The Development of Natural History-(2)

Yoshico Cato

(iii) James Keir(1735-1830)

James Keir, Dr. Lind's cousin, was born in Edinburgh, Scotland, in 1735 and was brought up with Lind (*DNB*). Like Lind, he studied at Edinburgh University, and while a student of the Medical Department, he became friendly with Erasmus Darwin (1731-1802). Later, Keir joined the army and served as a soldier for a number of years, but after retiring from the forces and living with Richard L. Edgeworth in Hare Hatch for a few months, he moved, in 1768, to West Bromwich, a few miles west of Birmingham.

Once settled in West Bromwich, Keir was quickly attracted to the Lunar Society, and, being a man of common sense, he soon became one of its leading members. James Watt (1736-1819) called him a 'wonderful chemist', and, in 1780, he established the Tipton Alcali Factory, regarded by many as the first example of a modern chemical industry; here he succeeded in making soda from salt. Since Keir was at the centre of the Lunar Society, it is very probable that through Keir's relationship with Lind, Shelley became aware of and attracted to the prominent scientists of the Lunar Society.

(iv) Erasmus Darwin(1731-1802)

A prominent figure among Keir's acquaintances in the Lunar Society was his Edinburgh friend Erasmus Darwin, the grandfather of Charles Darwin, the theorist of evolution. Erasmus himself, a doctor and a naturalist, was also a poet. Among his achievements as a scientist and poet, was the notable influence that he exercised upon Shelley. In the following sections, we shall be tracing this influence in Shelley's poetry. And since he seems to have played an important role in the making of Shelley as a poet, we need to summarize his life, together with offering the outline of his major poetry, such as, for example, the work to which we have already referred, 'The Loves of the Plants'.

(iv-a) His Life

Erasmus Darwin's forebears came from Lincolnshire, minor gentry who had served both King James I and his son King Charles I. Erasmus's father, Robert Darwin (1682-1754), was a lawyer, but he had retired young; his mother was Elizabeth Hill (1702-97). They had 7 children, and Erasmus, the last, was born at Elston Hall near Nottingham, in the English Midlands, on Dec.12, 1731. He entered Chesterfield School in 1741, and St. John's College, Cambridge, in 1750, on an Exeter Scholarship, to study classics and mathematics. His poem written on the death of Frederick, the Prince of Wales (1751), was published in the European Magazine (1795). While at Cambridge, he often went to London, where he attended the lectures of the famous surgeon, William Hunter. From 1753 to 1756, he studied medical science at Edinburgh University,

at that time the most advanced medical school in Europe, and, in 1755, he took the M. B. at Cambridge. Although both he himself and his grandson Charles Darwin insisted that he was awarded his B. A. and M. D. at Cambridge, no record of these degrees has been found.

In September, 1756, Erasmus started in practice as a doctor in Nottingham, but since he had no patients, his practice never came to anything. In November, he moved to Lichfield, an ancient cathedral city to the north of Birmingham, a small city still, yet at the heart of what would become the Industrial Midlands. Here, he lived there for 25 years, and here, he prospered, becoming famous as a doctor who never claimed payment from the poor, but gave them foods and blankets. In 1757, he married Mary Howard (1740-1770), a daughter of Charles Howard, a lawyer, and Penelope, his wife. Of their three surviving sons, Charles, the eldest, lost his life from an infectious disease contracted during a dissection during his college days, while Erasmus, the second son, became a lawyer, and Robert Waring, the youngest, born in 1766, also a surgeon, was to be the father of Charles Darwin. At the beginning of the 1770s, Mary Parker bore his illegitimate child, but in 1775, he became acquainted with Elizabeth Pole, daughter of Charles Colyear, the Earl of Portmore, and after her first husband died, he married her in 1781.

(iv-b) Science and Poetry

Later, the Darwins moved to Ratburn Hall, a few miles from Derby, but in 1783 they moved to Derby itself, and, later again, to Breadsall Priory, north of the town. Six of their children survived. While working as a doctor, Erasmus took to the study of natural science, and turned as well to the invention and innovation of machines. On 6 occasions between 1757

and 1760, he published papers on these topics in the *Philosophical Transactions*.

The first paper argued that electricity never exerts a bad influence upon the mechanical characteristics of the air. The second concerned the medical treatment of a patient who had vomited blood. The others dealt with the properties of oxygen, the clouds, and photosynthesis. Since these are all of considerable importance in our study of the scientific sources of Shelley's poetry, we shall need later to consider them in more detail.

From the 1760s to the beginning of the 1770s, Erasmus Darwin's studies covered an impressive number of fields: gas, chemistry, the design of carriages, a speaking-machine, geology, steam engines, diseases, meteorology, a spinning machine, a water pump, a locking system for the hydrography of canals, a copying machine, a flying machine, and so on. During the latter half of the 1770s, however, he mainly concentrated on the theory and practice of botany. He created his own 'botanical gardens' in a Lichfield suburb, and his grandson Charles described its creation in his *Life of Erasmus Darwin*[46]:

> In 1776 he purchased the lease of a pretty valley, about eight acres in extent near Litchfield, and made it into a botanic garden; and this seems to have been his chief amusement. Miss Seward describes the place in her grandiose style as "a wild umbrageous valley... irriguous from various springs, and swampy from their plenitude." It now forms part of an adjoining park; and a Handbook for Litchfield says it is still a wild spot, but very picturesque; many of the old trees remaining, and occasionally a few Darwinian snow-drops and daffodils peeping through the turf, and bravely fighting the

[46] Desmond King-Hele, ed, *Charles Darwin's The Life of Erasmus Darwin* (Cambridge: CUP, 2003)31.

battle of life."

While at work on this garden, and with the help of the members of Lichfield Botanic Association, Erasmus began to translate the works of Carl Linnaeus (1707-1778), works that he published as *The System of Plants* (1783) and *The Family of Plants* (1787). The former was dedicated to Sir Joseph Banks, President of the Royal Society, the great botanist of whom we have already spoken and will write about in rather more detail below (part(v)).

While cultivating his garden and translating the works of Linnaeus, Erasmus followed the advice of Anna Seward and expressed the Linnean classification of plants in poetic form, hoping eventually to disseminate the knowledge among the common people; but he postponed publication of 'The Loves of the Plants' until 1789, because if people knew that a doctor had published poetry, it would, according to the opinions of the time, have hurt his name.

This long poem, in heroic couplets, consists of 4 cantos, and the storyteller is a 'Botanic Muse', who tells how 83 kinds of plants make love as if they were men and women, while commenting, in passing, on general literary topics. Erasmus had a thorough knowledge of natural history, and the poem is also worthy of note since in it Erasmus first proposed the idea of 'the evolution of nature' which was to become the source of 'the theory of evolution' which his grandson was to develop in *On the Origin of Species*. To quote a passage,

> Perhaps all the products of nature are in their progress to greater perfection — an idea countenanced by the modern discoveries and deductions concerning the progressive formation of the solid parts of the terra-aqueous globe. ('The Loves of the Plants', I, 65, n.)

In 'The Loves of the Plants', Erasmus describes the appearance of plants and the pollination of stamens and pistils, comparing them by means of personification to the appearance *of human courtship*, and he vividly describes the forms and colours of plants by pictorial expressions. His description of a flower called the Canna will offer us an example:

First the tall CANNA lifts his curled brow
Erect to heaven, and plights his nuptial vow;
The virtuous pair, in milder regions born,
Dread the rude blast of Autumn's icy morn;
Round the chill fair he folds his crimson vest,
And claps the timorous beauty to his breast.

('The Loves of the Plants', I. 39-44.)

Erasmus sees the red of the Canna flower as a red coat with which a husband gently protects his wife from the cold in a strange northern country. Yet the number of stamens and pistils of many of the flowers in this poem signify that not all flowers are monogamous; there are all kinds of couplings; polygamy, polyandry, wife or husband swapping, incest among brothers, sisters, parents and children, so that a reader is overwhelmed by the freedom, vigour, and variety of loves to be found in nature. It is perhaps no surprise that such views would have appealed to the polygamous Shelley.

In 1791, Erasmus combined the reprint of the second canto of 'The Loves of the Plants' and the first canto of the 'The Order of the Plants' and published them as his long epic poem *The Botanic Garden*. His fundamental attitude is expressed in the following passage.

The general design of the following sheets is to inlist [enlist]
Imagination under the banner of Science; and to lead her votaries
from the looser analogies, which dress out the imagery of poetry, to

the stricter ones which form the ratiocination of philosophy.[47]

The 'Loves of the Plants' is a long, didactic poem in four parts, each part corresponding to each of the four elements of earth, water, wind, and fire. Erasmus adds a great number of notes on the theory and experimental works of natural history. In the 'Loves of the Plants', Erasmus gives high praise to the achievements of contemporary naturalists and those industrial managers whom we have already met, many of them fellow members of the Lunar Society, people like Josiah Wedgwood, Sir William Herschel, Henry Cavendish, the American inventor and politician Benjamin Franklin, Joseph Priestley, James Lind, Matthew Boulton, James Brindley, Thomas Savery, John Whitehurst, and their confreres.

The poem contains vivid descriptions of the building processes, operating methods, functions, and effects of typical machines, alongside a poetic description of the natural world, inhabited by nymphs, gnomes, sylphs, salamanders. It is strange world of harmony between nature and industry, and throughout one feels the teleological confidence of the Enlightenment, the belief that the world is in the process of progress towards greater and greater maturity.

(iv-c) The Lunar Society

As the Lunar Society of Birmingham was a private group, no records remains, but Erasmus Darwin appears to have been perhaps the major driving force and he founded three associations; the Lichfield Botanic Association, the Lunar Society, and the Derby Philosophical Association. The most important of them was the Lunar Society.

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[47] Erasmus Darwin, i.

What bound all these men and their friends together were their revolutionary ideas, their belief in the natural and inevitable development of scientific technology and learning, while at the same time they aimed at social reform. They gathered and dined together, and had lively discussions on new scientific discoveries, the experiments and proofs of theories, the technological innovations, improvements, and inventions, and sometimes, of course, they seem to have fallen out; but their activities contributed to the rapid progress of the Industrial Revolution in England, and their leader, it appears, was Erasmus.

(v) Sir Joseph Banks (1743-1820)

Joseph Banks was a close friend of Dr James Lind, whose great influence upon the young Shelley we have already noted. His father was William Banks, a gentleman of Revesby Abbey, Lincolnshire, and he was born on Feb. 13, 1743. He was educated at both Harrow School (1752-6) and Eton College (1756-60), and it was at Eton that he appears to become stimulated by botany, perhaps (it has been suggested) because his mother, Arabella, owned a copy of John Gerard's famous and influential *Herbal*, the first plant catalogue ever published in Britain (1597).

Joseph entered Christ Church, Oxford, but as he found the lectures of Dr. Sibthorp, Prof. of Botany, uninspiring, he employed, in 1764 and at his own expense, a Cambridge botanist, Israel Lyons, to lecture to him. (Not only was leisure important if you wished to follow your scientific interests: so, of course, were the necessary funds.) Subsequently, at Oxford, he studied natural history, mainly botany and geology, and like most members of the nobility or the landed gentry, he finished his studies without taking a degree; yet he had already, in 1761, become a member of The Society

for the Encouragement of Arts, Manufactures, and Commerce, and, in 1766, he was elected a fellow of The Royal Society and a fellow of The Society of Antiquaries. After the death of his father, he was able to continue living in college, and he divided his time between Oxford and his mother's house in London, near the Chelsea Physic Garden, founded and maintained by The Society of Apothecaries.

While he was studying in The British Museum, he met the librarian Daniel Solander, who had trained under the great Linnaeus. Subsequently, Banks became a disciple of Linnaeus, and they exchanged letters. Later, Banks and Solander were to join Captain Cook's first expedition on the Endeavour. In fact, Banks served as a Linnaean naturalist on three expeditions, first in 1766 with Constantine Phipps in the expedition to Labrador and Newfoundland, where he collected specimens, which Solander helped him to put in order (they are now preserved in the Natural History Museum, London). From 1768 to 1771, he served Lord Sandwich, his close friend, on the first great Endeavour voyage of Captain Cook, whose chief purpose was to observe the transit of Venus in Tahiti. They anchored on the 13th of April, 1769, and remained there for three months. As well as studying its natural features, Banks was interested in Tahitian customs, and he and his colleagues went on to explore New Zealand and New Holland. Cook named a bay near Sydney Botany Bay, after the works of Banks. Since the Endeavour ran aground on the Great Barrier Reef in June, 1770, they had to go on to Batavia for repairs, which reawakened Banks' interest in the Australian Aborigines, but the voyagers did not have enough time to get in touch with them. During their three months' stay in Batavia, from the 9th of October, 1770, they lost thirty men to Java fever. They returned to the port of Deal, Britain, on the 12th of June, 1771, and it was on this occasion that Banks was introduced to

Kind George III, whose close friend and advisor he was to become. Cook set up another expedition, which Banks wanted to join, but as Lord Sandwich became jealous of him and hostile towards him, he had to abandon the idea. Instead, in 1772, as we have seen, Banks surveyed the geology and nature of Iceland, a very different clime.

In 1773, the King made Banks the virtual director of the Royal Botanic Gardens at Kew, London, and he became a member of the council of the Royal Society in 1774; in 1778, he was elected its President. In the following year, he married Dorothy Hugessen, parting with his mistresses, Harriet Blosset and Sarah Wells, though not without helping them financially. In 1781, the King dignified him with a baronetcy, and after he had expelled such enemies as Bishop Samuel Horsley, Banks controlled The Royal Society as its President until his death. With the King's support, Banks was able to exercise political influence upon the Royal Observatory, the Board of Longitude, the Board of Agriculture, and the Privy Council Committee on trade.

In 1797, with the help of his close friend, Charles Jenkinson, Lord Hawkesbury and later the first Earl of Liverpool, he was elected to the Privy Council, and from here his influence spread to the Board of Control for India, the Home Office, and the Admiralty. Later, in order to further imperial prosperity based on scientific investigation, he organized the Bounty expedition of 1787-89, the Investigator expedition of 1801-03 to Australia, and the Providence expedition of 1793. The last of these succeeded in transferring breadfruit from Tahiti to the slaves in the British West Indies. He also promoted an expedition to Africa, and became one of the founders of The African Society.

During these years, the French Revolution divided Europe, and the British and French navies were pitted against each other all over the

world. Unlike the members of the Lunar Society and Romantic Poets such as Wordsworth and Shelley, Banks opposed the French Revolution, for he was fundamentally conservative by temperament and upbringing, and he had a strictly hierarchical view of society. He opposed the Wood Bill of 1788 and defended the Corn Laws. Yet he does not seem to have been a very pious Christian.

As King George became increasingly insane, and as his friend, the earl of Liverpool, retired in 1802, Banks gradually lost his power, although, in 1795, he had been made a knight of the Order of the Bath. He suffered from severe gout, and died on Monday, the 18th of June, 1820. He was entombed in the parish church of Heston near his Middlesex country house, Spring Grove, in the village of Spring Grove. George Cuvier, a French naturalist, acknowledged him as 'a statesman of science' before the French Academie des Sciences[48] (Cuvier, 3, 49).

(vi) Sir William Herschel (1738-1822)

Sir William Herschel was born in Hanover, Germany, on the 15th of November, 1738, and in 1757 came to England to escape the French occupation of his home town (DNB). At first, he was a music teacher, but later he took up astronomy and constructed a powerful telescope through which he discovered Uranus and the nebulae. He was knighted in 1816. Erasmus Darwin refers to Herschel's 'Georgian star' (Uranus) in 'The Loves of the Plants' :

Three blushing Maids the intrepid Nymph attend,

And six gay Youths, enamour'd train! defend.

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[48] *Dictionary of National Biography* (Oxford : OUP,1893, 1967-68).

So shines with silver guards *the Georgian star*,
And drives on Night's blue arch his glittering car;
Hangs o'er the billowy clouds his lucid form,
Wades through the mist, and dances in the storm.

('The Loves of the Plants', I, 215-220) [Italics mine.]

We know that Dr Lind was a friend of Herschel's, and we know that Shelley knew him, too, because we have a record that he ordered a book by Herschel, or supposed that it was possible to have ordered it, if in vain: Let us see the letter from a French bookseller to Shelley:

A. & W. Galignani to Shelley
Librairie Francaise et Etrangre
DE . &w. GALIGNANI,
Rue Vivieune, No 8
Paris, 25th april, 1822

Sir

We have the honour to acknowledge the receipt of letter 2 d inst. And To inform you of our having forwarded on the 17th inst. the work of 'Laplace essai sur les probabilites', of 'Cuvier' the only two volumes as yet published, and 'Daubuisson's Geognoise' which is considered the best work of its kind. We inclosed in the parcel Lord Byron's 'Cain' [which you ordered previously, and the work of Mirabel which was also ordered by M. Horace Smith some time ago, & which we were waiting for an opportunity to forward. *Herschel's Work* notwithstanding all the enquiries we made could not be procured....[49]

[49] F. L. Jones, ed., *The Letters of Percy Bysshe Shelley*(Oxford at the Clarendon P, 1964) I, 458.

[Italics mine.]

Shelley had ordered this book, but the booksellers were unable to find it for him. It was in fact not a book, but an article in the *Philosophical Transactions* that he had ordered, and hoped to read. It is probable that he had already read it in Britain before he started his grand tour in Italy, and that he had wanted to read it again in Italy.

Herschel may not be the only astronomer to have influenced Shelley, but he is a very important one in that he was a close friend of Dr. Lind's, and Shelley, we know, made great use of astronomical imagery in such major poems as *Prometheus Unbound*.

(vii) Matthew Boulton (1728-1809)

Matthew Boulton was an engineer, born in Birmingham, where his father was a silver stamper and piercer. His family originally came from Northamptonshire, but his grandfather settled in Lichfield, from which he later moved to Birmingham to set up in business. After his father died in 1759, Matthew took over the business and turned it into one of the greatest success stories of the early industrial age. A considerable dowry by marriage enabled him to found the famous Soho workshops in Birmingham, where he not only vastly improved the workmanship of his wares in metal, pottery and other materials, but employed agents to advertise their artistic merits. Since the factory needed more energy than that which could be supplied by water-power alone, he introduced the steam engine. At first, this was used only for pumping water, and while he carried out experiments to improve the engine, these were not successful: it was not until he met James Watt that, between them, they were able to revolutionize not only the means of transport but industrial

operations as well.

When they began to work together, James Watt was in partnership with Roebuck, a friend of Boulton's, but, in 1772, Roebuck went bankrupt. Boulton had tried to assist Roebuck and Watt, who first visited Soho in 1767, and when Boulton and Watt themselves went into partnership, Boulton assisted, advised and encouraged Watt in his great project, a work that was completed when Boulton was over 60 years old. Boulton's other great achievement, and the one that brought him European fame, was his reformation of the copper coinage. In 1788, he established several coining presses at Soho, worked by steam engine, and he made coins for some of the colonies, such as the East India Company; in 1797, he began to produce new copper coinage for Great Britain, and, from 1805, helped to establish the new mint on Tower Hill.

He was a member of the Lunar Society and was elected a Fellow of the Royal Society. His friends included Franklin, Priestley, Erasmus Darwin, Wedgwood, and Edgeworth. He died in the house at Soho, now a museum to his memory, on the 18th of August, 1809.

(viii) Tiberius Cavallo (1749-1809)

The *Oxford DNB* tells us that Cavallo, the son of a physician, was born in Naples, Italy, on the 30th of March, 1749, but in 1762, he traveled to London, where he studied experimental electricity, and settled. He published several books on electricity; *A Complete Treatise on Electricity in Theory and Practice with Original Experiments* (1777), *An Essay on the Theory and Practice of Medical Electricity* (1780), *A Treatise on the Nature and Properties of Air and other Permanently Elastic Fluids* (1781), *History of Aerostation* (1784), *A Treatise on Magnetism in Theory and Practice* (1800),

and *Elements of Natural and Experimental Philosophy* (1804).

His first book established his reputation and, in 1779, he was elected a Fellow of The Royal Society, where he and James Lind became friends; and since Dr. Lind had been physician to King George III, Cavallo proposed electrical treatment as medical therapy for the king's condition[50]. It is not surprising, therefore, that the young Shelley should have been excited by experimental electricity, for Dr. Lind in his house in Windsor would almost certainly have taught him about Cavallo's theory of the importance of experiments for the advancement of natural knowledge. It is also important to note that at first Cavallo, like his friend Dr. Lind, was a supporter of the French Revolution,[51] but that later, like Wordsworth, he was dismayed by the politics of the Terror. Even so, he might well, like Dr Lind, have influenced Shelley's radicalism. In 1781, Cavallo had become a member of the Chapter Coffee House Society in London, and, in 1782, Bakerian lecturer at the Royal Society. His lectures covered a wide range of topics from electricity to astronomy: natural and artificial electricity, magnetism, experiments on 'inflamable airs' (Shelley's favourites), and instruments such as an air pump, a blowpipe, a pyrometer, a telescope, and a microscope. In 1782, he met the Italian physician Alessandro Volta in London, and, 1792, he contributed to the publication in the *Philosophical Transactions* of The Royal Society of Volta's memoirs on Galvani's experiments on Muscular motion.

In 1804, King George III gave him a royal licence to live in the Kingdom forever. He loved music and was a good musician. In 1809, he accepted the hospitality of his close friend, Thomas Rackett, an antiquarian, and lived in his house in Dorset for a few months. But after

[50] The *Oxford DNB* (Oxford, 2004) 591.
[51] King-Hele, ' Shelley and Dr. Lind,' 4.

he returned to London, he suffered from respiratory problems, and died of asthma on the 22nd of December, 1809. He was buried according to the rites of the Roman Catholic Church.

(ix) Joseph Priestley (1733-1804)

Joseph Priestley was a theologian and a man of science. After his father went bankrupt, he was adopted, in 1742, by his father's eldest sister, Sarah. When he was 12, he went to Batley grammar school, where he learned Latin and Greek, but since his teacher, John Kirkby (1677-1754), who taught him Hebrew during the holidays, had to close his school, Joseph was not able to become a minister, as his aunt had wished. His uncle advised him to study in Lisbon, where he learned French, German and Italian. After he had recovered from the symptoms of consumption, he entered Daventry Academy in 1751, and became the first student to begin his theological training under Caleb Ashworth. Under the influence of John Walker (1719-1805), who came from Cheshire, as well as of Samuel Clark (1727-69) and Doddridge, Priestley grew more liberal and turned away from orthodoxy, finally, in 1754, becoming an Arminian determinist.

In 1755, he became a minister in Suffolk, where he attempted, though in vain, to run a boarding school. While there, he gave dozens of adult lectures on the use of the globes. In 1758, he moved to Nantwich, Cheshire, where, in addition to his ministry, he ran a small school and gave private tuition. He made friends with Edward Harwood and Joseph Brereton (d. 1787), vicar of Acton, near Nantwich, and Brereton presented him with a telescope that he had made himself.

While studying at Warrington Academy, Priestley developed an

interest in natural philosophy, and, in 1762, he was ordained, but he taught English and Latin rather than theology, while his historical lectures and constitutional history, published in 1788, were recommended by the Cambridge professor of Modern History, John Symonds. Jeremy Bentham acknowledged that he was indebted to Priestley for the famous words 'the greatest happiness of the greatest number' taken from the 'Essay on Government', written at Warrington and published in 1768. In 1764, Edinburgh University awarded him the diploma of LL.D. Every year, he stayed for a month in London, where he met Benjamin Franklin. During the 1770s, he was concerned with the decay of church organization, the constitution of the Christian church, and the neglect of the sacraments among liberal dissenters. He argued for the withdrawal of the 'Regium Donum', an annual grant awarded to Irish Presbyterian clergy for loyalty to the crown, though the grant was not finally discontinued until 1869. He planned a new religious movement in the Theological Repository (1768-88) under the banner of Unitarianism.

Before he took up the ministry of Mill Hill Chapel, Leeds, in 1767, he lived in Meadow Lane, near Leeds, and in 1770 he founded the Leeds circulating library. In1771, Sir Joseph Banks appointed him 'astronomer' to Captain Cook's second expedition. In 1772, Priestley was appointed the librarian or 'literary companion' to William Fitzmaurice-Petty, second earl of Shelbourne, later first marquis of Lansdowne. The earl gave him a house at Calne, Wiltshire, and rooms in his London house in Berkeley Square. Priestley catalogued Shelbourne's books and manuscripts, and indexed his private papers, teaching his sons and preaching when he pleased, but as Priestley began to be attracted by materialism, Shelbourne tried to transfer him to Ireland, and he withdrew from Shelbourne's service. He published his 'Examination' (1774) of Scottish philosophy, and

an essay of it (1775) led him to be suspected of atheism. In 1780, he succeeded William Hawkes (1732-96) as junior minister of the New Meeting, Birmingham, and pursued catechismal instruction. He was acquainted with both the established clergy and the 'Lunar Society,' and he knew Boulton, Keir, Watt, Withering, and Erasmus Darwin. He published a 'History of Early Opinions concerning Jesus Christ' (1786), and after 1786 he supported Unitarianism, in 1790 publishing a 'General History of the Christian Church'. In 1791, while continuing his scientific experiments, which took up more and more of his time, he founded the 'Unitarian Society'.

He wrote two pamphlets on the relations of Great Britain with the colonies in 1769 and 1774, the second revised by Benjamin Franklin. He argued that the slave trade should be abolished, and though he never belonged to any particular political faction, he helped, in 1791, to found the Birmingham Constitutional Society. In his 'Letters to Burke' (1791) who, until 1783 had been his intimate friend, he attempted to vindicate the principles of the French Revolution (which Burke opposed), and he published the 'Dialogue on the General Principle of Government.' When, in 1791, he attended the Constitutional Society of Birmingham, to commemorate the fall of the Bastile, the chairman was James Keir, a cousin of Dr. Lind. Subsequently, the mob attacked his house of Fairhill, a mile from Birmingham, and destroyed it, including all his books and manuscripts, although Priestley and his family had escaped before the mob arrived. He passed the day in the company of Adam Walker, a lecturer in physics from London, who had dined at Fairhill, the same Adam Walker who would teach Shelley at Sion House Academy. Later he was invited to visit Paris and Toulouse, but he decided to settle in London, where he lectured at Hackney College on history and chemistry; but in 1793,

fearing for his life, he finally emigrated to America, as did his sons. His sons had been interested in a plan to settle in Pennsylvania on the Susquehanna, but he himself stayed in Philadelphia and gave up all ideas of settling in Pennsylvania. He held public services in his house, where he hoped to found a Unitarian congregation. He died on the 6th of Feb., 1804.

Priestley is famous as a man of science, mainly as a chemist, and most of all for his discovery of oxygen. He had been interested in science since 1758, when he acquired a small-pump, an electrical machine, and other instruments, and with them he began to make experiments[52]. After 1761, he seems to have preferred science to literature, and, in 1766, he was elected a Fellow of the Royal Society: it was on his visits to London that he was encouraged, especially by Benjamin Franklin, to write up the 'History of Electricity' (1767). He discovered that electrification was merely a modification of the body that was electrified, although he later identified 'the electric matter' with phlogiston ('Experiments ...on...Air', I, 186).

He also pointed out the need for the measuring of electric resistance and proposed a method of measuring what is now called 'impedance,' which was not then distinguished from resistance (*Phil. Trans.*, 1769, 63). In 1772 he corresponded with Volta then living at Como, Italy, and received, from Leopold, grand duke of Tuscany, a commission for an electrical machine, which Edward Nairue made under his direction. After 1770, he gave up the study of electricity, and started to study the problem of combustion, which, in a sense, sowed the seeds for the birth of modern chemistry[53].

My reasons for going into this in such detail is that Shelley was

[52] *The Philosophical Transactions*, 1770, 192.
[53] *Phil. Trans.* 1770, 211.

clearly fascinated by these experiments, and, according to his life written by his friend Thomas Jefferson Hogg, the young Shelley loved playing with Priestley's electrical machine and studied intensively the workings of electricity[54]. To understand Shelley properly, we have to understand the ferment of ideas from which his own ideas emerged.

In 1772, Priestley announced that he had discovered marine acid air (hydrochloric acid) and nitrous air (nitric oxide). He showed that in air exposed over water, one-fifth disappears in the process of combustion, respiration, and putrefaction, that plants restore the air vitiated by these processes, and that no known gas conducted electricity. He also proposed the use of carbonic acid for the creation of the mineral-water industry. He produced two gases, carbonic oxide and nitrous oxide. His paper was awarded the Copley medal of the Royal Society in 1773.

He later identified phlogiston with electricity and with hydrogen (*Phil. Trans.* 1785, 280). In 1774, he produced a new gas purer than ordinary air, which Lavoisier was later to name 'oxygen'. In the same year, he told Lavoisier how to produce oxygen, which Lavoisier made for himself, in Paris, and, in May, 1775, he explained the construction of the air, combustion and respiration. Priestley himself announced his discovery of oxygen in a letter to Sir John Pringle, which was read to the Royal Society on the 25th of May, 1775. In 1778 Priestley returned to a study of vegetable physiology that he had begun in 1772, and discovered oxygen in the bladders of seaweed.

In the same year, 1778, he discovered that oxygen is given off in the light from the green conserva in water; during the winter he found this to be vegetable matter, and extended his study to other plants. In 1781,

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[54] Hogg, I, 311-12.

he decomposed ammonia by means of an electric spark. He further discovered that when hydrogen and oxygen are exploded by means of an electric spark, it forms a dew. Later, Cavendish and Lavoisier repeated the same experiments. In 1793, he published the 'Experiments on the Generation of Air from Water,' dedicated to the Lunar Society and the 'Experiments relating to the Decomposition of Inflammable and Dephlogisticated Air' (*Phil. Trans.* 1791, 213).

In his last papers, he attacked Erasmus Darwin's theory of spontaneous generation and of evolution, while he also improved the methods of collecting gases, and he used mercury in the pneumatic trough, and dealt for the first time with gases soluble in water. Erasmus Darwin has a reference to mercury in his 'Loves of the Plants' :

So sinks or raises with the changeful hour
The liquid silver in its glassy tower.

(I, 311-12)

(x) James Watt (1736-1819)

Another friend of Erasmus Darwin and the members of the Lunar Society was James Watt, the inventor of the steam engine. Like Lind, Watt had been educated at the university of Edinburgh, and, through Lind, he became acquainted with Lind's English friends in the Lunar Society. Later, Watt became a member of the Royal Society of London, and in this sense, we can see that he was one of the stars that circulated around Lind and Shelley.

The *Oxford DNB* records that James Watt was born in 1736 in Greenock, Renfrewshire, where his forebears were prominent members of the community, and his grandfather was a well-known teacher of

mathematics. James was sent to M. Adams' school in Greenock, and then went on to Greenock grammar school. In 1745, he moved to Glasgow, where he learned Latin and Greek, and there he made friends with his mother's relative, George Muirhead, who held the chair of humanities at Glasgow University, as well as getting to know such members of the Literary Society as John Anderson, Robert Dick, Joseph Black, and Gilbert Hamilton. Dr. Robert Dick, later professor of natural philosophy became one of Watt's closest friends. Dick recognized Watt's potential and advised him to go to London with an introduction to James Short, a fellow Scot, a mathematician and a famous telescope maker. Watt went to London in 1755, and while there Short introduced him to John Morgan, a mathematical instrument maker living then in Cornhill. In 1756, Watt returned to Glasgow, where he assisted Dick to unpack and renovate some astronomical instruments. He was permitted to open a workshop in the university, and he was called an official mathematical instrument maker.

Watt began to think of applying steam power to road carriages and mining around 1759, and in the early 1760s, after experimenting on the force of steam in a Papin's digester, he built a model steam engine, although for a while he had to put the idea aside. In 1763, he was asked to repair the model of a Newcomen engine belonging to the natural philosophy class at Glasgow University. When he found problems in the boiler, he made a new model, and through the famous 'tea kettle experiment' he discovered the latent heat of steam. Later, Joseph Black explained to him the scientific principles, and this enabled him to invent the separate condenser.

During 1765 and '66, Watt built some atmospheric equipment for Dr. John Roebuck, who had studied medicine in Leiden, as well as at Edinburgh, and, 1768, he designed a colliery engine, incorporating a

separate condenser and an air pump. Roebuck lived in Birmingham, and had interests in chemistry: he discovered the refining of precious metals and developed the lead chamber process of sulphuric acid manufacture with Samuel Garbett, a member of the Lunar Society of Birmingham. Roebuck also ran a large-scale iron-manufacturing workshop at Carran, and employed the coke-smelting process of cast-iron manufacture. Dr. Black seems to have introduced Roebuck to Watt, but Roebuck went bankrupt in 1770, on having, in 1769, to pay the costs of obtaining the patent for the Watt engine.

The most important partnership in Watt's life began when he met Mathew Boulton in Birmingham in 1767, while on his way to London to attend the House of Commons committee on the Forth and Clyde Canal Bill (he had meant to see Samuel Garbett, Roebuck's partner). On his return journey he met Erasmus Darwin. In 1768, Watt visited Boulton's Soho Manufacturer in Birmingham, and stayed for two weeks. Boulton was the first person to mechanize laths for polishing steel, and later he developed the first flow-production system for the manufacture of coinage and medals. Ultimately, Watt's partnership with Boulton was to last for twenty years, throughout the 1780s and 1790s, since it was Boulton who underwrote Watt's experiments and turned his models into working machines.

Eventually, Watt was elected to The Royal Societies of London and Edinburgh, and his friends included Dr. Joseph Black of Glasgow and Edinburgh universities, and Dr. James Hutton, the Scottish geologist, who, too, had studied medicine at Edinburgh. As soon as he had settled in Birmingham, Watt became a member of the Lunar Society, and as most of the Lunar members became the Fellows of The Royal Society, Watt would have known them in both contexts. It should not surprise us, then, if

young Shelley would have heard of them through Dr. Lind at Eton, and have been inspired by the extraordinary ferment of scientific ideas and technological discoveries that these remarkable men developed and set in train.

(xi) Josiah Wedgwood (1730-95)

Josiah Wedgewood was a close friend of Sir William Hamilton, and he made his bust in the British Museum. He was, like William Blake, greatly concerned with the liberation of the slaves in the New World, and he produced special medals for assisting the movement of liberating slaves. He was radical, in a sense, like other Lunar members. In this sense, his thought might, like Lind's, have influenced the young Shelley.

Josiah Wedgwood, master potter, was born in Burslem, Staffordshire, in 1730. His family had a long connection with the Staffordshire pottery industry, and after Josiah had attended a small school in Newcastle under Lyme, he was apprenticed for five years to his brother at the Churchyard Works, to learn the art of throwing and handling. When he was 15 years old, however, he suffered from smallpox that weakened his right knee, and he was unable to work the kick-wheel without assistance; but he completed his apprenticeship, and, in 1754, he went into partnership with Thomas Whieldon, one of the best potters in England, at his factory at Fenton Vivian, near Stoke-on-Trent. In 1759, he left Whieldon and set up on his own as an independent potter. Until 1788, his cousin Thomas Wedgwood worked with him as his assistant.

In 1759, he opened a workshop at the Ivy House but later moved to Brick House. In 1762, he came to know Thomas Bentley, who spoke French and Italian and became his partner. He opened his first London

showrooms in 1765, and he was appointed official potter to her majesty, Queen Charlotte: his creamware was (and still is) called 'Queen's ware'. In 1766, he built a factory called Etruria, near the Trent and Mersey Canal, and Bentley was able to ship Wedgwood wares to America and the West Indies. After an operation, he had to be fitted with wooden legs, but that did not stop him from working, and in the Etruria factory he produced cameos, medallions, tablets for chimney pieces, library busts and ornamental vases in his refined black basalts (black stoneware). He told his partner, Bentley, that he intended to be 'Vase Maker General to the Universe' (Wedgwood Manuscripts 25-18240, 1 May, 1769). Wedgwood is said to have usually been the first to adopt or adapt improvisatory aids and techniques (*DNB*, 921).

Since a bust by him of Sir William Hamilton is now in the British Library, we can assume that Wedgwood, among his many acquaintances, would have known Hamilton, too.

(xii) The Inventors during the Industrial Revolution

During the age of the Industrial Revolution[55], Britain produced many inventors, and Darwin, Lind and their circle were not the only ones to stimulate Shelley's young heart: many others did, too. In Scotland, the economists Adam Smith and Thomas Robert Malthus[56] were also concerned with the happiness of British society. And there were such inventors and engineers as Sir Richard Arkwright, John Kay, James Hargreaves, and Samuel Crompton. Most of them became friends of James Watt and Josiah

[55] Masao Jimbu, *A History of Great Inventions and Discoveries.* Tokyo: Tokyo Tosho P, 2003, 36-43.
[56] T. J. Hogg and Edward Dowden, *The Life of Percy Bysshe Shelley*. London: George Routledge & Sons, 1906, 327.

Wedgwood. And we know that Lind was their friend. We cannot therefore ignore their influence upon Shelley.

Erasmus Darwin commemorated the technological innovations in the Industrial Revolution in Britain, among them such figures as Sir Richard Arkwright (1732-92), the inventor of a spinning machine.

So now, where Derwent rolls his dusky floods
Through vaulted mountains, and a night of woods,
The Nymph, Gossypian treads the velvet sod
And warms with rosy smiles the watery God;
His ponderous oars to slender spindles turns,
And pours o'er massy wheels his foamy urns;
With playful charms her hoary lover wins,
And wields his trident,... while the Monarch spins.
... First with nice eye emerging Naiads cull
From leathery pods the vegetable wool;
With wiry teeth revolving cards release
The tangled knots, and smooth the ravell'd fleece;
Next moves the iron hand with fingers fine,
Combs the wide card, and forms the eternal line;
Slow, with soft lips, the whirling Can acquires
The tender skeins, and wraps in rising spires;
With quicken'd pace successive rollers move,
And these retain, and those extend the rove;
Then fly the spoles, the rapid axles glow,
And slowly circumvolves the labouring wheel below.

('The Loves of the Plants', II. 85-104)

In this context, we might also take note of Arkwright's fellow inventor, John Kay (1704-80/81), who invented a fly-shuttle, but was

forced, like Priestly, into exile after a mob ransacked and broke up his house; James Hargreaves (bap. 1721-78), who invented the so-called 'spinning Jenny'; and Samuel Crompton (1753-1827), who invented 'the Mule.'

All of them came from the provinces, from Northern England, Scotland, or the Midlands, and mainly from the working or middle class rather than from the aristocracy or the gentry. But, though not without opposition from the church on the one hand and the workers on the other, they made the greatest contribution to the technological developments that went to create the Industrial Revolution in Britain, coming together and making friends with each other, brother engineers and scientists, in such local societies as the Lunar Society, where it was possible for like-minded men with a variety of scientific skills to share their ideas, learn from each other, help each other, and in general create an environment where ideas could blossom, and inventions be put to use. All of which is bound to have inspired such a scientifically minded genius such as Shelley, and thus have enabled him to out into living language what they had understood of the workings of the natural world.

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