Charles Darwin: Traveller, Author, and Naturalist

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During the 2009 Darwin commemorations, scientific researchers and scholars around the world seized the opportunity to reflect on Charles Darwin’s achievements. It soon became clear to the participants in those events that Darwin, as a historical figure, could mean many things to many people. Perhaps this is partly due to the rich documentary record that he left behind, comprising a large collection of personal papers and writings, his library, research materials, biological specimens, and a vast correspondence with naturalists all over the globe. Partly, there are many different ways in which to study evolutionary biology. And wide variety of artists and literary figures also find inspiration in his ideas. But we should not forget that, above all else, Darwin published a series of extraordinary books that became the foundation of modern biology. Prime among these books is *On the Origin of Species by Means of Natural Selection*, published in London in November 1859 (C.Darwin 1859, C.Darwin 1958).

Darwin is justly celebrated for this magnificent book, which made him one of the most prominent naturalists in the world, “first among the scientific men of England,” as the socialist philosopher Edward Aveling put it. Even Alfred Russel Wallace, who independently formulated the same idea of evolution by natural selection, said that “Mr. Darwin has given the world a new science, and his name should, in my opinion, stand above that of every philosopher of ancient or modern times.” As Wallace predicted, Darwin’s ideas came to lie at the heart of fundamental shifts in opinion that swept through the nineteenth century and beyond (Bowler ???, Browne 2006). Indeed the avenues of thought opened up by the theory of evolution by natural selection have guided and provoked research for 150 years. Today, greatly enhanced by the field of genetics
and much diversified in intellectual scope, the principles of Darwinism remain at the cutting-edge of scientific knowledge.

This essay aims to summarise where we currently stand in our historical understanding of Darwin as a thinker and writer. Nowadays there is much more willingness than before to see Darwin’s *Origin of Species* as a vintage text, written and published in its own context, some 150 years ago. We do not expect Darwin to be writing with an understanding of modern science. We can see that his use of the word ‘evolution’ is not the same as ours. He did not have access to today’s sciences of molecular biology or the facts of modern paleontology. We are consequently more easily able to recognise the debts he owed to the science of his own day and also to acknowledge the significance of other important evolutionary thinkers of the nineteenth century, particularly Alfred Russel Wallace, Robert Chambers, and Herbert Spencer. We have gained a more sophisticated grasp on the controversy that emerged in England during the Victorian period and can now see that it was not solely about Darwin and his theory. Other major cultural transformations were taking place: transformations in religious thought, social structure, political organization, education, and industrial progress. Darwin’s book certainly crystallized debate and anxiety about these changes. The *Origin of Species* excited intense attention, not just for the powerful reach of the proposals, or Darwin’s careful analysis of the problem of animal and plant origins, and his weighty accumulation of evidence, but also for the shocking absence—for some people, the *liberating* absence—of any allusion to the biblical story of creation. Darwin proposed an entirely natural process to explain the characteristics of the living beings that we see around us. This extraordinary combination of features was guaranteed to generate argument in Victorian
England, and ultimately the world over. Should divine forces be banished as an explanation for the apparent design and harmony of the world? What should humn beings think about their own origins? Was Darwin suggesting that humans emerged in a natural manner from ape ancestors? These were deep questions that continue to be asked today. However we regard it, the *Origin of Species* must surely be regarded as a major publishing event in the nineteenth century that changed the way that people thought about themselves and helped lay the foundations of the modern world.

What is also emerging from historical research into Darwin’s writings is the wide range of his scientific interests - from geology and coral reefs through detailed taxonomic studies of barnacles, human expressions, the domestication of plants and animals, to plant physiology, hybridization, and fertilization. Darwin was a superb experimentalist who designed many effective techniques to probe the natural world. Carried out with simple tools, these experiments provided insights into processes as diverse as the role of earthworms in recycling the land and the movements of climbing plants in their search for support. To look at Darwin the practising scientist provides an opportunity to get beyond the continuing uproar over evolution and celebrate the theory that he and Wallace put forward in the middle years of the nineteenth century.

Traveller

One longstanding question among historians is how did Darwin come to be the man who wrote the *Origin of Species*? Darwin’s voyage on HMS *Beagle* is now famous for turning his mind towards evolutionary theory, for giving him the intellectual stamina and materials to substantiate such a theory, and for the romantic symbolism of his travelling
around the world toward such an unsuspected goal. Darwin himself certainly appreciated the impact of the voyage. For him, the *Beagle* voyage opened the door to exceptional sights and opportunities—the impressive landscapes of South America, the biological diversity of the tropics, dramatic encounters with other cultures and other ways of life, hazardous travels off the beaten track, exotic islands, and countless moments when his imagination was powerfully stirred. On his return, his *Beagle* successes enabled him to join the world of natural history experts, and inspired the evolutionary views that were expressed in 1859 in the *Origin of species*. 'The voyage of the *Beagle* has been by far the most important event in my life and has determined my whole career,' he declared in his *Autobiography* (Barlow 1958).

The story has often been told. But there are always fresh perspectives to find in the comprehensive Darwin archives, mostly housed in Cambridge University Library, UK, but also in a fine collection at the American Philosophical Society, Philadelphia, and in other libraries and institutions around the globe. In 1831, when the invitation to travel on the *Beagle* arrived in Darwin’s hands, he had just completed his BA degree at Cambridge University in England, and he was expecting to return in the fall for theological training. This simple statement hardly conveys the intensity of family debate during the previous few years. Darwin’s father had despaired of him ever settling to a useful career, for Darwin had first withdrawn from medical training in Edinburgh, and now (in his father’s eyes) as a Cambridge undergraduate seemed to be specialising in hunting, shooting, and fishing. Hence Dr Darwin decided that after graduation his son’s future should be that of a minister in the Anglican church, a decision with which Darwin concurred, although he said he had some minor doctrinal doubts. Much later on Darwin appreciated the irony of
this possible future. Yet perhaps this possibility accounted for his eventual reluctance directly to challenge the teachings of the church, and generated the respect that he felt for those friends, teachers, and family members who were committed believers.

In fact Darwin was already an excellent naturalist. At university he longed to make a contribution to natural history at a time when science was not yet a structured profession. He spent so many of his university days collecting birds and beetles that he attracted the attention of Rev. John Stevens Henslow, the botany professor. Henslow introduced Darwin to some of the big issues in the biological sciences of the day and invited him to scientific evening parties to meet the famous men of the university. In this way Darwin became a young man of note. He was particularly inspired by the writings of Alexander von Humboldt, and early in 1831 began making plans to go on a natural history expedition that would follow Humboldt’s journey to Tenerife. When this fell through, the professor of geology, Rev. Adam Sedgwick, took him as an assistant for two weeks on summer fieldwork examining the earliest known rocks in Wales. Sedgwick taught Darwin geology in the field and showed him the rationale for sound scientific decisions. These two weeks gave Darwin a lifelong love for geology.

On his return to the family home in Shrewsbury, Darwin found a letter from Henslow offering him a voyage round the world on a British surveying ship, HMS Beagle. The invitation originated from Captain Robert FitzRoy (1805-65) who requested permission from the Admiralty to take with him a gentleman who could make good use of the journey for collecting natural history specimens. Such a gentleman would share the captain’s facilities as a guest and was expected to pay his own way. Henslow recommended Darwin “not on the supposition of yr. being a finished Naturalist, but as
amply qualified for collecting, observing, & noting any thing worthy to be noted in Natural History ... Don't put on any modest doubts or fears about your disqualifications for I assure you I think you are the very man they are in search of.”

The prospect of travelling across the world’s oceans in a British surveying ship ran far beyond the young man’s wildest dreams. At first Dr Darwin felt his son should not accept. The whole plan was ‘a wild scheme’ he declared. Fortunately, Dr Darwin was persuaded otherwise by his brother-in-law, Josiah Wedgwood Jr. Closely linked by marriage and friendship, the Darwin and Wedgwood families had done much to transform British culture during the Industrial revolution, and Dr Robert Darwin had married Susanna, the daughter of the first Josiah Wedgwood. Charles Darwin was their son. Now the older generation decided that he could go.

Today the multimedia fame of the Beagle voyage sometimes makes it hard to remember that its purpose was not to take Darwin around the world but to carry out British Admiralty instructions. The ship had been commissioned to complete and extend an earlier hydrographical survey of South American waters that had taken place from 1825 to 1830. FitzRoy had joined the Beagle two years into that former voyage. The area was significant to the British government for commercial, national and naval reasons, and the ship was charged with making accurate naval charts of the coastline from Montevideo to Cape Horn. FitzRoy’s interest in science encouraged him to equip the ship for its second voyage with several sophisticated surveying instruments and a number of chronometers (clocks calibrated with Greenwich Mean Time) for taking longitude measurements around the globe. The voyage lasted from December 1831 to October 1836, with most of the time being spent in South American waters. Excitingly for
Darwin, the expedition was due to return via the Pacific and Indian oceans. It offered him a circumnavigation of the globe.

Observer

Funny enough, however, Darwin’s voyage on the *Beagle* was mostly on land. Wherever it was convenient FitzRoy put Darwin ashore so that he could pursue his scientific observations. The two men would rendezvous several weeks later and move along the coast to another area. This method of traveling allowed Darwin to make several major inland expeditions in South America and on occasion to rent a small house as a temporary base. His diary, later reworked into a travelogue, *Journal of researches* (now usually known as the *Voyage of the Beagle*), describes his collecting adventures. At times he rode out with gauchos, making his way through political rebellions. Or he joined members of the crew on shooting expeditions to get meat for Christmas dinner. In Tierra del Fuego, he saved some of the sailors by rescuing a rowing boat from a tidal wave. He saw stars from the top of the Andes, climbed mountains in Tahiti, felt his blood boil over the injustice of human slavery that was still legal in Brazil, and splashed around in coral lagoons in search of evidence for their formation. These exploits were all recounted in a series of letters home to his sisters that still exist in the archive. Over the years Darwin’s sisters saw his ambitions changing. Indeed they began to recognise that he wished to become a scientist not a clergymen. A frequent additional objective in these letters was to request money from his father. Because Darwin’s participation in the voyage was an privately funded enterprise, Dr Darwin arranged for cash to be made available for his son at a succession of out-of-the-way places. Setting sail for Tahiti from the coast of South
America, Darwin promised that he would be “deuced clever” to spend money while at sea. Amused, Dr Darwin replied “but everyone tells me that you are very clever.”

During this voyage Darwin collected nearly ten thousand specimens of plants, animals, rocks, and fossils, and sent them back to England in wooden crates. He recorded a detailed inventory of these specimens that would sustain years of study and publication, and prove fundamental to his theory of evolution. Best of all, he developed a highly creative scientific imagination. Galloping, walking, sailing or climbing, he had plenty of opportunity to let his mind range over the fundamental problems facing naturalists in the early years of the nineteenth century and reflect on what ‘plan’ or ‘order’ might underpin the natural world.

High among these problems was the question of the ‘design’ of living beings. In Darwin’s day most naturalists believed that all organisms, including humans, were created in the shape most suited for the conditions in which they were to live. While there was debate over exactly how this might happen, and anxiety over those cases where animals or plants did not seem to be perfectly adapted to their intended place in nature, the general view was that all living beings, and the world itself, had been created by God, the ultimate divine force in the universe. The world was therefore constructed by God to present a harmonious collection of living kinds, a concept usually referred to as the balance of nature—although increasing numbers of radical critics and religious non-conformists were starting to put forward alternative suggestions, some of which were evolutionary (or transformist, in the terminology of the day). Early in the century, the theological author William Paley had fought against those dangerous alternatives with his ‘argument from design’. The existence of design in the natural world, Paley stated,
presupposed the existence of a designer. As he put it, the existence of a beautifully
crafted mechanism, such as a watch, logically required the existence of a watchmaker.
Darwin had been much impressed by Paley’s *Natural Theology* while a student at
Cambridge. It is often said—rightly—that in the *Origin of Species* Darwin replaced
Paley’s ideas by setting out an entirely natural explanation for design based on the
selection and preservation of adaptations. On the *Beagle* voyage he was learning to move
beyond the conventional, Paleyian view, in order to think about the origins of
adaptations, especially of those that did not seem perfect.

Furthermore, despite this sense that nature reflected a divine plan, few naturalists at that
time believed in the old bible stories as a valid scientific explanation of the origins of the
world. Although it may seem hard to acknowledge, adherence to a strictly literal
interpretation of the bible is only a relatively modern phenomenon. Long before Darwin’s
time, theological modernisation encouraged believers to adopt allegorical understandings
of the first few verses of the Christian bible. And the rise of geological science in the
eighteenth century had added new weight to that re-evaluation. Christian belief
nevertheless rested firmly on the doctrine that human beings were special, a miracle
occurring outside the world of scientific fact. The issue as Darwin encountered it was to
find ways of explaining the origin and design of animals and plants through natural
‘causes’ while yet retaining a separate and sincere belief in the divine. A truly radical
step was to claim that humans too were the product of natural causes.

Even so, Darwin was not an evolutionist during his time on board the *Beagle*. Recent
research into his notebooks and other writings, the busy round of meetings, library
researches and scientific societies into which he threw himself after returning to England,
and the more considered inspection of his specimens under the eyes of experienced naturalists in London and Cambridge, all add up to the conclusion that Darwin only became committed to the idea of transformism in the middle of March 1837, some five months after the *Beagle* docked in England. The customary image of Darwin voyaging alone through turbulent seas of thought as he paced the deck of the *Beagle* is a cinematic fantasy. Reality was rather different.

**Thinker**

Without question, Darwin’s travels provided an essential foundation for arriving at this momentous conclusion. Darwin retrospectively listed the three factors that he thought influenced him most during the voyage. First were the fossil mammals he found in Uruguay and Argentina, which displayed strong anatomical continuities with current species in the area. In an estuary by Buenos Aires he unearthed the remains of giant animals that turned out to be extinct versions of the capybaras, armadillos, and llamas that ran around the pampas today. He wondered why animals should retain the same anatomical structures through vast epochs of time. Second, he laughed to recall how he discovered an unknown species of rhea—the South American ostrich. This bird had been shot for the cooking pot and was already half-eaten before he noticed it was much smaller than the usual sort. The salvaged remains accompanied him back to England and were later given the name *Rhea darwinii*. Darwin’s research suggested that the two species of rhea, large and small, occupied their own territories and did not mix. Later on, he came to believe that one species had diverged—evolved—from the other. These features of the animal world suggested to him some kind of underlying genealogical tree.
Third, and most important, were the Galapagos animals. Ironically, what proved to be the most famous collection of all, Darwin’s birds from the Galapagos, was inadequately labelled. Except for the mocking-birds, Darwin did not pay any attention to the diversification of bird species on separate islands during the Beagle's five-week visit. Identifying the skins consequently proved tricky when he returned to London and he had to ask some of his former crewmates if he could borrow their specimens. Nonetheless, the Galapagos Islands impressed him greatly. He was fascinated by the land and sea iguanas, the giant tortoises, the tameness of the animals, the cacti, as well as the volcanic geology and arid landscape. How had the animals got there? And why were they found only there? He alluded to the likely relationship between the islands and the mainland in his ornithological notes on the return voyage. These remarks, and remarks made in another notebook begun on the way home, indicate that he wondered about the possibility of transmutation. At Cape Town in June 1836 he may have discussed the ‘creation’ of species by natural means with John Herschel, the British astronomer, who was there observing the Southern stars. Species originating through natural causes was an interesting idea already mentioned among British reformers and avant-garde scientists although it ran counter to the biblical story of the Garden of Eden.

Less generally known is that Darwin regarded himself mostly as a geologist during the voyage. He travelled with a copy of Charles Lyell's path-breaking summary of a new way of thinking about geological processes, the Principles of Geology, published in 1830-1833. This book influenced Darwin greatly. He was convinced by Lyell's argument that all changes in the earth’s surface were the result of a gradual accumulation of many small events. Darwin took this idea, applied it to biology, and turned it into a lasting
methodology that lay at the heart of his *Origin of Species*. For the rest of his life, he remained committed to the concept that many small changes can add up to larger effects.

The most unsettling of Darwin's adventures was his encounter with the indigenous inhabitants of Tierra del Fuego. He was stunned by their naked savage state, particularly in comparison with the three Yaghan Fuegians on board the ship. The three had been captured and taken to England by FitzRoy on the previous *Beagle* voyage, and educated and converted to Christianity at FitzRoy’s expense. They were now being repatriated in a Protestant mission station that FitzRoy intended setting up in Tierra del Fuego. Darwin recorded that they were thoroughly Europeanized, “I would not have believed how entire the difference between savage & civilized man is. It is greater than between a wild & domesticated animal.” He recognized that humans were all the same under the skin—it was only different levels of education and what he called ‘civilization’ that separated them.

So what kind of man returned? Stepping off the ship in Falmouth harbour in October 1836, Darwin was tired of the sea but had experienced the time of his life. He had seen places and done things that few young men could hope to do. As a thinker he had stretched and matured. Only a few months later he engaged seriously with the challenging notion of evolution. After two years of hard thinking and wide reading he ran across the concept of differential human survival in Thomas Malthus’s theory of population. This stimulated Darwin to propose that "favourable variations would tend to be preserved and unfavourable ones to be destroyed... The result of this would be the formation of new species.” Here, then, as he recorded in his *Autobiography*, he had found a theory by which to work.
Author

Darwin spent the next fifteen years or so profoundly engaged with publishing his *Beagle* results and professional undertakings in the world of scientific expertise. In 1839 he married his cousin Emma Wedgwood and, three years later, moved to the countryside in Kent. At Down House, he and his wife eventually had ten children, three of whom died in childhood. Financially, Darwin was fortunate enough to inherit a substantial sum of money from his father and did not need to take paid employment. At home, he also had household staff to assist him, and could therefore occupy his time with writing and researching. During this extended period he never lost sight of his theory of evolution by natural selection. He worked on the theory privately, in detail and in depth.

Darwin did not feel ready to write for publication until his friend Charles Lyell (the geologist from whose book he had learned so much on the *Beagle* voyage) urged him to begin. Both men were well aware of the controversial nature of Darwin’s suggestions, and Darwin was extremely cautious about putting forward such radical views. His wife and some other friends were religious, although not oppressively so. He did not wish to hurt them. Nor did he wish to be branded an atheist. But on Lyell’s advice, he started composing a big, densely packed book that he expected to be read only by scientists. He planned to call it ‘Natural Selection’.

In an extraordinary coincidence, however, one morning in 1858, the naturalist Alfred Russel Wallace sent Darwin his own account of evolution by natural selection. The date that Wallace’s essay arrived in Darwin’s hands will never be known for sure. But late in the evening of 18 June 1858 Darwin wrote to Lyell to express his despair at being
forestalled. ‘I never saw a more striking coincidence… if Wallace had my MS sketch written out in 1842 he could not have made a better short abstract!’

This dramatic event formed the backdrop to the composition and publication of Darwin’s *Origin of Species*. Darwin and Wallace’s views were made public in July 1858 in a double paper submitted to the Linnean Society of London. Then Darwin rapidly set to writing the book that became the *Origin of Species*, drawing on his long manuscript for most of the material. It was published by John Murray in London on 24 November 1859, to a storm of controversy.

Darwin called the *Origin of Species* ‘one long argument’. Few scientific texts have been so closely woven, so packed with factual information and studded with richly inventive metaphor. He abandoned what John Herschel devoutly called the ‘mystery of mysteries’ and replaced Paley’s vision of perfect adaptation with the law of natural selection acting on chance variations. Animals and plants should not be regarded as the product of a special design or special creation, he wrote. ‘I am fully convinced that species are not immutable,’ he stated in the opening pages.

The underlying theme was gradualism. Everything happened little by little, just as Lyell had claimed. Everything was linked by one and the same explanation. Time, chance, and reproduction ruled the earth. Struggle, too. Those readers who sought a radically new manifesto for the living world were sure to find it in Darwin’s words: no-one could afterwards regard organic beings and their natural setting with anything like the same eyes as before; nor could anyone fail to notice the way that Darwin’s biology mirrored the British nation in all its competitive, entrepreneurial, factory spirit; or that his appeal to
natural law unmistakably contributed to the general push towards secularisation and supported contemporary claims of science to understand the world in its own terms.

Few other scientific theories spread as far or as quickly as the theory of evolution by natural selection. Within ten years of the publication of the *Origin of Species* there were 16 different editions in English (including the British Isles and North America), and translations into German, French, Dutch, Italian, Russian, and Swedish, accompanied by important commentaries, criticisms, extracts, and supporting texts by other authors. There would be many more to come. To date, there have been 255 editions in English and translations into 29 other languages, including Turkish, Hindi, Ukrainian, and Yiddish, and one edition in Braille (Freeman 1977). Through these means, people all over the developed world increasingly encountered Darwin’s work and were able, if they wished, to participate in what was to become one of the first truly international debates about science.

**Experimenter**

In the years after the *Origin of Species* was published, Darwin continued to think and publish at an astonishingly intensive rate. He constructed the theory of sexual selection. He devised a theory of inheritance. He explored co-adaption between plants and insects for the purpose of fertilization, experimented on hybrid vigor in plants, documented the animal ancestry of mankind, and thought deeply about the adaptive purposes behind the evolution of the sexes. His major publications after the *Origin of Species* included an important study of variation under domestication (1868) that discussed heredity, variation, and the transmission of what would come to be known as genetic information.
He made lasting contributions to the sciences of mankind in his *Descent of Man* (1871), and the evolution of human expressions in *The Expression of Emotions in Man and Animals* (1872). His minor publications ranged very widely from seed dispersal to the transmission of ancestral characteristics such as stripes through many generations of horses (Wyhe 2009).

This is the Darwin who said in his *Autobiography* that he thought he was good at noticing those things that might usually escape attention. He said that he had to learn to be patient in getting results, and that a good dose of ambition never did any harm. “From my early youth I have had the strongest desire to understand or explain whatever I observed—that is, to group all facts under some general laws” (Barlow 1958). He was in fact characterizing himself as an experimentalist in an age when laboratories were hardly in existence.

In this regard, Darwin’s house was without question his laboratory. Darwin’s study was its control centre. This study was a scholarly space, but not directly comparable to an academic office. The room was completely domestic, full of Victorian furniture, with portraits of the people he most loved and respected above the fireplace, a comfortable chair or two, a red Turkish carpet, even a curtained lobby in a corner that marked off a small area which he used for washing and changing for bed. There he kept his shaving things (in pre-beard days) and a chamber pot. In this study he also conducted indoor experiments on plants, worms, and seeds, worked at his microscope, dissected, planned projects, and wrote all his books. His filing shelves were kept beside the chair, his chemical implements and simple microscope close to hand. He did not use a desk. He wrote in a large leather-covered chair, with a board over his knees. His space was not
entirely sacrosanct. Darwin’s children felt able to run in and out of the study to ask for things that might be needed for their games. They sat on the wheeled stool, used by their father as his microscope seat, and pushed themselves about the room with Darwin’s walking stick. It was the room where Darwin spent so many years studying barnacles under the microscope that one of his sons, when a very little boy visiting another child to play, innocently asked where does your father do his barnacles (F. Darwin 1887, 1, 136).

It was also the room from which Darwin ran his entire research and publishing ventures. Although Darwin did not actively engage in public debate, much preferring that quick-witted friends like Thomas Henry Huxley should carry his theories into the eye of the storm, he nevertheless participated directly through correspondence. Current research into the history of Darwin’s achievement, and the manner in which his evolutionary views came generally to prevail, shows that he actively embedded himself in a web of correspondence that materially advanced the reception of his work.

For these reasons, it is helpful to regard Darwin’s working practices as an intensified form of daily life. He was fortunate to be privately wealthy. The research on which he based the *Origin of Species* reflected this personal world of wealth and privilege: a world of gentleman landowners who were sufficiently well-financed and well-educated to pursue experiments in horticulture or land economy; a world in which plentiful correspondence was a vital link to contemporary opinion; a world of stability and prosperity where the many advantages brought by rapid industrialization and colonization were still not much in evidence in the countryside (Desmond and Moore 1991, Browne 1995, Browne 2002).
Darwin’s botanical and animal experiments were carried out in his own stable yard, greenhouse, or garden. He used domestic organisms easily procured from the catalogues of nurserymen or through gentleman farmers. If he need to carry out research using books or articles he relied on his subscriptions to private libraries or his membership of the elite scientific societies of London. Occasionally he yearned to acquire exotic species, and this yearning was the reason for Darwin’s first exchange of letters with Wallace in Malaysia in 1856 (Burkhardt et al, 1985, vol.6, letter to W.B. Tegetmeier, 26 November [1856]). Later, much of his botanical correspondence was dominated by the desire to obtain rare orchids or carnivorous plants for experimentation. Joseph Hooker at the Royal Botanic Gardens Kew (in London) was a loyal friend, for example, and often supplied interesting materials from the government glasshouses. On one occasion Darwin was distressed to realise that he had mistakenly destroyed a valuable Oxalis sent to him by Hooker for research into the ‘sleep’ of plants. His was a highly domestic research environment. Investigations into the ‘fixity’ of pigeon and poultry breeds turned into an admiration for the birds as pets. The family’s dogs became the object of close observation when he began exploring animal expressions and emotions.

The point is worth emphasizing because it was partly this reliance on commonplace features of Victorian life—letters, and small-scale experimental inquiries involving relatively accessible animals and plants—that generated the remarkable body of factual material on which the *Origin of Species* rests. Darwin took a certain pride in this ordinariness. Yet we can retrospectively see something special. When compiling a chapter of recollections of his father for *The Life and Letters of Charles Darwin* (1877), his son Francis recorded that:
it was as though he [Darwin] were charged with theorising power ready to flow into any channel on the slightest disturbance, so that no fact, however small, could avoid releasing a stream of theory, and thus the fact became magnified into importance. In this way it naturally happened that many untenable theories occurred to him; but fortunately his richness of imagination was equalled by his power of judging and condemning the thoughts that occurred to him. He was just to his theories, and did not condemn them unheard; and so it happened that he was willing to test what would seem to most people not at all worth testing (F.Darwin 1877,1, 149).

He also favored ingenuity and frugality. When the French naturalist Alphonse de Candolle went to visit Darwin at home in the 1870s he found the author of the *Origin of Species* in his greenhouse working on carnivorous plants with almost no tools except a schoolboy chemical balance and some tin plant markers. All the experimental chemicals that Darwin used in order to discern the power of plant digestion came from around the house—ammonia, beer, urine, spittle, and nicotine. Experimental plants were bedded out in the kitchen garden and parts of the lawn were sectioned off for recording the number of species able to grow in a demarcated area. Yet such observations always ran hand in hand with hard thinking. Every day, Darwin would take a number of circuits around what he called his thinking path, the ‘Sandwalk,’ to ponder whichever question was uppermost in his mind at the time.
Darwin did not work alone. A prominent characteristic of these projects was the help he requested from friends, relatives, and even enemies. His children became assistants from an early age. Darwin usually spent the summer months researching insect pollination, for example, and might use the veil of his wife’s hat to cover a particular plant. Or he could spend several hours a day closely watching ants or worms. At age five, his son Leonard ran to a garden flower and cried ‘I’ve got a fact to do’ – a neat encapsulation of the way that Darwin’s work was focus of the household. The household staff was also accustomed to furthering their master’s researches.

Indoors, Darwin’s wife Emma often acted as his amanuensis, copying out sections of the *Origin of Species* before publication, as well as other works and helping with his correspondence when he was unwell. Emma Darwin read the proof sheets of the *Origin of Species*, a sure sign that her religious beliefs were not holding Darwin back in any pragmatic sense. Later, when their daughter Henrietta was older, she acted as an editor for Darwin by going over his proof sheets for style. This female assistance is often ignored by historians (Harvey 2009). The proof sheets amended by Henrietta are now preserved in the Cambridge archive and we can see her comments in the margins: ‘this is a horrid sentence.’ Henrietta corrected the proof sheets of the *Descent of Man* for her father, who was so grateful that he sent her a substantial gift of money. All the family were involved in his work one way or another. Even the children’s governess was prevailed upon to translate some difficult German biological tracts. In this manner Darwin’s researches became a family enterprise. He was one of the last gentlemen of science with sufficient private income to work at home, outside the developing academic institutions.
A Talent to Experiment

Francis Darwin was convinced that much of his father’s talent lay in his urge to observe things for himself:

There was one quality of mind which seemed to be of special and extreme advantage in leading him to make discoveries. It was the power of never letting exceptions pass unnoticed. Everybody notices a fact as an exception when it is striking or frequent, but he had a special instinct for arresting an exception. . . . Another quality which was shown in his experimental work, was his power of sticking to a subject; he used almost to apologise for his patience, saying that he could not bear to be beaten, as if this were rather a sign of weakness on his part. He often quoted the saying, "It's dogged as does it;" and I think doggedness expresses his frame of mind almost better than perseverance. Perseverance seems hardly to express his almost fierce desire to force the truth to reveal itself.

(F. Darwin 1887, 1, 148, 149)

The most important work Darwin did after the *Origin of Species* was undoubtedly that relating to human beings (Desmond and Moore 2009). During the *Beagle* voyage and beyond he had made extensive notes on humankind, asking himself penetrating questions about physical and cultural anthropology, the mental and moral life of humans, metaphysics, history, and demography. During the 1860s and 1870s he thoroughly reviewed these materials and expanded their scope dramatically. His preparatory research
for the *Descent of Man* (1871) brought his concept of sexual selection to full development and required extensive documentation in the animal kingdom before he felt confident in applying it to explain the origin of human diversity (C. Darwin 2004). In that book he drew on correspondence with anthropologists and travellers the world over to discuss the differences and similarities between humans. One objective was to show that the mental life of human beings could have derived from that of animals—and he corresponded widely about the origins of language, religious belief and the moral sense, in order to gather evidence that animals possessed similar traits to a lesser degree.

The following year he brought out his book on the *Expression of the Emotions* (1872), a crucial follow up to the *Descent of Man*. In this he continued to argue for real links between humans and animals by documenting the mental life of human beings, and suggesting that the facial musculature, and by implication the emotions underneath, could be connected with those of our presumed animal ancestors (C. Darwin 1988, C. Darwin 2009). This book required a huge international research project that called on artists and photographers as well as anthropologists. One element of research support came from the many female members of the extended Darwin family who made personal observations for him on their children. Darwin also observed his own children very carefully when they were babies, having no conceptual problem in comparing them to the baby orang-utans that he saw in the London zoo (Keynes 2001).

Darwin’s experiments were necessarily small scale. The point was made with a sting when Francis Darwin went in 1875 to Württemberg to work with the great plant physiologist Julius Sachs. Sachs had the most advanced laboratory in Europe, filled with expensive physiological apparatus that made Francis envious. His father was not
convinced that they needed any of these instruments for their researches back at Down House, although he did allow Francis to buy a Zeiss microscope, which is still in the Darwin museum. On his return from Sachs’ laboratory, Francis pursued a new line of investigation into the movements of plant roots and shoots, and showed his father how to improvise smoked paper on a rotating drum by fastening a small cylinder on an open clock face. When their joint book on the *Power of Movement in Plants* (1880) was published, Sachs savagely criticised the results by claiming that work done in a country house simply could not match the new experimental results emanating from a laboratory (Chadarevian 1996). Darwin was irritated, to say the least. Nevertheless some of his proposals about tropisms were proved correct in the 1920s and 1930s.

What can be made of Darwin’s remarkable intellectual vision? He emerges as a magnificent and perceptive theorist, and as a gifted writer. We can see him as someone who worked within a vigorous social network rather than as a solitary heroic individual. We can admire his modesty, succinctly conveyed in a few words written to Huxley at the height of the debate about the *Origin of Species*: “I wish I could feel all was deserved by me.”

But it is also good to remember his ability to connect observation with theory, his persistence, ambition, and good humour, all excellent qualities to foster in modern laboratory practice. He was a fine experimental scientist. Writing after a visit to Darwin’s home in 1878, the British journalist Edmund Yates, felt sure that he had been in the presence of a very great investigative mind:
Without an atom of scientific jealousy, he is always ready to expound his views, to narrate the result of the delicate experiments on which he is perpetually occupied, and to assist other investigators from the stores of an experience that has ranged over the whole field of natural science, and the conclusions of a mind trained to reason closely on such facts as have been ascertained by actual observation. No naturalist of this or any other time has confined himself more strictly to well-ascertained facts, and devoted more labour to original investigation. The reason of this excessive care is to be found in the keystone of the Darwinian philosophy—La vérité quand même; the pursuit of truth through all difficulties, and without regard to consequences (Hodgson 1878, 224).
References


Bowler, Peter


