

The Lunar Society of Birmingham: A Bicentenary Appraisal

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THE LUNAR SOCIETY OF BIRMINGHAM;
A BICENTENARY APPRAISAL

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[Plates 11 and 12]

TWO hundred years ago there began to gather in an industrial town more than one hundred miles from London, that group of scientists and amateurs which became known as the Lunar Society of Birmingham (1). The Lunar Society was neither the first nor, in the long run, the most scientifically significant of the provincial societies to be organized in eighteenth-century Britain; of the towns possessing them, Birmingham might reasonably be thought one of the least likely to have produced a society worthy of particular notice (2). Yet, since the middle years of the nineteenth century, when its story began to be reconstructed, none of the provincial societies has attracted the attention of historians as has the Lunar Society.

Three of its characteristics may perhaps be credited for focusing interest on Lunar Society activities. Its mode of meeting—monthly, in the afternoon of the Monday nearest the full moon, alternately at the homes of the members—at once pragmatic and romantic, gave the society its name and captured historians' imagination by distinguishing it from the more ordinary 'literary and philosophical society' of its day. The quality of its membership gave guarantee that this was no provincial gathering substituting convivial mediocrity for the intellectual and cultural stimulation of London. There are fourteen persons who, fairly clearly, can be identified as belonging to the Lunar Society during its years of greatest activity: Matthew Boulton (1728-1809), Erasmus Darwin (1731-1802), Thomas Day (1748-1789), Richard Lovell Edgeworth (1744-1817), Samuel Galton, Jr (1753-1832), Robert Augustus Johnson (1745-1799), James Keir (1735-1820), Joseph Priestley (1733-1804), William Small (1734-1775), Jonathan Stokes (1755-1830), James Watt (1736-1819), Josiah Wedgwood (1730-1795), John Whitehurst (1713-1788), and William Withering (1741-1799). Of these, all but Johnson made substantial enough contribution to at least one aspect of the intellectual, cultural, political or economic life of eighteenth-century Britain to earn a place in appropriate historical studies; several are thus recorded more than once. Ten of the fourteen have been memorialized in the *Dictionary of National Biography* and eleven of them (all but Day, Small and Stokes) became Fellows of the Royal Society.

In a period when the Royal Society was at particularly low ebb, when scientific accomplishment was perhaps the least of the considerations for election to its fellowship, with less than 20 per cent. of the Fellows having contributed a paper of any quality to the *Philosophical Transactions*, membership of the Royal Society could not, of itself, support the claim of a Fellow to scientific eminence (3). But the Lunar Society Fellows were as atypical in this connexion as in others. Of the eleven lunatic (a self-description of Lunar Society members) Fellows of the Royal Society, all but one (Matthew Boulton) submitted at least one note on a scientific subject to the Royal Society. Though some of their papers remain unpublished in the archives of the Royal Society, more than thirty-five articles in the *Philosophical Transactions* resulted from scientific activities of Lunar Society members, and among these are papers of long-range importance in the history of chemistry, geology, thermodynamics, mechanics, and optics.

It is an odd claim to eminence for any society that a large number of its members were members also of another society to which they made contributions. But the Lunar Society had no journal of its own; indeed, it had no official list of members, no officers, kept no minutes, and, so far as has been discovered, had no constitution, set of rules, or by-laws. The archives of the Royal Society represent one of the few direct ways an 'official' evaluation of Lunar Society members and activities can be obtained. This points to the third of those characteristics so attractive to historians—the mystery which has enveloped the story of the Society. Not only are there no official records, there are very few contemporary public references to the Society's existence. *Aris's Birmingham Gazette* was published regularly throughout the period of the Society's life and contained frequent notices of club, library, and institution meetings; there are no specific notices of the Lunar Society. Edgeworth and Priestley each wrote published autobiographies; only Priestley's mentions the Society (4). Lunar members wrote biographical sketches of their fellow lunatics, Boulton, Day, and Watt; none mentions the Lunar Society. Every member of the Society save Boulton, Johnson and Small wrote books or articles, or both, in which references to the Society might naturally find a place; only Priestley and Stokes include such a reference and that of Stokes was published years after the Society came to an end (5).

Not until their children, grandchildren and associates began to publish biographies and memorials of Lunar Society members, some time after 1840, was this conspiracy of silence effectively broken, and the historical study of the Society essentially began with Samuel Smiles's *Lives of Boulton and Watt* of

1865. By that time the majority of what materials there once might have been recording the Society's activities had been scattered or destroyed. Historians were dependent upon Priestley's references—little more than incomplete lists of members—a few pertinent comments in filial biographies, one collection of Boulton and Watt letters preserved essentially intact, and the faulty memory of an aged lady, daughter of Samuel Galton, Jr, for specific information on the Society (6). The gaps thus left remained to be filled through the infinite imagination and conjectures of each historian who attempted to describe the Lunar Society. The consequence was, and is, a picture of the Society so extended in time, forward and backward, so extended in geography, throughout the Midlands and into Scotland, and so extended in membership, to include all persons of scientific or cultural importance ever to have associated with any known member, as to destroy any unique identity of the Society itself and confuse it and its efforts with the general growth of intellectual and economic activities in the provinces of eighteenth-century Britain.

This inflated, but fragmentary, picture of the Lunar Society was not, however, irrevocable. The Lunar Society was, after all, not a figment of historical imagination and, for all their untrammelled enthusiasms, its nineteenth-century chroniclers had grasped the essential factor in their story. Men of the calibre of Boulton, Watt, Darwin, Keir, Priestley, Wedgwood and Withering do not regularly meet over trivia; the Lunar Society must be of significance and somehow that significance must be revealed. In fact, because of their eminence, letters by and to members of the Society have been preserved in scattered profusion. One of the causes of their eminence were the books, pamphlets, and papers they wrote with equal profusion. Together, correspondence and publications provide an interlocking account of Society members and their activities which, incomplete as it yet remains, nonetheless enables a reconstruction of the history of the Lunar Society. And that history, by concentrating the personal and intellectual range of Society activities, makes up in intensity for the loss of imagined quantity. In its own way the Society was quite as significant to the social and intellectual history of provincial science and technology in eighteenth-century Britain as the most enthusiastic retailers of the Lunar Society legend can ever have thought it to be.

The story of the Lunar Society essentially begins in 1765 with the arrival in Birmingham of Dr William Small carrying a letter of introduction to Matthew Boulton from Benjamin Franklin. Small, recently returned from Williamsburg, Virginia, where he had been Professor of Natural Philosophy

at the College of William and Mary, had graduated M.A. from Marischal College, Aberdeen, in 1755, obtained an Aberdeen M.D. in 1765, and now was looking to settle in a medical practice in some congenial location. Though Small's tastes induced him to 'decline fellowships of Societies', he had been the centre of a small intellectual coterie of townspeople and students (including Thomas Jefferson) in Williamsburg and, from the fond descriptions of his personality left by Lunar Society friends, it seems inevitable that another such group should form about him as he became established in Birmingham.

The beginnings of that group were already at hand in Matthew Boulton, a native of Birmingham who had recently expanded the modest buckle factory inherited from his father into what was ultimately to be the most extensive manufactory in England, the Soho Works; in Erasmus Darwin, physician of nearby Lichfield after medical study in the University of Edinburgh, with John Hunter in London, and at St John's College, Cambridge; and in John Whitehurst, clock and scientific instrument-maker and itinerant builder of Derby. Boulton, Darwin, and Whitehurst had known one another for about ten years when Small appeared; they had together or in pairs entertained Franklin during his tours into the Midlands, and already begun some of those investigations into instrumentation, electricity, meteorology, and geology which later were to be so persistent a concern of Lunar Society members. The scant remaining correspondence from this early period does not, however, reveal much of the sense of group cohesion nor any of the centripetal tendency drawing others into the group which soon becomes apparent after Small's arrival.

The first new person to feel that pull was to be Josiah Wedgwood, who was just beginning his career as major pottery manufacturer at 'Etruria', near Burslem, Staffordshire. Wedgwood met Darwin while rallying support for the projected Trent and Mersey Canal. Darwin enlisted the aid of Small and Boulton (equally interested in cheap transportation) and Wedgwood, in turn, was interested in introducing Boulton's power machinery methods into the pottery works Whitehurst was helping him construct on what were to be the banks of the new canal. Mutual interests soon turned into friendship; Wedgwood became a member of the group.

A mutual interest in transportation problems was also responsible for bringing Richard Lovell Edgeworth into the attractive range of the Lunar Circle. Edgeworth, an Anglo-Irish gentleman resident in England, had a passion for mechanical invention shared by Erasmus Darwin. Hearing of a new carriage designed by Darwin, Edgeworth copied it, sent a description to

the Society of Arts in London and, to report the Society's reactions, visited Darwin at Lichfield in the summer of 1766, where he met Small and Boulton. Henceforth Edgeworth was always to work against a background of Lunar activity.

Thomas Day, the third new recruit, met Edgeworth in 1766 because both had been students at Corpus Christi, Oxford. Edgeworth, only the first of the Lunar Circle to find attractive qualities in the eccentric Mr Day, introduced him to Darwin, Whitehurst, and finally to Small, after which he remained within the orbit of the Lunar Circle, to posture, pontificate, philosophize, and to lend portions of his not inconsiderable fortune to assist in financing Boulton's Soho operations, canal projects, and other Lunar schemes. Day shared with other members of the Lunar Circle an interest in political and educational reform. This, and his love for Small, seems to have justified the adding of this bird of odd plumage to the growing flock of scientists and technicians.

Early in the summer of 1767 James Watt visited Birmingham carrying a message from his patron John Roebuck to Boulton's good friend Samuel Garbett. In Boulton's absence Darwin and Small showed Watt around the Soho Works and he was convinced that here was the place to complete the development of his newly-invented steam engine design. Boulton had already begun steam-engine experiments; Small, Darwin and Edgeworth already indicated more than casual interest in steam power, when Watt appeared. Negotiations promptly began, ultimately leading to the establishment of the firm of Boulton & Watt, so important to the progress of the industrial revolution and central to the development of the Lunar Society. Watt, essentially self-educated beyond an elementary schooling in his native Scotland, was an inventive genius, but uncertain in his dealings with people and constantly in need of encouragement. From his first visit members of the Lunar Circle met his needs, though he was not finally to settle in Birmingham until 1774. For those seven years, Watt was to be a non-resident member of the Lunar Circle, contributing to its range of interests and expertise through the constant stream of letters exchanged with the Birmingham 'philosophers' as they sent advice and encouragement and (especially Small) traded information on subjects as various as ceramics, chemistry, dyeing, metallurgy, horology, and optical systems.

James Keir, last of the group to be added during this early phase of its existence, also joined during 1767. A fellow student with Darwin at the University of Edinburgh, Keir had left without a degree to join the British Army early in the Seven Years' War. Military life failed to satisfy him, and



JOHN WHITEHURST, F.R.S. (1713-1788)

From an engraving in the possession of the Royal Society.

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JAMES KEIR, F.R.S. (1735-1820)

From an engraving in the possession of the Royal Society.

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its peacetime establishment bored him. In the summer of 1767 he visited Darwin at Lichfield, was introduced to Boulton, Small, Wedgwood and Whitehurst, promptly sold his captain's commission and settled near his new friends in Birmingham. Keir determined to exploit his training in chemistry and after some preliminary experiments in the production of alkali from salt, and an English translation of P. J. Macquer's *Dictionary of Chemistry* (completed during an extended visit with Edgeworth in 1769, published anonymously in 1771), he became manager and partner of a glass manufactory in Stourbridge. Keir brought to the Lunar Circle a professional concern with chemistry and a strong interest in metallurgy and geology to strengthen those areas of Society interest.

By 1768 the nucleus of the Lunar Society had come together, almost by accident, and remained together, through a multiplicity of shared or overlapping interests. Among the nine persons were to be found gentlemen, physicians, instrument makers, engineers and builders, and manufacturers of toys (in the eighteenth-century sense of small decorative items: buckles, buttons, clocks, ormoulu, Sheffield plate, etc.), glass, and ceramics. During this early phase, before the end of 1775, at least two, usually more, and sometimes all of these members were to join in experiments, observations, and projects concerning: acoustics, astronomy, chemistry, civic improvement, education, electricity, geology, heat, metallurgy, meteorology, optics, steam power, and transportation. Foreign as well as British visitors were beginning to come—to see the Soho Works, but also to consult on scientific or technological subjects of mutual interest. Through their profession, their education, and their institutionalization of practical and scientific concerns the Lunar Circle was linked with the Royal Society (Darwin became a Fellow in 1761), the Society of Arts (Edgeworth became a member in 1770, as did Wedgwood's partner, Thomas Bentley), and John Smeaton's club of civil engineers (Boulton, Edgeworth, Watt, and Whitehurst were all to become members). Members had ties with the Universities of Aberdeen, Cambridge, Edinburgh, and Glasgow, and with Warrington Academy. And a network of friendships had grown to include, among others, Benjamin Franklin, John Michell, Samuel More, James Brindley, Ralph Griffiths, John Roebuck, Joseph Priestley, Thomas Percival, Joseph Black and James Hutton. Here there was already a provincial centre for science, a clearing house for scientific and technological information. But there is, as yet, no sign that the association has become an organized one. Though there is ample evidence of a spirit of cohesiveness among them and such names as 'Birmingham philosophers' and 'fellow-schemers' are used in their letters to one another, there is no

indication of regularly-planned meetings and no use of the characteristic lunar name or dating. The group is still that informal collection described by Edgeworth when praising William Small:

Dr Small formed a link which combined Mr Boulton, Mr Watt, Dr Darwin, Mr Wedgwood, Mr Day and myself together—men of very different character but all devoted to literature and Science (7).

Early in 1775 the situation changed. Scarcely a year after Watt had moved to Birmingham, with the partnership between Boulton and Watt, for which he had schemed so long barely established, Small died. If the group was not to dissolve as spontaneously as it had been created, something must be found to substitute for that 'link which combined' its members. The substitute was to be the transformation of this association of friends into a society, meeting monthly, on the Sunday nearest the full moon at Boulton's home on Handsworth Heath. The formal organization took place during the summer and fall of 1775, with the earliest surviving indication of regular meetings and the lunar designation coming in a set of letters, with confusing and contradictory dates, which, however, imply that a meeting on Sunday, 31 December 1775, was the first clearly to possess those characteristics which mark the change from Lunar Circle to Lunar Society.

By the time the Society began its regular meetings there had already occurred additional changes in its membership. Through a suggestion by Darwin, William Withering had been brought to Birmingham from Stafford, as a medical replacement for Small. Another graduate of the medical school of the University of Edinburgh, Withering had already demonstrated a taste for natural philosophy which would fit him for membership in the Lunar Society with a brief note on agricultural chemistry published in the *Philosophical Transactions* and the compiling of a book on English botany, which was printed in Birmingham in 1776 (8). Withering had met Darwin while visiting his uncle in Lichfield, he had met Boulton at a meeting of the Royal Society, visited Wedgwood at Etruria, and was known at least by reputation as a 'very judicious Physician' to Joseph Priestley, before his settling in Birmingham. Over the years he contributed an interest in botany (the major source of his contemporary reputation), and joined other Society members in their studies of chemistry, heat, and mineralogy. He was never personally to replace Small, for his scientific interests were more circumscribed and less formal and theoretical and his personality less warm and ingratiating—indeed, Withering was involved in both of the disputes which later mar the personal relationships of members—but his membership in the Society is one of its enduring claims to fame.

Another loss in membership was threatened in 1775 when John Whitehurst accepted a position as 'Stamper of the Money Weights', leaving the Midlands for London. In fact the change worked to the advantage of the Lunar Society. In London Whitehurst became a resident outpost of the Society, executing commissions for members there, and providing another link with the Royal Society (he was elected Fellow in 1779), to whose meetings he frequently took Lunar Society members as guests. Nor was he to be permanently absent from Lunar Society meetings or surroundings. His position did not prevent frequent visits to Birmingham and Etruria and his geological field trips into Derbyshire and surrounding counties continued.

The period from 1775 to 1780 was one of major professional and scientific activity for Lunar Society members. Most of Boulton's and Watt's time was spent in the distribution of Watt's engine. Boulton's primary responsibility was organization and finance while Watt continued to improve the engine design, but both were away from Birmingham so frequently, on trips into the field to oversee engine construction, operation, and repair, that it soon became desirable to have a responsible manager to remain at Soho. The person first considered for the post was James Keir, whose talents and interests were insufficiently engaged managing the glassworks. In 1778 Keir resigned his position with the glass firm to join Boulton at Soho, but closer examination of the finances of that operation, then experiencing the English financial crisis of 1778-1779, was not encouraging. Keir lacked the sanguine vision of Boulton as to the possibilities of the engine business, and not even the organization of J. Watt and Company, with Boulton, Watt and Keir as partners, to market Watt's invention of the letter-copying press (patented in May 1780 and demonstrated before the Royal Society the same month by Boulton at a meeting to which he was taken by Whitehurst) was enough to fix his interest (9). Having gained from his experience with glass-making the observations included in his 1776 *Philosophical Transactions* paper, 'On the Crystallizations observed on Glass'—the first direct observations to support the theory of basalts as igneous in origin—and a knowledge of annealing which he shared with Wedgwood, Keir turned again to chemistry. He prepared another edition of his translation of Macquer's *Chemical Dictionary* (London, 1777), petitioned Parliament unsuccessfully for relief from the excise for salt to be used in manufacturing alkali, and in 1780 joined in partnership with an ex-army friend, Alexander Blair, to manufacture alkalis (by a new process involving waste products), soap, litharge, red lead, etc. (10). In time Keir's Tipton Chemical Works was to become the

major English chemical manufactory and a rival to Boulton's Soho and Wedgwood's Etruria as a showplace for visitors.

Wedgwood's activities during this period were less obviously critical to his career. With the invention of the queensware, black basaltes, and jasperware bodies already essentially complete and the establishment of the Grand Trunk Canal already providing a trade outlet to world markets, there remained for him only the task of further organization, refining, and controlling his manufacturing processes. There is little that more clearly reveals Wedgwood as a prototype manufacturer of the industrial revolution than his work at this stage. So far as the Lunar Society was concerned, the most interesting of his innovations was that relating to process-control, in the form of a ceramic pyrometer by which the high temperatures in pottery kilns could be measured. His first pyrometer, described in an unpublished paper communicated to the Royal Society in 1780 by Priestley, proved unsatisfactory, but this marked the beginnings of his work leading to the famous Wedgwood pyrometer of 1782, which provided a standard means of high temperature measurement for science for the next twenty or more years.

Of the five other Society members, only Whitehurst was represented during these five years with a major work, his *An Inquiry into the Original State and Formation of the Earth*, first published in 1778. The Lunar doctors, Darwin and Withering, continued to develop their medical practices. Darwin published a minor medical paper in the *Philosophical Transactions* in 1778 and in 1780 edited (with substantial revisions and additions) two medical essays written by his son, Charles, who had recently died of a fever contracted from a dissecting wound received during medical studies at Edinburgh; Withering published an *Account of the Scarlet Fever and Sore Throat . . .* (London, 1779), but both were just beginning the studies on which their fame now rests. Day began his withdrawal from Lunar connexions, marrying a girl chosen for him by William Small and retiring to land purchased near London, where he indulged his eccentricities in political propaganda, ineffectual farming operations, and a misanthropic philanthropy which earned him the small degree of grudging gratitude he thoroughly expected. Edgeworth, having visited Ireland, returned to England and continued his miscellany of mechanical inventions, visiting his Lunar Society friends with suggestions, and writing again to the Society of Arts. Not until his third marriage and return to Ireland in 1780 were the demands of an increasingly large family to impose on him those problems of education to which his most fruitful speculations were to be addressed.

This recitation of members' activities introduces the major problem of Lunar Society historiography—in what way are these individual accomplishments to be related to the influence of the Society as a whole? Although the members themselves are significant does this justify the inference that the Society is important? Superficially, at least, this is a difficult question to answer, for the extant references (primarily in correspondence or diaries) contain little specific information on what occurred at meetings of the Society. Even more to the point, these references suggest that the frequency of meetings from 1776 to 1780 had changed from regular, to infrequent, to occasional. This is only to be expected of so highly personal an organization, and one, moreover, whose meetings depended upon the presence at Soho of at least one of two very busy partners. Nonetheless, the suggestion is clear that their meetings were not of great value to members. This does not, however, mean that the Society was not valued. Too far from London for easy communication and too greatly different from their contemporaries to blend into their surroundings, the members had been brought together by friendship and mutual interest. Detailed study of their research and writing reveals enough of the exchange of information and ideas between them to prove that they formed so coherent a society, meeting continually in day-to-day situations and writing notes and letters to one another, as to make the Society meetings merely the social representation of group activities so mutually interdependent as to be independent of formality.

Late in 1780 the situation was again changed with the settling in Birmingham of Joseph Priestley. Priestley had already had a distinguished scientific career and he was known personally to many Lunar members or their friends. He had met Wedgwood during the 1760s while teaching at Warrington Academy, with which Boulton and his early friend John Roebuck had also had some connexions. He had visited Soho in the company of his patron, Lord Shelburne; he met Whitehurst in London. He had corresponded with Boulton and Keir, referred to the work of Darwin, Boulton, Small, Keir and Withering in his scientific publications. He was friendly with Benjamin Franklin, John Michell, John Smeaton, and Thomas Percival, and was brother-in-law to John Wilkinson, principal supplier of machined castings for Watt's engine. Moreover, as early as 1767 Priestley had written encouraging the formation of provincial societies and, after suggesting duties and organization, outlined the advantages to be expected from their regular activities (11). It is, therefore, not surprising that he should quickly have become a member of the Lunar Society nor that the Society should soon after have shown signs of renewed regularity. Priestley, as a clergyman,

could not meet on Sunday afternoons, while continued meeting at Boulton's would retain the dependence on Boulton's presence which had previously discouraged regularity. Soon after Priestley became a member the monthly Lunar meetings were switched to the now familiar pattern of Monday afternoons nearest the full moon, at the homes of the various members. Although a complete record does not exist and there is some indication, particularly after the first few years, that meetings sometimes were not held, and that many occurred with substantially fewer than the full membership present, during the years from 1781 to 1791 the Lunar Society of Birmingham appears to have been most regularly active and productive.

One development during the next ten years of Lunar Society existence was an apparent membership policy. Shortly after Priestley became a member, Erasmus Darwin remarried and moved with his new wife to Derby. Darwin remained an active member of the Society, writing letters and frequently attending meetings; he even organized a Derby Philosophical Society in frank imitation of the Lunar Society (12). The loosening of his connexions with the Society must, however, have loomed larger in the sensibilities of the members in the flush of revitalization than later would be warranted, and for the first time it would appear that a replacement for an absenting member was actively sought. The addition was Samuel Galton, Jr, who had the distinction of being a Quaker gun-manufacturer, but can more solidly be remembered as the author of a children's bird book, *The Natural History of Birds* (London, 1791) and of a paper outlining the trichromatic theory of colour (read but unpublished by the Royal Society, published in the *Monthly Magazine* in 1799 as 'Experiments on Colours'), and as the grandfather of Francis Galton. Samuel Galton, Jr seems to have been a worthy addition to the Lunar Society, but the disappearance of his many-volumed commonplace book of scientific observations and experiments, his 'Book of Knowledge', casts his scientific role in obscurity.

Edgeworth also moved from regular range of Society activities when he returned to Ireland with his family in 1782. He too continued a heavy correspondence with Society members and visited them frequently while both the *Philosophical Transactions* and the *Transactions of the Royal Irish Academy* record the continuation of his scientific interests. Edgeworth's 'replacement' was Jonathan Stokes, a young protégé of Withering, graduate M.D. of Edinburgh with an interest in chemistry and geology and a substantial formal knowledge of botany. Stokes was brought to the Birmingham area (he settled first as a physician in Stourbridge) in 1783 to assist in a new edition of Withering's *Botanical Arrangement of British Plants* (Birmingham,

1787-1792) and to prepare an English translation of Linnaeus's *Systema Vegetabilium*. In this he was forestalled by Darwin's Botanical Society of Lichfield edition, *System of Vegetables* (Lichfield, 1783). The Lichfield society also did a translation of Linnaeus's *Genera and Mantissae Plantarum* as *Families of Plants* in 1787. When the first two volumes of the Withering-Stokes *Botanical Arrangement* was published, the two men quarrelled bitterly—the cause is not clear, but may have been over distribution of royalties and credit for the new edition—and Stokes left the area and the Society. His 'replacement', in turn, seems to have been Robert Augustus Johnson, whose name, in connexion with Society affairs, first appears in 1787. Johnson's qualifications for membership, beyond his quiet good nature, are unknown. Second son of a gentleman cleric of Lincolnshire, he had, for a time, been an officer in the Army, married the widowed youngest sister of William, Lord Craven, in 1773, and settled in the Craven estate at Coombe Abbey, near Coventry. He had some minor interest in chemistry, and wrote a note on an earthquake shock which was published in the *Philosophical Transactions* in 1796. In time he was to become a sinecurist and pluralist clergyman. He died in 1799 without having made a substantial impact on Society activities.

Two more significant losses in membership, by death, occurred during the decade 1781-1791. Whitehurst died in London in 1788, having completed a second edition (London, 1786) and collected some materials for yet a third (posthumous, with *The Works of John Whitehurst*, London, 1792) of his *Inquiry into the Original State and Formation of the Earth*, and involved his Lunar friends in discussions and experiments leading to his *Attempt toward Obtaining Invariable Measures of Length, Capacity, and Weight* (London, 1787). Thomas Day died on his estate near Anningsley, Surrey, in 1789, having recently completed his 'great' work, the didactic children's book *The History of Sandford and Merton* (London, 1783, 1786, 1789). Whitehurst's death was a real loss to the Society, it is hard to see that Day's was, though his friends mourned and Keir wrote a brief memoir of him (published in London, 1791). Day had increasingly withdrawn from fellowship with Lunar Society members, his political tracts increasingly revealed the conservative bent of his radicalism, and only the inexplicable popularity of his three-volume story for children (which he had written with the strong encouragement of Darwin, Edgeworth and Keir) remains as an indication of his claim to membership in the Society.

Another sign of new order in the Society's affairs after 1780 was the increasing formal affiliation of members with recognized scientific bodies. Boulton and Watt became members of the Royal Society of Edinburgh in

1784; Edgeworth of the Royal Irish Academy in 1785, having in 1781 already become a Fellow of the Royal Society of London. Josiah Wedgwood was elected Fellow of the Royal Society in 1781, while Boulton, Watt and Withering became Fellows in November and Keir and Galton in December of 1785. Robert Augustus Johnson became F.R.S. in 1788. During the same period there were indications of Lunar Society affiliations in such other societies as the Manchester Literary and Philosophical, the Linnaean, the Medical Society of London, and a miscellany of agriculture, natural history, and philosophical discussion clubs. British and foreign notables continued to come—to visit Soho, Etruria, or Tipton, be passed along to the others, and leave impressed with the factories, but more so with members of the Lunar Society. Names of such scientists as Afzelius, Berthollet, Camper, Faujas de St Fond, Kirwan, de la Métherie, Montgolfier, and Swediaur appear in the journals or correspondence of members; Kirwan and de la Métherie, indeed, refer explicitly to the Society and sent it news of new discoveries.

More significantly, the decade between 1781 and 1791 was one of substantial accomplishment by members of the Lunar Society. Boulton and Watt began to gain the financial rewards of their previous efforts, particularly as the Watt engine was adapted to circular motion and applied to machinery. Both began to explore new subjects. Boulton devised applications of the Watt engine to the Albion Mill in London and to coining presses; he interested himself (and Watt) in Arkwright's patent problems, in Aimé Argand's lamps and Henry Cort's puddling process. Watt indulged himself in a continuing spate of improvements of his engine, and in botanical and chemical studies. Some of Darwin's work, with the Botanical Society at Lichfield, has already been mentioned; he also published a paper in the *Philosophical Transactions* of 1788, on adiabatic compression and wrote his most famous book, *The Botanic Garden* (Lichfield, 1789; London, 1791) in which, among other topics, he celebrated the accomplishments of his Lunar Society friends in Alexandrian couplet and explanatory note.

Keir published chemical articles in the *Philosophical Transactions* and began compiling his own *Dictionary of Chemistry* (part one only, published Birmingham, 1789). Priestley's creative scientific work had essentially been completed before his arrival in Birmingham; most of his subsequent science writing was in defensive reaction against the new chemistry of Lavoisier. Actually his greatest activity in Birmingham was in politics and religious polemic (unshared by his Lunar fellows), but some of his experiments before the Lunar Society set in train the work of Cavendish and Watt leading to the discovery of the composite nature of water. Wedgwood's work is notable

for a new formality, resulting in a series of thermometric and chemical papers published in the *Philosophical Transactions* and an ingenious study on removing the cords and striae in optical glass which, unfortunately, remained unpublished until recently (13). Withering published his clinical study, *An Account of the Foxglove* (Birmingham, 1785) and, like other Lunar members inspired by Priestley to a study of chemistry, published chemical-mineralogical papers in the *Philosophical Transactions*.

Again the question can be raised on how far these individual achievements were dependent upon the existence of the Society, and again the best answer can only be found in noting, first, that the significance of most societies is measured chiefly by the sum of individual accomplishments of their members, and second, that the correspondence and published papers of Lunar Society members continues to exhibit a mutual exchange of advice and assistance substantially larger than that shown by most of the more famous societies.

Another indication of the importance of the Society to its members is, however, to be seen in the change in their productivity with the failure of the Society after 1791. The outbreak of the French Revolution soon put a strain on personal relationships within the Society where differences in politics had caused little trouble during the American Revolution. This strain was intensified by the disastrous Church-and-King riots in 1791, which destroyed Priestley's home and laboratory and drove him from Birmingham. The rioters also invaded Withering's home and caused Boulton and Watt to arm their trusted employees lest Soho be attacked, but their greatest damage was to the continued fellowship of the Lunar Society.

Although the Society continued to meet—perhaps as late as 1803—there is noticeably a change in the composition of its membership and in the quality and quantity of the members' work (14). Some of the change must obviously be credited simply to the toll of time. Of the nine original members of the group, three were already dead and two (Darwin and Edgeworth) moved out of the immediate range of Society activity when this last period commenced, while Wedgwood was shortly to die (1795). Of the six later members, Withering spent the last seven years of his life suffering from pulmonary consumption before his death in 1799, Priestley left England for the United States in 1794, Stokes had already left the Society, and so little notice was taken by the Lunar remnant of Johnson's death in 1799 as to enforce the doubt that his membership had ever been of much significance. It is a fair conclusion that by 1795 the effective core of the Lunar Society had been reduced to Boulton, Galton, Keir and Watt, with Darwin (until his death in 1802) and Edgeworth contributing chiefly by correspondence. Evidently the

Lunar sons, Matthew Robinson Boulton and Gregory and James Watt, Jr, and perhaps Samuel Tertius Galton, were added to Society membership during this period. Perhaps also William Murdock and John Southern were rewarded for their years as faithful employees at Soho with membership in the Society. But though this contributed to the continuing of Lunar Society meetings, it did little toward maintaining that active work which distinguished the Society far more than meetings had ever done.

This is not to say that members no longer produced work of quality, but most of that work was done by members essentially *in absentia*: Darwin's *Zoonomia* (London, 1794-1796), *Phytologia* (London, 1800), and *Temple of Nature* (London, 1803); Edgeworth's *Practical Education* (London, 1798), and *Professional Education* (London, 1809); and Priestley's continuing chemical publications from the United States. Withering pushed through another edition of the *Arrangement of British Plants* (Birmingham, 1796), for all his bad health; Keir maintained his interest in geology, and the Society, as represented by individual members, continued to investigate a wide variety of subjects—though less intensively, and to a smaller published extent. But the most notable characteristic of all this work is the rapid falling off of what formerly had been a principle mark of a Lunar Society paper—the sign of continually drawing upon the experience and enthusiasms of all the members. What little suggestion there is of such co-operative endeavours in the post-1791 publications appears to draw upon earlier momentum, with but one exception.

One project only served to unite the efforts of the Lunar Society during these final years from 1791 till its insensible dissolution, and that one made so strong a personal appeal to the immediate interests of the individual members as to explain its uniqueness. But in this, as in so many other things, Lunar Society support of the Pneumatic Medical Institution is so characteristic of its earlier, more fruitful, days as to serve us here as a summarizing valedictory (15). In 1793 Thomas Beddoes of Bristol published proposals for the establishment of a medical research establishment to test the therapeutic value of the various gases which had been discovered during the previous half-century. Beddoes was already known to Society members. As a chemical lecturer at Oxford he had ordered apparatus from Wedgwood similar to that supplied to Priestley, and Boulton had tried to gain access for his son to the lectures. Beddoes had visited Keir and discussed chemistry with him; Keir invited Beddoes to write articles for his *Dictionary of Chemistry*, though they disagreed on theory. They joined in lamenting the death of Thomas Day, for whose reforming spirit Beddoes had the greatest admiration. Beddoes had also

corresponded with Darwin, and even written poetry in frank imitation of Darwin's *Botanic Garden*. Finally, after being introduced to Edgeworth's family by Darwin, Beddoes married Anna Edgeworth, and his assistant, John King, later married Emmeline Edgeworth.

Agreeing that it was worth an investment of some capital if only to find that gases were not serviceable to medicine, Lunar members and their families subscribed to the Institution. Josiah Wedgwood donated to it just before his death and the 1796 list of subscribers includes: Matthew Boulton, his son and daughter; James Watt, Mrs Watt, and James, Jr; Erasmus Darwin and his sons Robert Waring and Erasmus, Jr; Richard Lovell Edgeworth and Lovell Edgeworth; James Keir and his partner, Alexander Blair; and Robert Augustus Johnson. There was more to this support than a spontaneous flood of enthusiasm for medical research in general. One of the major illnesses to be studied in this new way was consumption. Withering was dying of consumption, one of Edgeworth's wives and her daughter had died of it, Lovell was thought to have it; Watt's daughter Jessy and his son Gregory were both consumptive, as was Sally Priestley Finch, while Tom Wedgwood's illness was thought, for a time, to be consumption. Under the circumstances it is hardly surprising that Beddoes's proposed research was of interest to Society members.

Typically they were to do more than subscribe. Boulton and Watt attempted to use their personal influence to win Parliamentary support for the Institution. Darwin lent the sheets of his still unpublished *Zoonomia*; Withering, unconvinced by pneumatic treatment of consumptives, nonetheless wrote expressing his belief that some gases might prove valuable *materia medica*. Watt helped design apparatus for generating and administering gases; he also wrote parts of the tracts 'advertising' the Institution: *Considerations on the Medicinal Use and on the Production of Factitious Airs* (in five parts, London, 1794-1796; Watt wrote Parts II and V as well as letters on his own experiments appearing in the other parts). The firm of Boulton & Watt manufactured and sold the apparatus. Finally, Beddoes acquired a young assistant, Humphry Davy, recommended to him by Gregory Watt, Tom and Josiah Wedgwood, Jr, who consulted with James Watt and James Keir, in Birmingham before taking the post. The optimism for medicinal use of airs rapidly faded as they were tried, but one spurt of enthusiasm was produced by Davy's experiments with the physiological effects of nitrous oxide (now called laughing gas), in which he was assisted by James Watt, Jr, Gregory Watt, Matthew Robinson Boulton, Joseph Priestley, Jr, and Lovell Edgeworth.

How typical it all was: concerted effort to find a practical application for the scientific discoveries of one of the members which, moreover, would have broad social value; careful (and probably premature) scientific experimentation combined with capital investment and political action; direct personal interest and the possibility of financial gain; and to conclude it all, ancillary scientific discovery and the encouragement of young scientists who were to influence the future. No other eighteenth-century scientific society combined more effectively the varying currents of enlightened thoughts and attitudes into the stream which watered the nineteenth century. No other society so clearly represented the best of the new revolution of industrialism.

NOTES

- (1) This paper, written on the occasion of the bicentenary celebration for the Lunar Society in Birmingham, is substantially based on the writer's book, *The Lunar Society of Birmingham. A Social History of Provincial Science and Industry in Eighteenth-Century England* (Oxford, 1963). To this should perhaps be added the critical comments of Eric Robinson, particularly on the dates of the Society's organization and dissolution—see note 14 below.
- (2) For example, the Spalding Gentleman's Society is the oldest of England's provincial societies while organization of the Peterborough Society followed shortly after. Manchester's Literary and Philosophical Society supported the major researches of John Dalton and James Prescott Joule, the societies in Dublin and Edinburgh were deemed important enough to justify royal charters, and Bath's Philosophical Society might have been expected to reflect the tone of that fashionable watering place. The slight bibliography relating recent researches on these and similar societies is indicated in my 'Histories of Scientific Societies: Needs and Opportunities for Research', *Hist. Sci.* 2, 70-83 (1963).
- (3) See L. Pearce Williams, 'The Royal Society and the Founding of the British Association for the Advancement of Science', *Notes and Records Roy. Soc. Lond.* 16, 221-233 (1961); or Sir Henry Lyons, *The Royal Society 1660-1940* (Cambridge, 1944).
- (4) Joseph Priestley, *Memoirs of Dr Joseph Priestley* (London, 1806), vol. 1, p. 97. Edgeworth's *Memoirs of Richard Lovell Edgeworth, Esq.* (London, 1820) contains frequent references to Lunar Society members and their work, though without specific reference to the Society; it is a fascinating account of eighteenth-century life in Britain.
- (5) Jonathan Stokes, *Botanical Commentaries* (London, 1830), I, cxxv-cxxvi. Priestley dedicated his *Experiments on the Generation of Air from Water . . .* (London, 1793) specifically to the members of the Lunar Society, and his American publications: *Observations on the Doctrine of Phlogiston* of 1797, and both the 1800 and 1803 editions of *The Doctrine of Phlogiston Established* all mention the Lunar Society by name.
- (6) The Boulton and Watt papers preserved at the Assay Office, Birmingham, have been a continuing invaluable source of information; Christiana C. Hankin, ed., *Life of Mary Anne Schimmelpenninck* (London, 1858) must be read with considerable caution.
- (7) Edgeworth, *Memoirs*, I, 188.

- (8) William Withering, 'Experiments upon the different Kinds of Marle found in Staffordshire', *Phil. Trans.* **63**, 161 (1773); *Botanical Arrangement of All the Vegetables Naturally Growing in Great Britain . . .* (Birmingham, 1776).
- (9) There is evidence, however, that Keir was still involved in the copypress business as late as 1782, while a reference exists to a glass firm, Scott, Keir, Jones & Co., in 1789.
- (10) A recent detailed and ingenious study of this process (written by Keir's great-great-grandson) can be read in J. L. Moilliet, 'Keir's Caustic Soda Process—an Attempted Reconstruction', *Chem. Ind.* No. 10, 405-408 (1966).
- (11) Joseph Priestley, *History and Present State of Electricity* (London, 1767), p. xvi.
- (12) See Eric Robinson, 'The Derby Philosophical Society', *Ann. Sci.* **9**, 359-367 (1953).
- (13) Robert E. Schofield, 'Josiah Wedgwood and the Technology of Glass Manufacturing', *Technology Cult.* **3**, 285-297 (1962).
- (14) Eric Robinson's 'The Lunar Society: Its Membership and Organization', *Trans. Newcomen Soc.* **35**, 153-177 (1962-1963), prints brief extracts from memorandum books of Gregory Watt and Matthew Robinson Boulton citing Lunar meetings in 1800, 1801 and 1802.
- (15) Of the many accounts of the Pneumatic Medical Institution, one of the most complete is F. F. Cartwright, *The English Pioneers of Anaesthesia (Beddoes, Davy and Heckman)* (Bristol & London, 1952).