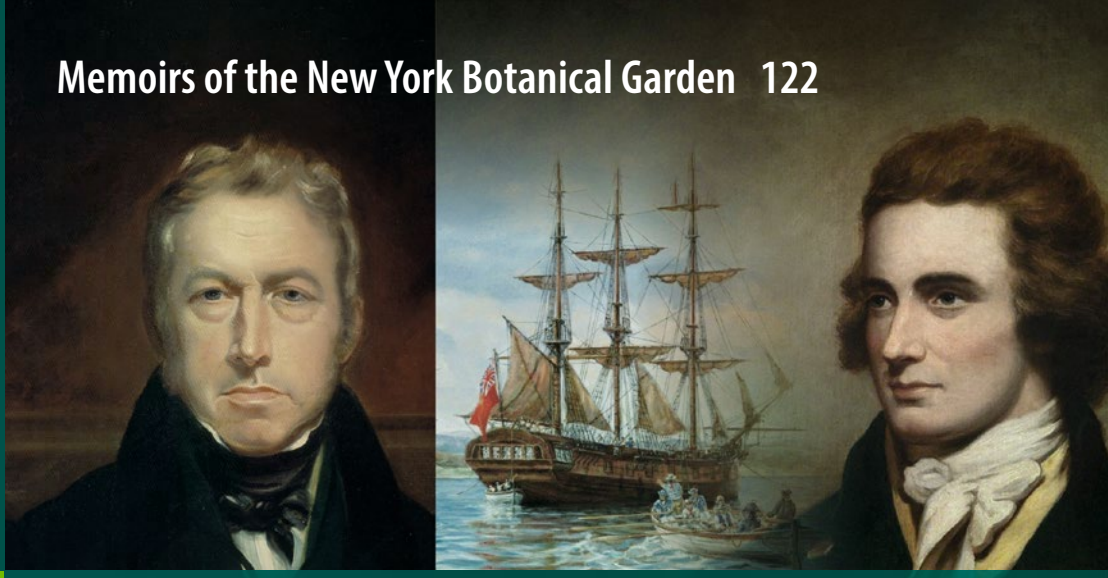
Memoirs of the New York Botanical Garden 122



Robert Brown and Mungo Park

Travels and Explorations in Natural History for the Royal Society

Joel Schwartz

New York Botanical Garden

Springer

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Travels and Explorations in Natural History for the Royal Society

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Cover images: (left) Portrait of Robert Brown by an unknown artist (detail), © The Trustees of the Natural History Museum, London; (center) H.M.S. Investigator, commanded by Matthew Flinders—July 1802 by John Sheard Grafton (detail), 2006, from Elynor Frances Olijnyk, AHA AAMH, Taking Possession: A Saga of the Great South Land (Marino, South Australia: Photographic Art Gallery, 2007), ©Photographic Art Gallery, 2007; (right) Portrait of Mungo Park by Atkinson Horsburgh, © Scottish Borders Council.

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In memory of my wife Rhoda Schwartz, a dedicated science teacher, whose light will shine forever.

Preface

In the lobby of the Royal Society of London, there is a fine staircase that ascends up to the research rooms of the library. On the wooden wall lining the back of the staircase, there are the names of the presidents of the Royal Society embedded in the wood in gilt lettering, beginning with the first, mathematician Viscount William Brouncker (serving from 1662 to 1677), and ending with the current president, biophysicist, Sir Venkatraman Ramakrishnan (since 2015). The names of many illustrious scientists are found in this group, including Sir Isaac Newton (1703–1727) and Thomas Henry Huxley (1883–1885). Naturalist and botanist Sir Joseph Banks's name stands out because he had the longest tenure of any other of these figures (1778–1820).

Joseph Banks (1743–1820) was a significant naturalist-explorer in his own right. He served as Captain James Cook's naturalist on H.M.S. *Endeavour*. As a result of his contributions and social position, he became the President of the Royal Society of London, an organization of the nation's most eminent thinkers and scientists founded in the 1660s. As President of the Royal Society, Banks enjoyed an exalted status in government circles. His long service as the Society's President (1778–1820) is testimony to that fact. Thus, he enjoyed a privileged position in British science.

Banks played an important role in determining policy with respect to scientific expeditions. He helped initiate investigations in natural history growing out of voyages of exploration. He was the focus of activity in natural history and other fields of scientific inquiry in Britain during his tenure at the Royal Society. He initiated most projects, and naturalists sought his attention and approval.[1] His leadership of the Society shaped Robert Brown and Mungo Park's careers.

Banks made several important voyages on his own before his leadership of the Society. As the naturalist on Cook's first epic journey on H.M.S. *Endeavour* (1768–1771), he helped prepare several young naturalists for botanical exploration, particularly his assistant, Daniel Solander (1733–1782), who originally was a

[1] See Patrick O'Brian's *Joseph Banks. A Life* (Boston: David R. Godine, 1993) and Susan Faye Cannon's *Science in culture: the early Victorian period* (New York: Science History Publications, 1978).

disciple of Linnaeus but chose to move to Britain and work under Banks. Many other naturalists were motivated to follow in Banks's footsteps. The varied collection of plants gathered from colonial territories influenced the development of botany. It has additional relevance for Americans because the origins of botany in the United States can, in part, be attributed to the work of Banks and his disciples.

Banks's experience as the naturalist on Captain Cook's first voyage around the world made him an advocate for journeys of exploration. He helped shape the development of botany, earth science, art, horticulture, and other aspects of British science and culture in the late eighteenth and early nineteenth centuries after his voyage on the *Endeavour*. All efforts to conduct travels on behalf of natural history in Britain went through him, and he had a role not only in the implementation of such projects but also in gathering the results of such journeys: the flora, fauna, fossils and other geological samples, and seeds of many of the plants that were collected. His greatest legacy was the effect he had on the naturalists who followed him into a career of exploration in natural history, particularly Robert Brown and Mungo Park.

Banks advanced international cooperation in science by maintaining contact with France during the French Revolution and the Napoleonic Wars. In spite of this open-minded attitude, the tensions from the Napoleonic Wars as well as other international events that occurred during most of his tenure as President often tested his belief that there should be no borders as far as science was concerned. This was borne out when the man he selected to be Captain of the *Investigator*, Matthew Flinders, was held captive by the French when hostilities between the British and French resumed before Flinders could safely return to England. Although Banks was unable to provide much assistance to Flinders, he never wavered from his belief that science should be a collaborative effort among scientists from many nations. Nevertheless, his role in organizing expeditions resulted in assisting Britain's interests in furthering its imperial ambitions. Sir Joseph Banks, therefore, was a central figure in the great expansion of scientific exploration in the late eighteenth and early nineteenth centuries and played a central role in the events discussed in this book.

Kew Gardens, NY, USA Joel Schwartz
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Acknowledgments

After my retirement from full-time teaching at the City University of New York, I conducted research for *Robert Brown and Mungo Park: Travels and Explorations in Natural History for the Royal Society*. At about the same time, I was also completing my previous book, *Darwin's Disciple, George John Romanes, A Life in Letters*. During the past decade, I have been busily working on *Travels and Explorations*, describing the lives and careers of Scottish naturalists Robert Brown and Mungo Park. I have been the beneficiary of support and guidance during this time, and therefore I am indebted to those who gave me their advice and assistance.

The New York Botanical Garden and its excellent LuEsther T. Mertz Library have played an important role in shaping my appreciation of the botanical sciences and have been very supportive in allowing me to complete this book. Numerous people at the Mertz Library went out of their way to provide me with assistance, most particularly, Susan Fraser, the Thomas Hubbard Vice President and Director of the Library. She was instrumental in helping me publish this work. William R. Buck, Senior Curator Emeritus of the Institute of Systematic Botany of the New York Botanical Garden and Editor, Memoirs, has provided me with his expertise and insight. Michael Brown of the NYBG Press Office helped facilitate the publication of this work and made many useful suggestions. Others there, such as Reference/Circulation Librarian Marie Long, were also very helpful.

My parents were a source of inspiration in guiding me toward serious pursuits. My father, George Schwartz, was a high school teacher, a college biology instructor, a naturalist, and a skilled microscopist. My interest in Robert Brown may have evolved from the range of my dad's interests. My mother, Hannah Schwartz, was dogged in her efforts in getting me to develop serious interests, taking my sister and me on long subway trips to museums, to pottery classes, and to music lessons. Many times, she urged me to read such works as Zsolt Harsanyi's *The Star Gazer*, understanding that books like this classic would broaden my perspective.

My teachers at Stuyvesant High School were also important in my early education. The New York City school system was instrumental in guiding young people to make the most of their abilities. Institutions such as the public schools in America are under assault today, and the degradation of this valuable resource will

compromise the future of our country. Several professors at the University of Rochester helped shape my career. The late Professor Hayden White in the history department helped me to develop a deep appreciation of intellectual history. Professor Richard Lewontin, the renowned geneticist, furthered my development in the biological sciences.

In Britain, Gina Douglas, the former librarian and archivist at the Linnean Society, and Lynda Brooks, the current head librarian, have been responsive to my questions. I had the assistance of numerous people at the British Library, the Natural History Museum and Botany Department, the Royal Society, and the Royal Botanic Gardens, Kew. I am indebted to the New York Public Library Rare Book Room; the Linnean Society of London; the Museum of Natural History in London; the Scottish Borders Council; the Jens Nachtigal website; the Hydrographic Office of the United Kingdom, London; the Ministry of Defense Collection, London; the National Picture Library of Australia; the Western Australian Herbarium (Department of Parks and Wildlife); the Australian Botanic Garden; the University of Sydney Archives; and the State Libraries of Victoria, New South Wales, and South Australia for the use of their illustrations and maps.

For much of this time, I have had Wertheim Study privileges at the New York Public Library and with Melanie Locay, Research Study Liaison, and Rebecca Federman, Research Services Coordinator, who continue to provide support in allowing me to conduct my research and writing in relative peace and quiet. For the past few years, I have been part of a writing group at the offices of the Professional Staff Congress of CUNY, composed of people from different fields. Special mention should go to Lecturer Constance H. Gemson, the tireless leader of the group, and Professors Irvin Sam Schonfeld, David Kotelchuck, and Helen Yalof, whose useful comments have been quite helpful. Our monthly meetings have brought me a great deal of joy as we critique each other's writing projects.

Most of all, special thanks to my late wife Rhoda, whose support has been very valuable in writing this book, and my sons Mark and George who have given me a great deal of advice and help while they tend to their own families and careers.

Contents

Introduction: Collecting, Observing, and Describing the Natural World

Prior to publication of Charles Darwin's *Origin of Species* (1859), the predominant view was that living things were the products of God's creation and had not appreciably changed since the biblical account related in Genesis. While there were naturalists and philosophers since antiquity that questioned the prevailing notion that species were immutable, these ideas were not able to take root until the increase of governmentally funded geographic expeditions in the late eighteenth and early nineteenth centuries. The narrow experience of most naturalists before the mid-eighteenth century explains, in part, why belief in the immutability of species prevailed.

Travel to exotic places increased in intensity. Voyages of exploration allowed naturalists to travel to exotic lands, ushering in an "age of discovery." The explorer-naturalists on board ships encountered living things not seen before. The natural specimens they brought back, and the discovery of fossil forms of extinct organisms, weakened the arguments of those who maintained their belief in the literal interpretation of the Bible. Such voyages increased in the middle of the eighteenth century with the development of the marine chronometer, making it possible for ships at sea to determine the longitude of their location. Naturalists who planned to embark on voyages no longer had the same concerns as their predecessors because they were able to determine their exact position at sea. Alexander von Humboldt, Charles Darwin, Alfred Russel Wallace, and others had the opportunity to explore exotic, often unfamiliar, territory, leaving the cultivated lands they grew up in. They observed the ferocity in nature with abundant varieties of many unfamiliar forms of life and geological phenomena in their original setting, making it more difficult to sustain the view that living forms were immutable.

Beginning in the seventeenth century, voyages of discovery resulted in exploration of much of the previously unknown world. Early pioneers included German-born naturalist and illustrator Maria Sibylla Merian (1647–1717), who studied plant life in Dutch Guiana (Suriname), and the British physician and naturalist Hans Sloane (1660–1753), who traveled to Jamaica and collected 800 species of plants

and animals, forming the bulwark of the British Museum's collections.[1] The German-born physician and botanist Paul Hermann (1646–1695) studied native plants of Ceylon (Sri Lanka) for the Dutch East India Company. Later on, the Dutch Governor of Ceylon, Johan Gideon Loten (1710–1789), also collected flora, fauna, and minerals for the Dutch East India Company.

Captain James Cook's voyages around the world were partly the result of these earlier adventures. These voyages spurred many advances in the natural sciences, ethnology, geography, and astronomy.[2] Sir Joseph Banks (1743–1820), Cook's naturalist on H.M.S. *Endeavour*, became the President of the Royal Society of London, an organization of the nation's most eminent thinkers and scientists established in the 1660s. Under Banks's leadership, the Society played an important role in shaping the careers of Robert Brown and Mungo Park. Georg Forster (1754–1794), a naturalist, illustrator, and humanist, succeeded Banks on Cook's later voyages. Forster promoted enlightenment thought and attempted to introduce liberal ideas by participating in the development of the short-lived democratic Mainz (German-speaking) Republic. Ultimately, he fled, spending the later part of his life in exile in Paris. The adventures of these seventeenth- and eighteenth-century naturalists inspired naturalist-explorers such as Brown and Park.

Robert Brown (1773–1858) and Mungo Park (1771–1806) were two explorer-naturalists who played a pivotal role in the development of natural history. Their adventures and investigations in natural history created a fertile environment for breakthroughs in taxonomy, cytology, and eventually evolution. Brown's pioneering work in plant taxonomy enabled biologists to look at the animal and plant kingdoms differently, and Park's journeys led to significant discoveries of a previously unknown world. Brown's and Park's adventures formed a bridge to such expeditions as Charles Darwin's voyage on H.M.S. *Beagle* (1831–1836), which led to a revolution in biology and the full explication of the theory of evolution. Thomas Henry Huxley's lesser known trip as naturalist on H.M.S. *Rattlesnake* (1846–1850) allowed him to revise the taxonomy of animals, particularly invertebrates.

Brown and Park came from similar backgrounds. They were born and grew up in the same region of southern Scotland and were strongly influenced by the ideas emanating from the Scottish Enlightenment of the late eighteenth century. This period was marked by rich intellectual and scientific development, growing out of scientific societies and Edinburgh University. As young men, they both explored the rugged hills in southern Scotland as well as its Highlands in search of native plants. They both went to Edinburgh University, the center of Enlightenment ideas, for

[1] James Delbourgo discusses the impact of Hans Sloane's acquisitions in *Collecting the World. The Life and Curiosity of Hans Sloane* (London: Penguin Books, 2018). [First published by Harvard University Press as *Collecting the World. Hans Sloane and the Origins of the British Museum* in 2017.]

[2] James Cook. *The Journals of Captain Cook, Prepared from the Original Manuscripts by J.C. Beaglehole for the Hakluyt Society, 1955–67* (London: Penguin Classics, 1999). This work, selected and edited by Philip Edwards, provides a firsthand account of Cook's adventures, with both the background and impact of these journeys.

their medical studies at roughly the same time. However, Park and Brown were quite different in temperament, and they approached scientific investigations in a different manner. Park, a handsome man with considerable charm, was not reluctant to speak his mind. Brown was rather diffident and often reluctant in advancing his ideas but was a meticulous worker. Although they shared similar experiences and associations in Edinburgh, they never referred to one another in their correspondence with others. Their lives and careers demonstrate how scientists from very similar backgrounds can develop independently from one another.

Park was Banks's original choice to be the naturalist for the expedition to Australia, but he refused the position after the Admiralty, also a sponsor of these voyages, did not offer him a proper salary for his services. This refusal proved to be a fortuitous circumstance for Brown, his career, and indeed the course of natural history, because Brown's dedication demonstrated that he was the right man to conduct the exceedingly difficult work demanded of him. But initially that was not clear to Banks. At the time, Park seemed to have greater promise than Brown. Park's early career was quite heroic, and his escape from captivity during his first trip to Africa added to his legend. Park, perhaps, reminded Banks of himself as a younger man, another factor in his appointment to carry out investigations in Africa.

While Park went on his first African journey, serving more as an explorer than naturalist, Brown was busily engaged in field studies at the time in his native Scotland (as well as in other parts of the British Isles), observing and describing many varieties of plants he encountered. Soon after Brown's return, Park went to Africa again and made critical observations in ethnology and geography. Park's last expedition to Africa stands in contrast with Brown's experience in Australia. His death in Africa occurred while he was exploring the Niger River region, an area previously unknown to Western societies.

Brown's service as naturalist on H.M.S. *Investigator* was critical in Brown's development as a scientist. Commanded by Matthew Flinders, the *Investigator* surveyed the southern and northern coasts of Australia (called New Holland at the time, 1801), i.e., circumnavigation of the entire continent.[3] Ably assisting Brown on the *Investigator* was the Austrian-born botanical and zoological draftsman, Ferdinand Lucas Bauer (1760–1826), who was very much like his brother, Francis (Franz) Andreas Bauer (1758–1840), a uniquely skilled scientific illustrator and observer of natural history.[4]

[3] Flinders is recognized as the inventor of a device used to counteract the magnetism of the ironclad ships, the "Flinders bar." While earlier navigators had observed errors in their compasses, which could not be explained by magnetic variation, Matthew Flinders was the first to make a systematic investigation of the problems caused by the presence of iron in the ship. He suggested that it would be possible to correct such errors by using a vertical unmagnetized iron bar near the compass to counteract deviation caused by magnetic induction in the soft iron of the ship. Although such devices were not used until the second half of the nineteenth century, they were called Flinders bars in recognition of the originator of the idea, although Flinders had not actually used such a device.

[4] William T. Stearn, "Franz and Ferdinand Bauer, masters of botanical illustration," *Endeavour* 19 (1960): 27–35.

The period between Brown's return to England and Banks's death and immediately afterwards (from 1805 to 1826) was perhaps Brown's most productive period, highlighted by his published works. Initially, this work was conducted with Banks's support, although Brown worked increasingly on his own. Brown published the majority of his work during this period of time. Brown also facilitated the transfer of Banks's collections, library, and various herbaria (collections of preserved plant specimens) to the British Museum, allowing him to gain the position of curator of these materials and enabling him to receive a reliable source of income.[5] Brown's discoveries of Brownian movement, the phenomenon of protoplasmic streaming, and the nucleus, the dark-staining body present in cells, are perhaps the most notable of his achievements and highlight his skill in microscopy.

Brown's later travels and fieldwork, particularly his work in taxonomy, led him to adopt a more natural system of classification instead of the artificial one of Linnaeus. Brown's position as naturalist on H.M.S. *Investigator*, very much like Thomas Henry Huxley's work on the classification of animals later on, led him to revise plant taxonomy. The evidence Brown amassed from his Australian travels supported his revision of plant classification. The collections that Brown received (after his return from Australia), from the East Indies, Africa, and Central and South America from other naturalists, reinforced the changes he made in plant taxonomy (classification) and demonstrate his contributions in the more theoretical aspects of biology.

Brown had a positive influence on other naturalists such as Charles Darwin and Joseph Dalton Hooker (1817–1911). Before Darwin sailed on H.M.S. *Beagle*, Brown showed him how to use the microscope in his investigations. Years after Charles Darwin returned to England from his epochal voyage on H.M.S. *Beagle*, he recalled, "I saw a good deal of Robert Brown, 'facile Princips Botanicorum,' as he was called by [Alexander von] Humboldt. He was remarkable for the minuteness of his observations, and their perfect accuracy. His knowledge was extraordinarily great, and much died with him, owing to his excessive fear of ever making a mistake." Darwin continued, "I called on him, two or three times before the voyage of the *Beagle*, and on one occasion he asked me to look through a microscope and describe what I saw. This I did, and believe now that it was the marvellous currents of protoplasm in some vegetable cell."[6]

Darwin's correspondence, particularly with his close associate, Joseph Dalton Hooker, cited Brown numerous times. It illustrates the regard Darwin and his associates had for Brown's abilities as a naturalist in addition to capturing the essence of Brown's single-mindedness in pursuing his scientific interests. Despite not being particularly close—Darwin was a good deal younger than Brown, and there is no

[5] Brown agreed to the transfer of the Banks herbarium and library to the British Museum and was officially appointed Under-Librarian with the designation of Keeper of the Sir Joseph Banks Botanical Collection, i.e., the Banksian Collection.

[6] Charles Darwin, *Autobiography of Charles Darwin, and Selected Letters*, ed. by Francis Darwin (New York: Dover Publications, 1958), p. 36. Darwin wrote these remarks in 1875, and they are in a collection of his reminiscences.

record of correspondence between them—Darwin's description of Brown is quite appropriate. Naturalists held Brown in great esteem. He enjoyed a fine reputation among naturalists inside and outside of Britain. Botanists with the opportunity to travel on voyages of exploration, microscopists and cytologists, naturalists engaged in plant geography, and taxonomists, all admired his work.

Mungo Park died 3 years before Darwin's birth. Thus, his life had little impact on Darwin and other contemporary naturalists save those whose imagination was captured with narratives of Park's adventures and heroism. His premature death limited his accomplishments in the sciences.

Brown helped Hooker obtain his position as naturalist on H.M.S. *Erebus* and *Terror*. Hooker served on *Erebus* and *Terror*, ships that explored the southernmost regions of the world in the 1840s. His opportunity to take part on this voyage was the result of Brown's friendship with Hooker's father, William Jackson Hooker (1785-1865), the first director of the newly reincorporated Kew Gardens.[7] Brown's relationships with contemporary naturalists further elucidate his importance in the development of nineteenth-century natural history.

Therefore, Robert Brown is an important but often neglected figure in science. In spite of his nineteenth-century contributions to natural science and the relevance of his work to modern natural history, he has been overlooked. His work in natural history, taxonomy, and cytology, highlighted by his discovery of the phenomenon of random movement of particles and protoplasmic streaming, and his role in the discovery of the cell nucleus, brought him respect and admiration from peers. Yet he remains largely unknown today, except for the discovery of the random motion of particles in a suspension ("Brownian movement," named in his honor). Through skillful use of the microscope, he examined the fine structure of plants, critical in allowing him to support a natural system of classification. However, his retiring nature, even with associates—he was naturally shy and rarely talked about himself—hampered him from receiving greater recognition despite his prowess as an acute observer of natural phenomena.

Although Mungo Park's career in the sciences did not nearly match Brown's, Park's role as an explorer and adventurer left an indelible mark on British history. Initially, Park's scientific career appeared to be more promising than Brown's, and he had an indirect but vital role in Brown's career. Their early lives growing up in rural Scotland and their exposure to the intellectual ferment in late eighteenth-century Edinburgh played a critical role in directing their careers in the natural sciences.

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[7] After Banks's death, the Royal Gardens at Kew had sunk to the status of a royal pleasure garden. The Parliament decided in 1840 that Kew Gardens be developed into a national botanic garden, and it became a public institution under the Board of Woods and Forests. It was decided that a director must be appointed, who would be capable of carrying out the intention of the Parliament. Thus, in March of 1841, Sir William Hooker was appointed to this position. See Raymond G. C. Desmond's, "The Hookers and the Development of the Royal Botanic Gardens, Kew," *Biological Journal of the Linnean Society* 7 (1975): 173–182.

Chapter 1
Scientific Ferment in Late Eighteenth-Century Edinburgh

Contents

Edinburgh and the Scottish Enlightenment

Brown and Park benefited early in their careers from the fertile intellectual climate generated in late eighteenth century and early nineteenth-century Scotland, particularly Edinburgh, during the height of the "Scottish Enlightenment." Brown and Park's immersion in the atmosphere of late eighteenth-century Edinburgh was fortuitous in shaping their early development. It was a period of great intellectual activity, with remarkable advances in science and technology—the growth and development in the geological sciences was one such example—as well as in literature and the arts.

During this period, attention to scientific ideas in Scotland flowed from the activity of the Edinburgh University Medical School. Under the guidance of the school's professors, and with the support of private physicians, advances in medicine created interest in a wide range of fields, including chemistry, physiology, and botany. As interest in the large range of scientific fields grew, scientific activity became more professionalized.[1] The favorable climate also assisted the development of medical societies such as the Society for the Improvement of Medical Knowledge (founded

[1] The Society for the Improvement of Medical Knowledge consisted of "the medical professors of the University and many of the leading members of Edinburgh Colleges of Physicians and Surgeons …. The professionalization of Edinburgh medical science is further indicated by the proliferation of specifically medical societies and clubs … the convivial Aesculapian Club (1773), the Harveian Society (1782) …." Steven Shapin, "The Audience for Science in Eighteenth Century Edinburgh," *History of Science*, 12 (1974), 95–121, 98. Robert Chambers was another notable figure nurtured by this atmosphere. See Joel Schwartz, "Robert Chambers and Thomas Henry Huxley, Science Correspondents: The Popularization and Dissemination of Nineteenth Century Natural Science," *Journal of the History of Biology* 32 (1999): 343–383.

J. Schwartz, *Robert Brown and Mungo Park*, Memoirs of The New York Botanical Garden 122, https://doi.org/10.1007/978-3-030-74859-3_1

in 1731), the Aesculapian Club (begun in 1773), and Harveian Society (established in 1782), among the more prominent groups.[2]

Commercial activity also aided Edinburgh's growth as a center for medical education and research. Local trade and mercantile guilds understood that by supporting scientific investigation, promising students would not be so easily drawn away by London's energy and the prosperous commercial and technological center of nearby Manchester.[3] Scientists were influenced by the stimulating public life in all of Great Britain, especially in those regions most directly affected by the industrial revolution. Their activity was inextricably linked with the success of commerce and the new wealth it generated. Business interests assisted scientific inquiry; they understood that scientific innovation had a favorable impact on economic development.[4]

The Royal Society of Edinburgh was founded in 1783. Like the medical societies, it acted as a spur for scientific development and was also a reflection of the growth in Scottish science. The founding of the Society marked a change in Scotland, with the natural sciences becoming more specialized and medicine more professionalized. The study of botany grew in importance economically and became an independent branch of natural history. Because the Royal Society was founded to foster all scientific disciplines, it was an environment conducive for Brown to be able to pursue his interest in natural history, particularly botany.[5]

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[2] Jacqueline Jenkinson indicated that the "development of the medical profession in Scotland is reflected in the rise of medical societies," *Scottish Medical Societies, 1731–1939, Their History and Records* (Edinburgh: Edinburgh University Press, 1993), p. 2. She has traced the development of these groups from their establishment in the eighteenth century to modern times.

[3] Shapin cited the role of Edinburgh's trade and merchant guilds in fostering the growth of Scottish medical teaching and clinical research, "The Audience for Science in Eighteenth Century Edinburgh," p. 97. Jack Morrell focused on Glasgow's expansion as a scientific center and contrasted it with Edinburgh's, finding that it was based on "the entrepreneurial skill of her businessmen … merchants and manufacturers," while Edinburgh's growth represented by the Royal Society of Edinburgh benefited more from "the contributions made by the University professoriate, the medicals, the lawyers, and the lowland landed gentry," Jack Morrell, "Reflections in the History of Scottish Science," *History of Science* 12 (1974): 81–94, p. 89. Republished in *Science, Culture and Politics in Britain, 1750–1870* (Aldershot, Hampshire: Variorum, 1997), pp. 81–94.

[4] Agriculture also fostered the development of areas of science that were medically related; one such example was the development of the smallpox vaccine. Chemistry and geological science also flourished in this atmosphere.

[5] Paul Wood discusses the development of the sciences during the Scottish Enlightenment, and the role of the Royal Society of Edinburgh in "Sciences in the Scottish Enlightenment," *The Cambridge Companion to the Scottish Enlightenment*, Alexander Broadie, ed. (Cambridge: Cambridge University Press, 2003), pp. 107–110. Scotland was also affected by the marked increase of exploration that took place in the eighteenth century as it became more integrated with the rest of Britain. The search for the natural resources of distant lands included plants and plant products. Plants were studied and cultivated to see if they had economic or medicinal value. The study of botany was enhanced by herbarium specimens and botanical illustrations, and advances in taxonomy that simplified the description of plants. As a consequence, botany developed into a separate branch of natural history.

Edinburgh was exhilarating for young men like Brown and Park. The intellectual climate had as much of an impact on Brown as did his formal education. Edinburgh from the middle to the late eighteenth century was a place marked by exciting new ideas in the arts, literature, and particularly the sciences, i.e., the "Scottish Enlightenment," a period from approximately the 1740s to the early 1800s. The movement's origins can be traced to when Scotland joined England to become part of Great Britain (the Act of Union in 1707). The Highland clearances that began in the early part of the eighteenth century—whether they were a direct consequence of the Act of Union or a manifestation of changes in Scottish society is not certain—involved the forcible removal of people who practiced a more diversified agriculture to make room for sheep farming. This depopulation of northern Scotland destroyed clan society and was accompanied by a great loss of life, resulting in the migration of many Scots to North America. Despite the hardships that followed the 1707 Act of Union (e.g., the Highland Clearances and the depopulation caused by the Clearances), some benefits accrued to the Scots. Although Scotland lost some of its autonomy, a positive aspect of this annexation was that Scotland opened up to fresh ideas.[6] Scottish thinkers began questioning assumptions previously taken for granted, and developed a uniquely practical branch of humanism.

An early important figure in this movement was philosopher Francis Hutcheson (1694–1746) who was at Glasgow University from 1729 to 1746. Hutcheson's leading idea was that virtue is what brings the greatest good to the most people.[7] Many outstanding figures emerged during this period of Scottish history, e.g., Scotland's beloved writers, poet Robert Burns and novelist Sir Walter Scott, architect Robert Adam, philosopher and skeptic David Hume, and economist-philosopher Adam Smith, to cite just a few examples.

The Scottish Enlightenment eventually shifted its focus from intellectual and economic matters to scientific concerns, highlighted by the contributions of James Anderson, a farmer and lawyer with a strong interest in agronomy who applied scientific principles to farming. The "Scottish Enlightenment" accounted for a disproportionately large number of contributions to British science and letters, including such notable individuals as the founder of modern geology James Hutton, engineer and inventor James Watt, chemist Joseph Black, naturalist John Walker, and later on physicist James Clerk Maxwell.[8]

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[6] Scotland reaped the economic benefits of free trade within the growing British Empire. It also benefited in having established Europe's first public education system since classical times. There is a question about how much the "Act of Union" led to the "Highland Clearances." The Scottish legal system allowed landlords to exploit the system. Scottish farmers may have been better served by the English legal system.

[7] Philosopher David Hume was concerned with the nature of knowledge, and embraced the scientific method with ideas about evidence, experience, and causation, in addition to modern attitudes concerning the relationship between science and religion.

[8] Described in more detail in Alexander Broadie's *The Scottish Enlightenment: The Historical Age of the Historical Nation* (Edinburgh: Birlinn Ltd., 2001).

Brown's immersion in the atmosphere of late eighteenth-century Edinburgh influenced his development as a scientist of the first rank. Edinburgh University Medical School became the center of scientific ideas in Scotland. With guidance from the school's professors and support of private physicians, developments in medicine created interest in a wide range of fields, including chemistry, physiology, and botany. The development of medical societies previously mentioned (e.g., the Society for the Improvement of Medical Knowledge, the Aesculapian Club, and Harvian Society) was also a sign of professionalization in the medical sciences in Edinburgh during this period.[9] Because Brown was not born into privilege and needed to support himself, he welcomed the opportunities created by these developments in the sciences. Brown was drawn to making a career in the sciences not only out of necessity but also because he was fascinated by the growth of many branches of the sciences in late eighteenth-century Edinburgh.[10] Scientific inquiry was no longer restricted to rich amateurs but was becoming a legitimate means of supporting those who actively engaged in scientific investigation.

The symbiotic relationship between science and commercial interests enhanced Edinburgh's growth as a center for medical education and research. Business interests helped promote scientific activity because they understood that scientific innovation could impact economic development favorably. Agriculture fostered the development of science that was medically related. One such example was the development of the smallpox vaccine. Chemistry and geological science flourished in this atmosphere.[11] The founding of the Royal Society of Edinburgh in 1783, shortly before Robert Brown's arrival there less than a decade later, was a favorable development for young men like Brown. Because the Society's commitment was to support all scientific disciplines, the study of botany also reaped the benefits of this favorable climate.[12] Brown felt free to pursue his interest in natural history, particularly botany, and he did so with great enthusiasm.

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[9] Steven Shapin, "The Audience for Science in Eighteenth Century Edinburgh," *History of Science* 12 (1974): 95–121.

[10] Jacqueline Jenkinson, *Scottish Medical Societies, 1731–1939, Their History and Records* (Edinburgh: Edinburgh University Press, 1993), p. 2. See note 2 on page 244.

[11] Shapin, "The Audience for Science in Eighteenth Century Edinburgh," p. 97. Morrell, "Reflections in the History of Scottish Science," *History of Science* 12 (1974): 81–94, p. 89. Republished in *Science, Culture and Politics in Britain, 1750–1870* (Aldershot, Hampshire: Variorum, 1997), pp. 81–94. See note 9 on pages 244–245.

[12] Fredrik Albritton Jonsson expresses a somewhat different view in *Enlightenment's Frontier, The Scottish Highlands and the Origins of Environmentalism*, suggesting that the Scottish Enlightenment had its origins in the mountains and moss bogs of the Scottish Highlands. He maintains that Environmentalism began in the Highlands, which according to Jonsson helped spawn the Enlightenment, more than the Edinburgh University and the Scientific Societies (New Haven & London: Yale University Press, 2013).

Chapter 2
Scientific Exploration During Voyages of Discovery

Contents

The age of exploration developed from scientific discoveries that took place in England's two great universities, Cambridge and Oxford. In the sixteenth and seventeenth centuries, the study of geography helped generate the growth of new ideas. Mathematical geography flourished at Corpus Christi and St. John's College, Oxford, and Peterhouse and Corpus Christi College, Cambridge. The work of England's foremost mathematical geographer, Edward Wright (1561–1615), and the contributions of mathematician, astronomer, and physicist, Thomas Harriot (1560–1621), aided nautical exploration by putting the theoretical information they learned to practical use in navigation.

In 1589 Wright received permission to take a leave from Cambridge to accompany the Earl of Cumberland on an expedition to the Azores. He already enjoyed considerable standing in the field of mathematical navigation, and his critique of the sea charts of the time—which he called "an inextricable labyrinth of error"—helped cement his reputation. When Wright left Cambridge, he became a mathematical lecturer; the need for lecturers in navigation was acute at the time. In 1614, while serving as a lecturer, the East India Company took over patronage, paying Wright an annual salary of £50. Wright was also a surveyor for the New River project whose purpose was to bring water to London. Wright's *Certain Errors* was justification for the Mercator-map projection, up to that time, the most important advance in marine cartography.

After completing his undergraduate studies at Oxford, Harriot was asked by Sir Walter Raleigh—who needed an expert in cartography and the theory of oceanic navigation—to accompany him on a colonizing expedition to Virginia in 1585.

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