

1 From Ray to Leeuwenhoek

JOHN RAY (1627–1705)

I begin in seventeenth-century England with a naturalist whose writings earned him the titles of ‘the father of natural history’ and ‘the Aristotle of England and Linnaeus of the time’. Cuvier said that his works were the basis of all modern geology, von Haller that he was the greatest botanist in the memory of man. John Ray, the third child of Roger Ray, the village blacksmith, and his wife Elizabeth was born in the hamlet of Black Notley in rural Essex on November 29, 1627. Elizabeth Ray ‘was of great use in her neighbourhood,’ we are told, ‘particularly to her neighbours that were lame or sick, among whom she did a great deal of good, especially in surgical matters’. Her son John was educated at Braintree School, where his ability was recognised, and at the age of sixteen went to Cambridge, supported by a bursary from a local squire. After two years at the Catharine Hall he migrated to Trinity College, where there was less scholasticism. The brilliant Isaac Barrow was a fellow-pupil; their tutor described them as more able than Isaac Newton was as an undergraduate. After graduation Ray was elected to a minor fellowship and began the study of botany. In the following decade he held a series of college offices. Ray was a prolific writer all his life; his first book, published in 1660, was a flora of the neighbourhood of Cambridge. D’Arcy Thompson, writing in 1922, says Ray describes localities so minutely that Cambridge students still gather some of their rare plants in the copses and chalk-pits where he found them centuries before.

Ray took holy orders at the end of 1660, but had to resign his fellowship two years later because he refused to subscribe to the 1661 Act of Conformity, the only fellow of Trinity to refuse and one of only twelve in the whole university. This left him without any professional means of livelihood. Ray had made a number of friends who shared his rejection of scholasticism in favour of a science based on observation and experiment. Some of them were elected to the Royal Society in the early years of its existence. One was Hans Sloane, whose profile follows later in this chapter, another was Robert Boyle. However the most important in Ray’s life



was Francis Willughby (1635–1672), a gifted youth of great promise who died young. He was the only son of the baronet Sir Francis Willughby of Middleton Hall, Warwickshire, and of his wife, Lady Cassandra. Eight years younger than Ray he came up to Cambridge in 1652 and proved to be an exceptional student, particularly in mathematics. He also became interested in natural history, especially zoology. Later Willughby spent some time in Oxford studying at the Bodleian Library, and became one of the original fellows of the Royal Society at the age of twenty-five. He and Ray became close friends and he was able to provide Ray with much-needed financial support.

Ray's botanical expeditions started in 1659. At first he was on his own, travelling usually on horseback, sometimes on foot. Although botany was his primary purpose, he also liked to collect information about the places he visited. Later Willughby started to come with him; then his former pupil Philip Skippon joined them. Willughby proposed that the three of them should cross the English Channel and tour on the continent. They set off for France in 1663, travelling in stages through the Low Countries, then up the Rhine and down the Danube to Vienna. Then they crossed the Alps into Italy, where they spent some time in Padua studying anatomy. After visiting some of the other Italian cities they split up at Naples, with Willughby returning home via Spain while Ray and Skippon went on to Sicily and Malta before taking a more circuitous route which took them via Rome,

Venice and Geneva to Montpellier, then enjoying a golden age as a centre of intellectual life, especially medical and botanical studies. They reached home in the spring of 1666, the year of the Great Plague, having been away three years. On the tour Ray had visited some of the great continental centres of learning, met some of the leading experts in his field, and made himself familiar with the flora and fauna of Western Europe.

Willughby had paid Ray's expenses on their tours and now he also provided him with a base for his work at Middleton Hall, the residence of his parents. From there Ray brought out his *Catalogus Plantarum Angliae et Insularum Adjacentium* and *Collection of English Proverbs* and prepared several more books, including his *Observations Topographical, Moral and Philosophical*, containing a list of foreign plants, and his *Collection of English Words*, which contained much information about local dialects. He was elected to the Royal Society in 1667, and occasionally attended its meetings.

Willughby married the heiress Emma Barnard in 1668, and children followed rapidly, but he died four years later. In his will his benefactor and friend left Ray an annuity of £60, which freed him from financial worries, and entrusted Ray with the education of his sons. He left many papers on natural history, although he had published nothing. Ray felt it his duty to go through them and publish what he could, in Willughby's name, so for the next three and a half years he was occupied in preparing *Ornithology* and *Historia piscium* for publication. Ray also acted as resident chaplain for the household and tutor for the Willughby sons. They had a governess named Margaret Oakley who married Ray in 1673.

During the first six years of marriage they had no fixed home. Unfortunately Willughby's widow had taken a dislike to Ray and when Lady Cassandra died in 1675 he had to leave Middleton Hall. He needed to complete his work on Willughby's papers and so they found a nearby place to live. In 1677 he declined an invitation to become secretary of the Royal Society. The same year they moved to another house a few miles from Black Notley. When his father had died in 1656 Ray had provided for his 'most dear and honoured' widowed mother, to whom he was devoted, by having a house built for her at Black Notley, called Dewlands. When she died in 1679 he and Margaret moved into Dewlands and started a family; they had four children, all daughters, who helped him by collecting Lepidoptera and other material. Working alone in his library of 1500 volumes he produced a stream of botanical books, also several widely read religious works. One, *The Wisdom of God, Manifested in the Works of the Creation*, many times reprinted, was the source of William Paley's famous *Natural Theology*, which became

a standard work in the nineteenth century. Another, *Persuasives to a Holy Life*, was based on sermons he had given in Cambridge long before.

Ray died on January 17, 1705, having been in poor health for some time. Throughout his adult life he corresponded regularly with his friends and with other naturalists. He was a man of great industry and had a flair for collecting information and arranging it systematically. According to Cuvier 'the particular distinction of his labours lies in an arrangement more clear and determinate than those of any of his predecessors and applied with more consistency and precision'. His great contribution to botany was the system of classification that he introduced, which although later superseded, produced order out of unsystematic descriptions. He applied similar principles to the very difficult classification of insects and other invertebrates. His last works, *Historia Insectorum* and *Synopsis Avium et Piscium*, were published posthumously.

MARIA SIBYLLA MERIAN (1647–1717)

There were plenty of women naturalists but it is hard to find out much about them. An exception is Maria Sibylla Merian, who is surely one of the earliest. She was born in the free imperial city of Frankfurt-am-Main on April 12, 1647, the first child of the artist and publisher Mathias Merian the Elder by his second wife Johanna Sibylla Heim. Mathias was then in his fifties, known throughout Europe for his engravings of cityscapes and landscapes, his scientific books, and his editions of the illustrated series *Grands voyages* (accounts of journeys to the New World) begun by his first father-in-law, Theodore de Bry. Mathias died when Maria Sibylla was only three, and her mother soon remarried. Her second husband was the widower Jacob Marrel, a still-life painter, engraver and art dealer.

Mathias Merian the Elder and Jacob Marrel had both acquired citizenship in Frankfurt, and Maria Sibylla could later claim her own Burgerrecht as Mathias' daughter. Both men enjoyed affluence and prestige and ranked as artists well above other craftsmen in Frankfurt's ordering of estates. They were immigrants, as was Maria Sibylla's mother; Mathias was a native of Basel; Johanna Sibylla came from a Walloon family that had migrated from the Netherlands to nearby Hanau; Marrel had a French grandfather who had moved to Frankfurt, but he himself had been born in the Palatinate town of Frankenthal and had spent years in Utrecht before settling in Frankfurt.

Maria Sibylla's half-brothers, Mathias the Younger and Caspar Merian, were establishing themselves as engravers, publishers and painters, producing topographic works in the tradition of their father, recording

Maria Sibylla Merian (1647–1717)

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ceremonial events like the coronation of the emperor Leopold I at Frankfurt, and much else. Almost all the women artists of the early period were, like Maria Sibylla Merian, born into families of artists. In that setting their talent could be welcomed, and contemporary beliefs about the dampening effects of the female temperament on genius could be disregarded. While her mother taught her embroidery, she was able to learn drawing, watercolour, still-life painting and copperplate engraving from her stepfather along with his male pupils. She was also able to study the large collection of prints, books and paintings belonging to Jacob Marrel and the Merrians.

Maria Sibylla's fascination with natural history began early: 'from my youth onward I have been concerned with the study of insects. I began with silkworms in my native city, Frankfurt am Main; then I observed the far more beautiful butterflies and moths that developed from other kinds of caterpillars. This led me to collect all the caterpillars I could find to study their metamorphoses . . . and to work at my painter's art so that I could sketch them from life and represent them in lifelike colours.' In 1665 she married Johann Andreas Graff of Nuremberg, a favourite pupil of her father's. After five years in Frankfurt, where their first daughter, Johanna Helena, was born, they moved to his home town where some of the artists

were trying to form an academy. Another daughter, Dorothea Maria, was born to the young couple.

Between 1675 and 1680 Maria Sibylla produced a three-part book of illustrations of flowers, without text; some caterpillars, butterflies, spiders and other creatures were depicted on the plants, but otherwise it was a conventional book of its type. Then in 1679 she produced another, two-volume book, all about caterpillars, their wonderful transformation and singular flower-food. The insects were not merely adjuncts to paintings of flowers, they were there for themselves, shown in the various stages of their existence. The text gave a careful description of each stage; there were other books about insects being published at this time but hers was unique in giving a full account of their external appearance through the life cycle with illustrations all taken from life. Ten years previously the Dutch physician Jan Swammerdam had published his *General History of Insects*, the foundation of the new entomology. Beautifully produced, her book on caterpillars was published in Frankfurt in 1683. Linnaeus consulted many of her illustrations in the course of his work on a system of taxonomy, in some cases examining specimens she had prepared.

Two years later, against a background of family lawsuits, Maria Sibylla left her husband, resumed her maiden name and joined a religious community in Waltha Castle near Wieuwerd in West Friesland. This Protestant sect, the Labadists, had an international following, with some 350 adherents, both men and women, some of whom were elect, others just aspirants. They had to give all their possessions to the community and retire to live a spiritual life of love and discipline. She did not have to separate herself from her daughters and was allowed to continue her artistic and entomological work. After five or six years she changed her mind about the Labadists and left for the flourishing commercial city of Amsterdam.

Here she was welcomed by fellow naturalists and collectors: in the botanic garden she could see plants from the Americas, Africa and the Pacific, whose seeds or specimens had come from Dutch traders and officers of the Dutch East India Company. She could also visit the museum of anatomical and other rarities built up by professor Frederick Ruysch and the cabinet of curiosities formed by burgomeister Nicolas Witsen, president of the East India Company, whose tropical insect specimens she examined with wonder. She wanted to see for herself where these creatures came from and so 'I was moved,' she said, 'to make the long and costly journey to Suriname,' the Dutch colony in Guyana. The Labadists had tried, unsuccessfully, to establish an outpost there, but had been defeated by the climate.

Some descriptions of the flora and fauna of that part of the world had already been published by European settlers and government officials, but she had to defray her own expenses. To do so she sold a large collection of her paintings of fruit, plants and insects and specimens from the collection she had formed, as well as all her household effects. In 1699 she settled with her daughter Dorothea in Paramaribo, the chief town of the colony, and began work by making excursions into the interior, where she found the Africans and Amerindians more helpful to her than the European settlers. After almost two years she could not bear the heat any longer: 'I did not find,' she wrote, 'in that country a suitable opportunity to carry out the insect studies I had hoped to do, as the climate there is very hot. The heat caused me great problems, and thus I found myself compelled to return home sooner than I had anticipated.'

She returned, with her daughter, to Amsterdam in 1701, loaded with drawings and paintings, preserved butterflies, crocodiles and snakes, lizard's eggs, bulbs, chrysalises and pressed insects for sale. Four years later *The Metamorphoses of the Insects of Suriname* appeared in Amsterdam, a magnificent folio volume of sixty copperplates with text in Dutch and Latin. This was a success, widely read by naturalists, but still did not earn enough to cover the cost of production and pay back her travel loans. Her elder daughter Johanna Helena also went out to Suriname where she married the administrator of the orphanage in Paramaribo. The younger daughter Dorothea became the second wife of the Swiss painter Georg Gsell and went to live in St Petersburg; their daughter married the great Swiss mathematician Leonard Euler. After two years of ill health Maria Sibylla died on January 13, 1717.

SIR HANS SLOANE (1660–1753)

The Sloane family migrated to Ireland from Scotland during the reign of James I, and became wealthy. The subject of this profile was the youngest of seven sons born to Alexander Sloane and Sarah Hicks. Hans Sloane's first name was intended as a compliment to the Hamiltons, earls of Clanbrassill, a family in which it was common. Sloane's father was the earl's receiver-general of taxes from County Down. Nothing is known about the Hicks family except for a suggestion that Sarah's father may have been chaplain to Archbishop Laud.

In his youth Sloane turned his interest towards natural history: 'I had from my youth been very much pleas'd with the study of plants, and other parts of nature, and had seen most of those kinds of curiosities, which are



found either in the fields, or in the gardens or cabinets of the curious in these parts.' County Down, with Strangford Lough, presented many opportunities for the study of natural history. Sloane visited Copeland Island where he was much intrigued with the seaweed on the seashore, which the Irish were accustomed to chew in order to cure the disease of scurvy.

Sloane was probably consumptive. At the age of sixteen he was 'taken with spasms of blood . . . but avoided the consequences of a disorder which must otherwise have proved fatal to him'. Three years later in 1679 he was well enough to go to London to study medicine. He lodged near the laboratory of the Worshipful Society of Apothecaries, where he studied chemistry under Nicholas Staphorst and botany at the Apothecaries' physic garden at Chelsea. He attended lectures on anatomy and medicine, but most important at this period of his life were his friendships with two of the greatest English men of science of the day, Robert Boyle and John Ray.

In 1683 Sloane went to France. On his way to Paris he met the chemist Nicolas Lemery; in the French capital he visited the Jardin du Roi and frequented the Charité hospital. He also heard lectures on botany and anatomy. In those days it was impossible for a Protestant to take a university degree in Catholic France, but the Provençal town of Orange was still under the House of Orange. Its university gave examinations and conferred degrees but

offered no instruction in medicine. Sloane graduated as doctor of physick there in 1683, then went to Montpellier to complete his studies, working under the physicians Charles Barbeyrac, Pierre Chirac and Pierre Magnol.

The persecution of Protestants in France was starting in 1684, when Sloane returned to London with the intention of practising medicine. For the contributions he had already made to botany he was elected Fellow of the Royal Society. The next year Robert Boyle recommended Sloane as a skilful anatomist to the famous surgeon Thomas Sydenham, who was not impressed by his academic studies and told him ‘that is all mighty fine, but it won’t do; . . . no, young man, all this is stuff; you must go to the bedside, it is there alone that you can learn disease’. The secret of Sydenham’s success lay in his systematic approach to the symptoms presented by his patients, and Sloane followed his example. He was admitted a Fellow of the Royal College of Physicians of London in 1687, as so often at loggerheads with the Society of Apothecaries. One bone of contention was that physicians treated the poor free of charge but apothecaries charged for their medication.

When Christopher Monck, second duke of Albemarle, was appointed governor of Jamaica, he appointed Sloane to accompany him to the island as his personal physician. The expedition was of great value to Sloane, not only giving him first-hand experience of a relatively little-known island but also enabling him to search for new drugs. The description of the voyage and the observations on the inhabitants, diseases, plants, animals, some of which he brought back alive, and meteorology of the West Indies make Sloane’s book on Jamaica valuable even today. The duchess of Albemarle was suffering from the first stages of the mental illness which turned to madness later. As a result the duke became an alcoholic and died within a year of arriving in Jamaica. Sloane escorted the duchess back to England in 1689.

Four years later he became secretary of the Royal Society, also physician to Christ’s Hospital the following year. In 1695 Sloane married Elizabeth, daughter of John Langley and widow of Fulk Rose, formerly of Jamaica; they had four children, of whom two died in infancy. Their mother died in 1724. Sloane was now launched not only in the highest and scientifically distinguished society, but also in his profession of medicine, which became very lucrative. He might charge one guinea an hour to those who could afford it, nothing to the poor and needy. His wife’s fortune, derived from her first husband’s sugar plantation, made Sloane wealthy, apart from the income from his fashionable medical practice. In 1712 he was appointed physician to Queen Anne; four years later George I conferred a baronetcy

on him, a kind of hereditary knighthood, but unlike a peerage not entitling the holder to a seat in the House of Lords. In 1712 he purchased the manor of Chelsea, treating the manor house as his country residence but did not make it his main residence until much later. He also purchased the adjacent mansion where Sir Thomas More had lived, then in a state of decay, but had it demolished. His Chelsea property included the historic physic garden, which he later conveyed to the Society of Apothecaries, on condition that they maintained it properly. Out of gratitude the society commissioned a statue of their benefactor which still stands in the garden. In 1715 he was elected president of the Royal College of Physicians.

A great believer in the importance of diet Sloane, who became familiar with chocolate in Jamaica, found it to be more digestible when mixed with milk. Sir Hans Sloane's milk chocolate was produced by Messrs Cadbury until 1885. He also played an important part in establishing the practice of inoculation against smallpox. In 1739 he was associated with Thomas Coram in the foundation of the Foundling Hospital, one of many philanthropic initiatives he supported. Having been secretary of the Royal Society since 1693 he succeeded Newton as president in 1727, serving until 1741 when he resigned owing to failing health. Sloane was a fellow of the society for almost sixty-eight years, which was a record. He entertained his scientific and medical friends regularly.

Throughout his life Sloane amassed collections. Beginning with botanical specimens collected in France and the West Indies, he added other collections of plants, animals, insects, fossils, minerals, precious stones and ethnographical specimens. He also branched out into Egyptian, Assyrian, Etruscan, Roman, Oriental, Amerindian and Peruvian antiquities. To these were added drawings and etchings by Albrecht Dürer, Hans Holbein and Wenzel Hollar, and a valuable collection of coins and medals. Sloane's library contained over 50 000 books and 3500 bound volumes of manuscripts; his herbarium filled 337 folio volumes. Scholars had ready access to the collections, which were moved to Chelsea from Bloomsbury in 1742. The names of Sloane and his relatives are to be found all over his former Chelsea estate, notably in Sloane Street and Sloane Square.

In his will he offered all these treasures to the British nation, on condition that £20 000 was paid to his daughters, who might have expected to inherit the valuable collection. After Sloane's death on January 11, 1753 the trustees whom he had appointed met; the matter was brought before parliament, which received Royal Assent for the Act which enabled Sloane's collection to be acquired and a suitable building purchased to house it. Thus