proper balance.

Others agreed on the ideal but did not see the Polytechnic as having embodied it. For some, the Polytechnic needed more instruction and less

entertainment. A visiting *Punch* reporter observed the confusion of two Frenchmen at the Polytechnic in 1865 when they viewed the entertainment. Under the impression that the Polytechnic "was The Literary and Scientific Institution of England," the two foreigners mistook "the comic dialogue as the lecture of some learned profession" and wondered if they should have come at all ("A Wonderful Shillingsworth" 1865, 236). When Pepper briefly retired from his position as manager of the Polytechnic in 1858, the *Illustrated London News* hoped that his successor would "not permit the desire of gain to pervert it to the more ordinary ends of mere amusement," adding that lately "there was a tendency this way, as if amusement were about to supersede instruction" ("Royal Polytechnic Institution" 1858, 631). A few months later, with Pepper still out of the picture, the *Illustrated London News* praised the new management for banishing "everything which is not in some way connected with the purposes for which it was originally designed, and substituted in the room of exhibitions fit only for a place of mere amusement lectures on all subjects connected with popular science and natural philosophy" ("Polytechnic Institution" 1858, 241).

But where some were critical of the Polytechnic for its seeming emphasis on entertainment, others saw it as presenting too much instruction. The *Illustrated London News* had just three months earlier encouraged the new management to reduce the amount of sugarcoating needed to induce visitors to swallow the bitter pill of instruction. During the Christmas season, it pleaded for more sugar as "just now, we don't want the pill at all" ("Christmas Holidays" 1858, 608). In 1869, a reporter from *All the Year Round* recalled visiting the Polytechnic as a boy and suspected that he had been lured there under false pretenses. "There was an indefinable feeling," he remembered, "as if it were not a real, out-and-out, holiday place: as if our education were in some way going on whenever we were there. Instruction, we felt, lurked behind amusement, and it was impossible to forecast from the programme of the entertainments, exactly at what point the baleful genius of mental improvement might be expected to claim its victim." Whatever the reactions of boys of the past, the reporter thought that the boys of 1869 might find the Polytechnic somewhat dull ("Playing with Lightning" 1869, 617). The combination of instruction and entertainment in public science proved during this period to be volatile and unstable. At what point did science lecturers like Pepper go too far in incorporating entertainment? Was there a point at which they ceased to present popular science and offered mere amusement?

Refashioned Sites, Changing Experiences, and Scientific Spaces

In the post-Crystal Palace era, science lecturing was a competitive business. Wood barely eked out a living as a lecturer and scientific author, even though the popularity of his sketch lectures led to extensive tours across England and to the United States. Not only were lecturers competing with one another to draw audiences, they were also vying with the theater, the panorama, the exhibition, museums, and other forms of popular entertainment. In order to compete, both Pepper and Buckland refashioned the sites at which they lectured by bringing in elements drawn from cultural spaces associated with the world of entertainment. When Buckland went to speak at various sites around England, he transformed them by incorporating features of the freak show, the zoo, and the museum in his lectures. Pepper's Polytechnic was a new kind of hybrid scientific institution, which included elements of the exhibition hall, museum, laboratory, and lecture hall all under one roof. But Pepper refashioned this already existing site through his use of the theatrical. In the process of refashioning these sites, Pepper and Buckland also reformulated scientific lecturing and thereby provided new experiences for their audiences. Pepper's audiences could be terrified by the appearance of his ghost and then calmed and edified by his scientific explanation for apparent supernatural phenomena. When Buckland lectured, his audience was amused by his racy style, fascinated by exotic specimens, and taught to see design in the scheme of things. Instead of sermonizing, predominantly an aural experience, Pepper, Buckland, Ball, and Wood incorporated a variety of visual elements into their lecturing. More than ever, those who attended lectures experienced science as if it were part of the world of entertainment.

Though the inclusion of more entertainment in lecturing raised questions about the validity of "popular" science, it also allowed Buckland, Pepper, and other lecturers to bring science into new spaces and thereby into the center of Victorian culture. Alberti has remarked that the inclusion of lectures and displays relating to science side by side with musical performances and other entertainments in a typical conversazione program reflected "both the heterogeneity of Victorian institutional culture, and the increasing prominence of natural knowledge within it" (Alberti 2003, 215). One of the hallmarks of science from about 1830 was the proliferation of its sites. More and more science periodicals began to appear, accompanied by a huge explosion of books, periodical literature, museums,

exhibitions, and many other sites that are explored in this book. In older stories about the formation of the worship of science from about 1850 to 1890, historians tended to credit elite scientists such as Darwin or Huxley of Victorians. But as scientific naturalists began to cultivate the strategy of professionalization, it committed them to privileging select spaces in which to practice legitimate science, such as the laboratory above all else. They were also selective about the sites in which they would communicate the results of their research and their views on the broader implications of scientific discoveries, whether it be in the *Nineteenth Century*, *Nature*, or other respectable periodicals, in elite scientific institutions such as the Royal Institution or the annual meeting of the British Association for the Advancement of Science, or on carefully organized lecture tours abroad. By pursuing professionalization as a route to reforming science, scientific naturalists left huge cultural spaces open to lecturers such as Pepper and Buckland. They and individuals like them set out to fill up all of the cultural nooks and crannies they could find with science and to expand the extent and nature of the diverse sites of science. As a result, they altered the spatial economy of science.

NOTES

I am indebted to James Secord, whose work on John Henry Pepper gave me the basic idea for this piece. He also identified some of the illustrations and commented on an early draft of the essay. William Brock, Jeremy Brooker, Mark Butterworth, Jill Howard, Frank James, and Dana Rovang all supplied me with useful insights into various aspects of popular science lecturing. This piece was vastly improved as a result of the attention of Aileen Fyfe's keen editorial eye. Jean Koo obtained copies of the illustrations as well as permissions to reproduce them. I am grateful to Brenda Weeden, Elaine Penn, and the staff at the University of Westminster Archives for their crucial help in locating key sources on the Royal Polytechnic Institute. Quotations from materials held at the University of Westminster Archives are reproduced by courtesy of the University of Westminster Archive Services. Quotations from Frank Buckland's *Commonplace Book* are reproduced by kind permission of the President and Council of the Royal College of Surgeons of England.

1. The Lowell Institute was established after the death of John Lowell Jr. in 1839 when he left \$250,000 to endow a public series of lectures by well-known intellectual figures. The physicist John Tyndall gave the lectures in 1872, and J. G. Wood delivered a series of twelve lectures in 1883 (Sopka 1981, 193, 202; Wood [1890], 189).

2. Some Christian groups were also moving away from traditional forms of worship in the latter half of the century. For a study on how evangelical Protestant groups used the theater as the basis for reenvisioning their worship space, see Kilde 2002.

3. I am using the term *spatial economy of science* as a playful parallel to the nineteenth century notions of economy, and economy of nature, that signified an interlocking, complex system in overall balance. By *spatial economy of science*, I hope to convey the idea of a complicated system of people, actions, and movements occupying diverse spaces and places in the marketplace of science.

4. For a more recent and detailed analysis of Davy's lecturing, see Golinski 1992, 188–285. Ralph O'Connor has pointed out that geologic lecturers such as Gideon Mantell and Hugh Miller still appealed to moral and poetic elevation after 1830 (O'Connor 2003). Hays's assertion that such appeals were no longer in vogue must therefore be qualified.

5. For a discussion of the public lecture as a means of scientific education in this period, see Inkster 1980.

6. There are two biographies of Frank Buckland: Bompas 1909 and Burgess 1968.

7. Buckland may have found the basic theme for his lecture in the American William Alcott's 1834 book *The House I Live In; or, The Structure and Functions of the Human Body*. First published in 1837 in England, Buckland likely encountered this work on physiology as a medical student. He used a similar title for the lecture and drew the same analogies, and he adopted the natural theology framework. In his preface, the editor, Thomas C. Girtin, presented the book more as "an appropriate introduction" to Paley and natural theology than as a physiology handbook ([Alcott] 1837, v). I am indebted to Aileen Fyfe for pointing this out.

8. Buckland maintained his high regard for Hunter throughout his life. In *Notes and Jottings from Animal Life*, Buckland remarked that as Hunter was the "founder of the system of modern surgery, and the discoverer of many of Nature's sanitary laws, [he] may be justly regarded as one of the greatest benefactors to the human race" (Buckland 1882, 84).

9. Nash's song about the Polytechnic should not be seen as unusual because scientific themes were taken up in the performing arts, including burlesque, throughout the nineteenth century. Jane R. Goodall has explored the appearance of evolutionary themes in the performing arts during Darwin's lifetime (Goodall 2002).

10. For a current reprint edition of this book with a useful introduction by Jim Secord, see Pepper 2003.

11. For a discussion of some of Pepper's other illusions, see Lamb 1976, 43–50.

12. Altick's account of the declining fortunes of the Royal Polytechnic Institution in the 1860s, after an unfortunate accident that claimed the life of a young girl in 1858, is somewhat misleading. According to him, the Polytechnic never recovered despite being rescued temporarily by the introduction of Pepper's ghost (Altick 1978, 388–89). Although the Polytechnic was in a precarious economic position, it nevertheless managed to pull in the crowds up until Pepper's departure in 1872.

REFERENCES

- Alberti, Samuel J. M. M. 2003. "Conversazioni and the Experience of Science in Victorian England." *Journal of Victorian Culture* 8:208–30.
- [Alcott, William]. 1837. *The House I Live In; or, The Structure and Functions of the Human Body*. Ed. Thomas C. Girtin. London: John W. Parker.
- Allen, Emily. 2003. *Theatre Figures: The Production of the Nineteenth-Century British Novel*. Columbus: Ohio State University Press.
- Altick, Richard D. 1978. *The Shows of London*. Cambridge, MA: Harvard University Press, Belknap Press.
- "Amusements of the People." 1850. *Household Words* 1:13–15.
- Ball, W. Valentine, ed. 1915. *Reminiscences and Letters of Sir Robert Ball*. London: Cassell.
- Banham, Martin. 1995. *The Cambridge Guide to Theatre*. Cambridge: Cambridge University Press.
- Boase, Frederic. 1965. "Pepper, John Henry." In *Modern English Biography, Volume VI L–Z, Supplement to Volume III*, 386–7. London: Frank Cass.
- Bompas, George C. 1909. *Life of Frank Buckland*. London: Thomas Nelson and Sons.
- Booth, Michael R. 1981. *Victorian Spectacular Theatre 1850–1910*. Boston: Routledge and Kegan Paul.
- Brock, W. H. 2004. "Pepper, John Henry." In *Dictionary of Nineteenth-Century British Scientists*, vol. 3, ed. Bernard Lightman, 1572–73. Bristol: Thoemmes Continuum.
- Brooker, Jeremy. 2005. "Paganini's Ghost: Musical Resources of the Royal Polytechnical Institution." In *Realms of Light: Uses and Perceptions of the Magic Lantern from the Seventeenth to the Twenty-first Century*, ed. Richard Crangle, Mervyn Heard, and Ine van Dooren, 146–54. London: Magic Lantern Society.
- Buckland, Francis T. 1860. *Curiosities of Natural History*. 4th London ed. New York: Rudd and Carleton.
- . 1882. *Notes and Jottings from Animal Life*. London: Smith, Elder.
- Burgess, G. H. O. 1968. *The Eccentric Ark: The Curious World of Frank Buckland*. New York: Horizon Press.
- Cane, R. F. 1974–75. "John H. Pepper—Analyst and Rainmaker." *Journal of the Royal Historical Society of Queensland* 9:116–28.
- "Christmas Amusements." 1865. *Illustrated London News* 46 (January 7): 19.
- "Christmas Holidays." 1858. *Illustrated London News* 33 (December 25): 608.
- Collins, J. P., and J. Walter Smith. 1915. "Robert Ball, a Star Among Star Gazers." *Boston Evening Transcript*, April 10, 5.
- County Record Office. 1892. "Memoranda of merits and disadvantages of accepting the Lowndean Chair 1892." R32/61. Shire Hall, Cambridge.
- Dawson, Gowan, Richard Noakes, and Jonathan R. Topham. 2004. Introduction to *Science in the Nineteenth-Century Periodical*, by Geoffrey Cantor, Gowan Dawson, Graeme Gooday, Richard Noakes, Sally Shuttleworth, and Jonathan R. Topham, 1–34. Cambridge: Cambridge University Press.
- "Easter Monday and Its Amusements." 1844. *Pictorial Times* 13: 233, in University of Westminster Archives, R Illust 11.
- "Fish and Oyster Culture." 1865. *Nottingham and Counties Daily Express*, March 4, 8.
- "Frank Buckland" 1880. *Nature* 23 (December): 175.
- Gammond, Peter. 1991. *The Oxford Companion to Popular Music*. Oxford: Oxford University Press.
- Gates, Barbara T., and Ann B. Shteir, eds. 1997. *Natural Eloquence: Women Reinscribe Science*. Madison: University of Wisconsin Press.
- "Ghosts without Spirit." 1863. *Punch* 45 (October 10): 146.
- "Gilchrist Lectures at Goole. Mr. Robert Ball on 'Other Worlds.'" 1890. *Goole Weekly Times*, January 10, 3.
- Golinski, Jan. 1992. *Science as Public Culture: Chemistry and Enlightenment in Britain, 1760–1820*. Cambridge: Cambridge University Press.
- Goodall, Jane R. 2002. *Performance and Evolution in the Age of Darwin: Out of the Natural Order*. London: Routledge.
- Hays, J. N. 1983. "The London Lecturing Empire, 1800–50." In *Metropolis and Province: Science in British Culture, 1780–1850*, ed. Ian Inkster and Jack Morrell, 91–119. Philadelphia: University of Pennsylvania Press.
- Inkster, Ian. 1980. "The Public Lecture as an Instrument of Science Education for Adults—The Case of Great Britain, c. 1750–1850." *Pedagogica Historica* 20:80–107.
- Jacyna, L. S. 1983. "Images of John Hunter in the Nineteenth Century." *History of Science* 21:85–108.
- John Bull*. 1861. In *Frank Buckland, Records of My Life* [Commonplace Book], vol. 2, p. 38, [Nov. 30, 1861], Library, Royal College of Surgeons, London.
- Kilde, Jeanne. 2002. *When Church Became Theatre: The Transformation of Evangelical Architecture and Worship in Nineteenth-Century America*. Oxford: Oxford University Press.
- Lamb, Geoffrey. 1976. *Victorian Magic*. London: Routledge and Kegan Paul.
- Layton, David. 1977. "Founding Fathers of Science Education (4): A Victorian Showman of Science." *New Scientist* 75 (September 1): 538–39.
- "Lecture at the Midland Institute on Tides." 1881. *Birmingham Daily Gazette*, October 25, 6.
- Lightman, Bernard. 2000. "The Visual Theology of Victorian Popularizers of Science: From Reverent Eye to Chemical Retina." *Isis* 91: 651–80.
- Livingstone, David N. 2003. *Putting Science in Its Place: Geographies of Scientific Knowledge*. Chicago: University of Chicago Press.

- London as it is To-Day: Where to Go, and What to See.* 1850. London: H. G. Clarke.
- Magic and Mystery Box 2. n.d. Ticket Show Places 27a and 27b, John Johnson Collection, Bodleian Library, Oxford University.
- Mayer, David III. 1969. *Harlequin in His Element: The English Pantomime, 1806–1836.* Cambridge, MA: Harvard University Press.
- Meisel, Martin. 1983. *Realizations: Narrative, Pictorial, and Theatrical Arts in Nineteenth-Century England.* Princeton, NJ: Princeton University Press.
- "Modern Astronomy. Prof. Ball's First Lecture at the Lowell Institute." 1884. *Boston Herald*, October 15, 4.
- Morus, Iwan Rhys. 1998. *Frankenstein's Children: Electricity, Exhibition, and Experiment in Early-Nineteenth-Century London.* Princeton, NJ: Princeton University Press.
- "Mr. Buckland on Natural History." 1861. *Windsor, Eton, and Slough Royal Standard and Four Counties General Advertiser* (Feb. 2), in *Frank Buckland, Records of My Life* [Commonplace Book], vol. 2, p. 6, Library, Royal College of Surgeons, London.
- Nash, John. [1860?]. *Laughing Gas or A Night at the Polytechnic.* London: Weippert.
- O'Connor, Ralph. 2003. "Hugh Miller and Geological Spectacle." In *Celebrating the Life and Times of Hugh Miller: Scotland in the Early 19th Century*, ed. Lester Borley, 237–58. Cromarty: Cromarty Arts Trust.
- Our Special Sightseer. 1870. "Monday Out." *Fun*, December 3, 223.
- Pepper, J. H. 1890. *The True History of the Ghost and All About Metempsychosis.* London: Cassell.
- . 2003. *The Boy's Playbook of Science*, vol. 6 of *Science for Children*, ed. Aileen Fyfe. Bristol: Thoemmes Press.
- "Philosophical Drama." 1854. *Punch* 27:179.
- "Playing with Lightning." 1869. *All the Year Round*, May 29, 617, in University of Westminster Archive, Original Cutting, R Illust 21b.
- "Polytechnic." 1863a. *Illustrated London News* 42 (February 28): 218.
- "Polytechnic." 1863b. *Illustrated London News* 42 (June 6): 610.
- "Polytechnic." 1863c. *Times* (London), May 20, 9.
- "Polytechnic." 1869. *Times* (London), March 30, 10.
- "Polytechnic Institution." 1858. *Illustrated London News* 33 (September 11): 241.
- "Polytechnic Institution." 1863a. *Illustrated London News* 42 (January 3): 19.
- "Polytechnic Institution." 1863b. [January 4], in University of Westminster Archives, R 82.
- "Polytechnic Institution." 1865a. *Times* (London), October 13, 12.
- "Polytechnic Institution." 1865b. *Times* (London), December 25, 10.
- "Polytechnic Institution." 1866a. *Art-Journal* 28:256, in University of Westminster Archives, Copies from Contemporary Periodicals.
- "Polytechnic Institution." 1866b. *Times* (London), April 10, 10.

- "Polytechnic Institution." 1867. *Times* (London), December 23, 6.
- "Polytechnic Institution." 1868a. *Times* (London), March 9, 7.
- "Polytechnic Institution." 1868b. *Times* (London), April 14, 9.
- "Polytechnic Institution." n.d. Book of Press Cuttings Relating to R[oyal] P[olytechnic] [Institution]. University of Westminster Archives. R 82.
- Prior, Katherine. 2004. "Gilchrist, John Borthwick." In *Oxford Dictionary of National Biography*, vol. 22, ed. H. C. G. Matthew and Brian Harrison, 217–20. Oxford: Oxford University Press.
- "Reading Room and Library." [1864]. *County Times*, in *Frank Buckland, Records of My Life* [Commonplace Book], vol. 2, p. 169, Library, Royal College of Surgeons, London.
- "Rev. J. G. Wood." 1890. *Saturday Review* 69:479.
- "Round About Town. At the Polytechnic." 1880. *Punch*, September 25, 133, in University of Westminster Archive, R82.
- "Royal Polytechnic." 1856. *Athenaeum*, December 27, 1612.
- "Royal Polytechnic." 1864. *Illustrated London News* 45 (December 31): 666.
- "Royal Polytechnic." 1866. *Illustrated London News* 48 (May 26): 511.
- "Royal Polytechnic." 1870. *Illustrated London News* 57 (November 26): 538.
- "Royal Polytechnic Institute." 1854. *Illustrated London News* 25 (August 26): 179.
- "Royal Polytechnic Institution." 1854a. *Athenaeum*, October 28, 1306.
- "Royal Polytechnic Institution." 1854b. *Illustrated London News* 25 (October 7): 335.
- "Royal Polytechnic Institution." 1857. *Art-Journal* 19:35, in University of Westminster Archive, Copies from Contemporary Periodicals.
- "Royal Polytechnic Institution." 1858. *Illustrated London News* 32 (June 26): 631.
- Rupke, Nicolaas A. 1994. *Richard Owen: Victorian Naturalist.* New Haven, CT: Yale University Press.
- Secord, James A. 2000. *Victorian Sensation: The Extraordinary Publication, Reception, and Secret Authorship of "Vestiges of the Natural History of Creation."* Chicago: University of Chicago Press.
- . 2002. "Quick and Magical Shaper of Science." *Science* 297 (September 6): 1648–49.
- "Sketch of Frank Buckland." 1885–86. *Popular Science Monthly* 28:406.
- Sopka, Katherine Russell. 1981. "John Tyndall: International Populariser of Science." In *John Tyndall: Essays on a Philosopher*, ed. W. H. Brock, N. D. McMillan, and R. C. Mollan, 193–203. Dublin: Royal Dublin Society.
- "Spectre Drama at the Polytechnic Institution." 1863. *Illustrated London News* 42 (May 2): 486.
- "St. John's School—Mr. Frank Buckland's Lecture on Natural History." 1863. *West London Observer*, November 7, in *Frank Buckland, Records of My Life* [Commonplace Book], vol. 2, p. 148, Library, Royal College of Surgeons, London.
- Turner, Gerard L'E. 1987. "Scientific Toys." *British Journal for the History of Science* 20:377–98.

- Upton, John. [1910]. *Three Great Naturalists*. London: Penguin Press.
- Walpole, Spencer. 1881. "Mr. Frank Buckland." *Macmillan's Magazine* 43 (February): 303-9.
- Wayman, P. A. 1986. "A Visit to Canada in 1884 by Sir Robert Ball." *Irish Astronomical Journal* 17:185-96.
- . 1987. *Dunsink Observatory, 1785-1985: A Bicentennial History*. Dublin: Dublin Institute for Advanced Studies and Royal Dublin Society.
- Wells, Ellen B. 1990. "J. G. Wood: Popular Natural Historian." *Book and Magazine Collector*, no. 79 (October): 56-64.
- Whitehead, Alfred. 1889. "The Late Rev. J. G. Wood." *Times* (London), March 9, 15.
- "Witney. Witney Natural History Society." 1861. *Jackson's Oxford Journal*, November 2, in *Frank Buckland, Records of My Life* [Commonplace Book], vol. 2, p. 48, Library, Royal College of Surgeons, London.
- "A Wonderful Shillingsworth!" 1865. *Punch* 49 (December 16): 236-37.
- Wood, Rev. Theodore. [1890]. *The Rev. J. G. Wood: His Life and Work*. New York: Cassell.
- "Working Men's Association Lecture." 1859. *Windsor and Eton Express*, February 12, in *Frank Buckland, Records of My Life* [Commonplace Book], vol. 1, p. 160, Library, Royal College of Surgeons, London.
- Yanni, Carla. 1999. *Nature's Museums: Victorian Science and the Architecture of Display*. London: Athlone Press.



SECTION II

Print