

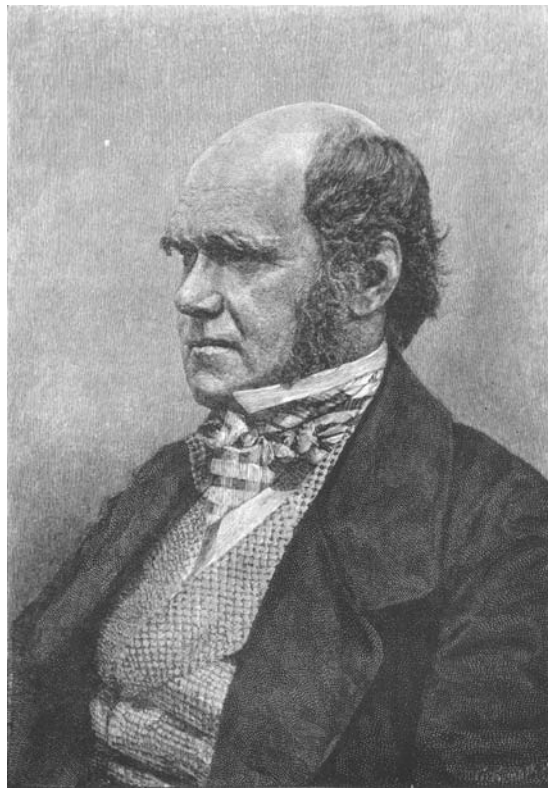
OCCASIONAL PAPERS
OF THE
CALIFORNIA ACADEMY OF SCIENCES

No. 155

February 12, 2009

DARWIN
A READER'S GUIDE

Michael T. Ghiselin



CALIFORNIA
ACADEMY OF
SCIENCES



DARWIN: A READER'S GUIDE

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California Academy of Sciences

California Academy of Sciences
San Francisco, California, USA
2009

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ISSN 0068-5461

Printed in the United States of America
Allen Press, Lawrence, Kansas 66044

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Preface

The inspiration for this guide can be traced to my decision way back in 1966 to read all of Darwin's major works and write a book about him, *The Triumph of the Darwinian Method*, published in 1969. Subsequently, I have continued to be an avid reader of Darwin's publications and have written quite a number of shorter pieces on his life and works. The guide itself has evolved out of my notes, bibliographies, and other scholarly apparatus. The chronology owes a great deal to my contributions to the *Dictionnaire du Darwinisme* edited by Patrick Tort. An early version of the biographical dictionary was created when I prepared the *Darwin CD ROM* in collaboration with Pete Goldie. Further material was gathered in the expectation of producing a third edition of the CD ROM. Alas, because of changes in the economics of electronic publishing, that project never came to fruition, though the second edition is still available. This is not, however, a re-issue of materials published earlier. The chronology and the biographies are based on notes that have been extensively reworked and much expanded. Over the years I have continued to enlarge my personal, computerized bibliography, and the selections from it presented here are based on literally years of work. Although the introductory section bears some resemblance to those I have written for re-issues of Darwin's books, it was written entirely from scratch.

With the approach of the bicentennial of Darwin's birth and the 150th anniversary of the publication of *The Origin of Species*, the need for a guide like this became increasingly obvious. My colleague Alan Leviton gave me a great deal of encouragement and we worked out a plan to publish this guide in both hard copy and on line.

Acknowledgments

Several persons have helped me assemble the materials used here and get them into electronic form and I am most grateful to them. These include Rasmus Winther and Subir Trivedi. Michele Aldrich read a draft with great care and provided much useful advice and greatly improved the manuscript. Alan Leviton was supportive of this project, both improving the manuscript and getting it ready for publication. I am particularly anxious to thank my old friend Barbara Pope, a plant physiologist who has spent many months in the Darwin archives at Cambridge University. She played various important roles in preparing the manuscript, volunteering her time and providing a generous donation in support of publication. Lastly, I want to thank Hallie Brignall, the Academy's Managing Editor of Scientific Publications, for critiquing galley proofs of this publication.

DARWIN: A READER'S GUIDE

INTRODUCTION

Charles Darwin's book entitled *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life* was published in 1859. It shook the world like no other publication before or since and initiated a revolution in our thinking that is still gathering momentum. It is among the most important scientific books ever written, and for many of us the one most worthy of being read and understood. Although well written, and intended for a broad audience, it is anything but a piece of light literature. It challenges the reader to study and to reflect. Furthermore, the *Origin* was intended as an "abstract" of a much longer work, to be entitled *Natural Selection*, which was neither finished nor was it published in Darwin's lifetime. Instead Darwin published a series of sequels to the *Origin*, which bear such titles as *The Variation of Animals and Plants under Domestication* and *The Descent of Man, and Selection in Relation to Sex*. These too deserve to be read, and read with understanding.

Might we not say much the same of the entire corpus of Darwin's writings? After all, he was the author of a travel book recounting his voyage around the world that is a masterpiece of the genre and one that has delighted readers ever since it appeared in 1839. This first volume made his scientific reputation as a geologist, and that aspect of his work is crucial to understanding what kind of thinker he was. A full twenty percent of his life's work was devoted to a massive treatise on barnacles, a publication which, if not must reading for everybody, is of more than just historical interest. A variety of people, in addition to zoologists, might find parts of it quite fascinating. Much the same might be said of his writings on floral anatomy, plant physiology, plant and animal behavior, psychology, and, especially, earthworms.

Although the exercise of reading all of Darwin can be rewarding, most readers will not have the time or the inclination to go so far. A good sample, suited to the reader's tastes and interests, seems more realistic. But the reader might welcome an overview as well as some guidance with respect to the interpretation of the various works. Beginners need to know where to begin, and even the most experienced might

appreciate some guidelines. Interested persons include both the more casual and general reader and the scholarly community, including students as well as professionals in many branches of knowledge. A fair number of readers might get more deeply involved with Darwin than they had originally intended, and that would hardly be regrettable.

Bearing such needs in mind, I have prepared this *Guide*, one that reflects my personal experience and draws upon the materials I have accumulated with the passage of decades. The *Guide* begins with a short biography of Darwin that differs somewhat from some of my other biographical pieces in that it expressly focuses upon Darwin's literary productions. It provides background, context, and explication for the texts. Because Darwin dealt with different topics at different times in his life, there is a roughly chronological order, beginning with natural history and geology, and ending with physiology and psychology. That justifies emphasizing the major works and treating them in a more or less logical sequence.

The next section of the *Guide* is a Chronology, or timeline, showing dates relevant to the study of Darwin's life. Some of these are obviously important, whereas others are rather trivial, perhaps being mentioned solely for their curiosity value. Included are details of Darwin's life both public and private. This part will probably be most useful to students and the community of professional Darwin scholars. However, one can easily imagine uses to which it might be put by the general reader. For example, Darwin's account of his trip around the world was based largely on the journal that he kept. However, for literary reasons, he did not present his visits to particular places in strictly chronological order. So, if one is interested in knowing what he did, and when and where he did it, the task can be frustrating, especially if one does not have the original version of his journal at hand.

Next comes the Darwin Biographical Dictionary, an alphabetically-arranged series of biographical sketches of persons of interest to students of Darwin's life and works. Similar biographical sketches can be found elsewhere, and readers also have recourse to standard biographical works including encyclopedias.

Yet these do not always provide the kind of information that a student of Darwin needs. Here the goal has been to emphasize the relevance of each person to our understanding of Darwin and his life. The choice of whom to include has been a bit arbitrary at times. Every effort has been made to include the persons mentioned in the Chronology. Also included are many of the important people whose names are encountered in Darwin's works and a fair number of minor figures as well.

The final section consists of bibliographies. These have been prepared from my personal database on topics that interest me. I have not been able to check all of the references against the originals, especially secondary sources taken from other bibliographies. I have, however, checked many of these. In the case of Darwin's own publications, I have been particularly fastidious but fear I may have made some mistakes. However, I was able to identify and correct the year of publication normally attributed to one of Darwin's own works by examining the signatures of an original copy in the California Academy of Sciences' library showing clearly that it could not have been published as early as had been thought.

Here is as good a place as any to point out how often the titles of Darwin's own books turn up in emended form, and this is often indicative of how poorly the work has been understood. Consider three examples. *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life* becomes *On the Origin of Species by Means of Natural Selection, or, The Preservation of Favoured Races in the Struggle for Life*. A clause that explains the then unfamiliar term 'natural selection' has been converted into an alternative title. *The Variation of Animals and Plants under Domestication* becomes *The Variations....* A process of varying is confused with the phenomenon of diversity. And finally, consider an example that suggests a failure to consult the original: *A Monograph on the Sub-Class Cirripedia* becomes *A Monograph of....* Let us not be too hard on those who make such mistakes, especially now, when computers automatically and, seemingly, without apparent human intervention, introduce errors into texts!

The first of the bibliographies is that of Darwin's own publications. With a few minor exceptions, I have checked all of these publications against the originals. Several of Darwin's books appeared in more than one edition. I have compared all of the editions word for word, and that can be an instructive

exercise. There are problems that one should watch out for with different printings and different editions. It also helps to know that all the variants in the six editions of *The Origin of Species* have been presented in a "variorum" edition by Morse Peckham (1959). Unfortunately, the variorum edition is rather difficult to use.

The second of the bibliographies gives works that were based on specimens that Darwin collected. Many of these contain quotations from Darwin's notes. It aims only at a good, representative sample.

The third of the bibliographies contains secondary literature, i.e., what people have written about Darwin. It also includes publications based on Darwin's notebooks, correspondence and manuscripts, generally with scholarly notes and commentary. There is a vast and growing body of literature on Darwin. It would be an impossible task, and a waste of time, to try to cite every work in which Darwin's name is mentioned, even in the title. For example, when scientists provide the scientific name of an animal or plant they include the name of the scientist who described it. Inasmuch as Darwin named many species of barnacles, a large number of papers by zoologists include his name for no other reason.

Such a bibliography as this obviously should include the important works, especially those of high scholarly quality. It is fairly easy to identify the books and journal articles that are considered important and of high quality by professional Darwin scholars. On the other hand, some works that are well known are not of very high quality. One neither wants to leave these out, nor does one want to ignore a book simply because it is written for a popular audience. But one must draw the line somewhere, and I have left out many works that seem to have little if any scholarly merit. On the other hand I have included much that I, personally, do not think very highly of.

At the end of the biographical essay, which immediately follows this introduction, I do recommend some works that seem to me particularly meritorious, interesting, or useful. Then there is the question of what really counts as Darwin studies. The bibliography includes a substantial number of items that are not primarily about Darwin himself, but deal with persons who were important in his life, such as his friends and collaborators Joseph Dalton Hooker and Thomas Henry Huxley, and of course Alfred Russel Wallace, with whom he shares credit for the discovery of natural selection. There are also some works that are valuable for understanding areas of knowl-

edge to which Darwin contributed or otherwise provide background information that might be useful to the reader.

DARWIN'S LIFE AND WORKS

Someone bent upon reading all of Darwin might reasonably begin with what is rather misleadingly called his autobiography and other works of an autobiographical character. However, such an entry into his works presents unexpected difficulties. In the first place, the "autobiography" was not written for publication but for his family, who did not have to be told, for example, not to take his modest assessment of his own abilities at face value. In the second place, the version that was edited and published by his son Francis in 1887 deleted some material that was deemed unfit for publication at the time. So it includes an expression of admiration for the philosopher Herbert Spencer, but not the expression of disapproval that qualified it. An unexpurgated edition was published by one of Darwin's grand-daughters, Norah Barlow. On the other hand, the autobiography is good reading and it provides a fair overview of Darwin's life and some insight into his character. Darwin also wrote a biography of his Grandfather, Erasmus Darwin, whose views on evolution are an important part of the history on the subject. Although it says little about evolution or other scientific topics, it is a most enjoyable book to read.

Charles Darwin was born on February 12, 1809. His father, Robert Waring Darwin, was a wealthy physician. His paternal grandfather, Erasmus Darwin, was also a highly successful physician as well a scientist, an inventor, and a famous poet. His notions about evolution were similar to those of Lamarck and appeared in print earlier. Charles Darwin's mother, Susannah Wedgwood, was the daughter of Josiah Wedgwood I, who founded the Wedgwood pottery firm. She was the sister of Charles's uncle, Josiah Wedgwood II, who continued to run the family business. She died when Charles was only eight years old and Charles and his younger sister Caroline were cared for by their older sisters. Charles shared an interest in chemistry with his older brother, Erasmus Alvey Darwin. That interest provides a good example of how young Darwin's education was largely extracurricular. He performed poorly in school and was sent, at the age of sixteen, to study medicine at the University of Edinburgh, where his elder brother Erasmus was already enrolled. Charles seems to have been an indifferent medical student, in part it would

seem because he had figured out that he would never have to work for a living. On the other hand, he joined the local scientific society, became acquainted with local scientists, and pursued his extra-curricular interests.

Darwin decided that he did not want to continue his medical education. His brother, although he did complete his medical degree, never practiced and spent his life as a gentleman intellectual in London. Their father, afraid that Charles would become an idle sporting man, insisted that he do something respectable. Therefore he was sent to Cambridge University to be educated as a clergyman. This makes more sense than one might think: a living in the country would provide him with a soft job and plenty of time in which to pursue his real interests. Furthermore, science was a respectable activity for a clergyman in those days, and Cambridge professors were often ordained as Anglican ministers. At Cambridge Darwin was again a rather indifferent student, though he completed the requirements for a degree and performed respectably on his examinations. The extracurricular activities were another matter. He became an avid beetle collector, and made contact with entomologists. He read Alexander von Humboldt's account of scientific travel in South America and it had a profound effect on him. Perhaps his most important reading at the time, however, was John Herschel's *Introduction to the Study of Natural Philosophy*. It was a major work on the philosophy of science, one that Darwin said was very important in his intellectual development. At Cambridge he met William Whewell, another important early philosopher of science. He became the protégé of John Stevens Henslow, the professor of botany, and spent a great deal of time with him. He attended Henslow's series of botany lectures twice. Another important figure in his life was the geologist Adam Sedgwick. Darwin accompanied him on a field excursion and evidently learned a lot from him.

After passing his examinations in January of 1831, Darwin still had to fulfill the residence requirements and his time seems largely to have been devoted to preparing for a career as a scientist, and that included some travel. By good fortune he was offered the post of unofficial naturalist and gentlemanly companion to the captain, Robert FitzRoy, on a surveying voyage on H.M.S. *Beagle*. Although Darwin's father at first refused to grant permission, his mother's brother, Josiah Wedgwood II, intervened and the invitation was accepted. The *Beagle* was scheduled to

map the South American coast and, by means of very accurate clocks called chronometers, to determine longitudes. The result would be better maps and improved navigation. FitzRoy was an able captain, much admired by his men, and intellectually well equipped for the task. But he was a difficult person, and suffered from bouts of depression. FitzRoy and Darwin became good friends, though their relationship was strained for a while because of differences about slavery. Measured in terms of the value systems of the day, Darwin was liberal, open-minded, and tolerant, whereas FitzRoy was rigidly conservative. They both approved of the work of Christian missionaries in Tahiti and co-authored an article to that effect when they reached Cape Town.

Darwin, although he was not the *Beagle's* official naturalist, was encouraged to collect and observe anything of interest to natural history that he might encounter during the voyage. The *Beagle* had an excellent collection of relevant scientific books on board so he was able to consult the literature during the trip. His original intent was to concentrate on the two areas in which he had gained experience at Edinburgh and Cambridge respectively: marine zoology and geology. He took the first volume of Charles Lyell's *Principles of Geology* with him, and the other two volumes reached him later on en route. Lyell was an advocate of the principle of uniformitarianism, and was opposed to the deluges and other major upheavals that had been invoked by advocates of catastrophism. Darwin was soon convinced of the merits of Lyell's approach and became one of his most effective supporters. As the voyage continued, Darwin realized that his geological researches were yielding important results. Yet he continued to observe and collect plants and animals. He also made some observations on behavior that seem, in retrospect, to relate to the kind of evolutionary speculation that he had encountered at Edinburgh. He traveled and collected extensively on land, and as a result realized that there had been a considerable amount of change, and rather recently. Giant animals had become extinct. Introduced animals and plants were invading new territory. And there were peculiar distribution patterns. Interest in such matters was further stimulated by Lyell's negative, albeit penetrating, assessment of the evolutionary ideas of Lamarck. During the voyage, Darwin evidently believed that species could change somewhat in adaptation to local circumstances, but not that such change could go so far as to bring new species into existence.

Along the Atlantic coast of South America Darwin found clear indications that the continent had been uplifted; on the Pacific coast he found further evidence of the same phenomenon. He worked out much of the geological history of the Andes. While he was in Chile, for example, a major earthquake occurred and he was able to document the immediate effects of upheaval. Sedgwick arranged for an account of his discoveries, sent as correspondence, to be published as Darwin's first contribution to the scientific literature. Darwin was ever concerned with the implications of his discoveries, and while still in South America he speculated about the uplift and subsidence of the land on a global scale. One result was the formulation of his famous theory of coral reefs. Coral grows in shallow water, along coasts and on islands. If an island rimmed by coral were to sink, and the coral were to grow at the same time, the island might gradually disappear and nothing but coral would be left. Later on in the voyage Darwin was able to test this theory by observations on coral formations at Tahiti and, more importantly, at Keeling Atoll in the Indian Ocean.

By his own accounts published much later, Darwin did not become an evolutionist during the voyage, though he began to think seriously about such matters. He was still a creationist both before and for some time after his famous visit to the Galapagos Archipelago, which is now treated as a living laboratory of evolution. The notion that he became a convert to evolution while visiting the Galapagos is a myth. He was looking for "centers of creation" that Lyell had invoked to explain the different faunas and floras in various parts of the world. He did not try to collect evidence related to evolution while he was there. As the voyage continued, however, he visited New Zealand and other islands with peculiar animals and plants, and of course the continent Australia too. The possibility of evolution may have been in his mind late in the voyage. However, he did not become convinced that evolution has in fact occurred until after he got home and had some of his specimens examined by specialists. Some of what he had thought were varieties turned out to be distinct species. And some of the South American fossils were giant relatives of smaller forms that were still living in the same area. There followed a period of some months, beginning in March, 1837, during which Darwin speculated a great deal and tried to invent a plausible mechanism for evolution, something that would explain the adaptations of animals and plants

without recourse to the supernatural. The development of his ideas can be traced in part because of the notebooks that he kept.

It was in October 1838 that Darwin read “for amusement,” as he misleadingly put it, Malthus’s *Essay on the Principle of Population*. Malthus, the first professor of economics, had pointed out that the potential rate of multiplication of any animal, man included, is so great that the supply of food and other resources will tend to restrict, and ultimately prevent, population growth. Malthus expressed the relationship by saying that the population increases geometrically, whereas the resources can only be increased arithmetically. We can ignore the niceties and details here, the point being that scarcity of resources means that there is competition between the organisms that make up the population for the wherewithal to survive and reproduce. Because some organisms are more vigorous, fertile, or otherwise well endowed than others, in subsequent generations the population changes in the direction of being more effectively equipped to win out in the reproductive competition. This was Darwin’s concept of natural selection, which he presented to the world as a well developed theory some twenty years later.

Darwin kept a diary during the voyage. It provided a lively account of his travels and observations on the state of society as well as the natural scene, and was clearly influenced by Darwin’s reading of Alexander von Humboldt’s *Personal Narrative*. Early in the voyage Darwin showed his diary to Captain FitzRoy, who liked it very much and encouraged him to publish it. The diary was the basis for Darwin’s first book, which is popularly known as *The Voyage of the Beagle*. It was extensively supplemented by additional material, and much revised. (The Diary itself, edited by Richard Darwin Keynes, has been published.) The first edition, published in 1839, appeared as part of a series that includes FitzRoy’s account of the voyage. It was prepared at a time when Darwin was convinced that evolution has in fact occurred, but before he read Malthus and discovered natural selection. A second edition, with a slightly different title, was published in 1845. (We will refer to the work as the *Journal of Researches*, or just the *Journal*, for short.) By then Darwin had developed his evolutionary theory extensively, and had even written a preliminary outline and then a draft of a short book explaining it. (Later published as the “Sketch of 1842” and the “Essay of 1844.”) As one might expect, the first edition of the *Journal* contains a considerable

amount of material having to do with evolution, plus some hints about the kind of evolutionary speculation that he had been considering. The second edition adds material that bears upon the theory of natural selection, even a brief passage on Malthus. If one is interested in the evolution of Darwin’s ideas, it can be an enlightening exercise to compare the three versions in some detail. For most readers, especially beginners, there is no particular reason for doing that, but the circumstances of revision should be borne in mind. The 1845 edition is the most widely available and just as good reading as the first. The book is one of the classics of travel literature and can be enjoyed simply as a literary work. Humboldt praised it for its “painterly” qualities. It also contains fascinating materials about the economy and the state of society at the time.

The book provides brief accounts of material that was discussed at greater length in Darwin’s later publications, such as his book on coral reefs, and the reader will probably have no difficulty understanding their significance. However, a few comments seem in order about some of the observations that were significant for his evolutionary ideas but for good reason he did not fully explain at the time. His observations on various peoples, including primitive ones, reflect a few of his ideas about social and cultural evolution. Darwin took considerable interest in groups of animals having representatives that live in habitats that are different from those to which the group as a whole seems to be adapted. These include terrestrial flatworms, a group that is largely aquatic, and the terrestrial crab *Birgus latro*. In the Galapagos Islands he experimented on the behavior of a lizard that makes excursions into the sea to feed. He explicitly mentions Lamarck in his discussion of a burrowing rodent, the tucutuco, in which the eyes seem to be degenerating. In the Falklands he encountered a goose that could no longer fly, though it could move over the surface of the water quite rapidly by a combination of paddling and flapping. He discusses the habit of cuckoos and other birds of laying eggs in the nests of birds of other species, a phenomenon that he later interpreted in evolutionary terms. Anybody would have been impressed by the extinct fossil mammals, many of them of large body size, that Darwin discovered. He, however, was impressed by their close relationship to smaller animals that were still living. It was an important clue to evolution. The new species of ostrich that he discovered in Patagonia was also a hint about evolution, for it replaced another one geographically. A poisonous snake, *Trigonocephalus*, behaves like a rat-

tle-snake but lacks a rattle and instead beats its tail against vegetation. Darwin used this as an example of change in behavior setting the stage for change in structure.

In addition to preparing the *Journal* for publication, Darwin was very active dealing with his collections, presenting his ideas to the scientific community, and otherwise furthering his career. He got to know many of the leading scientists of the day, the most important being Lyell, and became a participant in the activities of scientific organizations such as the Geological Society of London. Meanwhile he married and took a house in London. However, his health began to decline and in 1842 he and his family moved to the village of Downe, south of London. His residence was called "Down House" and he gave his address as "Down, Beckenham, Kent" or "Down, Bromley, Kent." The reasons for Darwin's ill health, which kept him largely incapacitated for much of his career, have been the subject of much speculation. At the very least we can say that his condition, whatever its physical basis may have been, was exacerbated by anxiety and stress.

Darwin had neither the time nor the expertise that would have been necessary for him to deal with all of his collections himself. They had to be turned over to specialists for interpretation. Preliminary publications on birds that were studied by John Gould reflected some of the evidence for evolution. Darwin asked various specialists to describe the materials, and obtained a grant to edit and publish the *Zoology of the Voyage*. This work, which appeared in installments over a period of several years, contains Darwin's commentary on biogeography, behavior and other matters. Other collections, including those of plants and various groups of insects were treated separately. Darwin reserved some of the marine biological materials for himself, but he did not do much with them until after he got the geology out of the way.

DARWIN'S GEOLOGICAL CONTRIBUTIONS

Darwin dealt with the geology of the voyage in a few short papers and in a series of three books: *The Structure and Distribution of Coral Reefs* (1842; 2nd ed. 1874), *Geological Observations on the Volcanic Islands....* (1844), and *Geological Observations on South America* (1846). Much of the material in these books is presented in more preliminary and less technical form in the *Journal*. Although *Reefs* was published first, the sequence of Darwin's research makes

it more readily understood if the three are read in the opposite order than the chronological sequence in which they appeared.

Darwin's geological books are of considerable philosophical and methodological interest and cast much light on his intellect and its development. A particularly useful document for understanding how he became a geologist is a chapter entitled *Geology* that he wrote for the British Navy's *Manual of Scientific Enquiry*, edited by Sir John Herschel and first published in 1849. In addition to giving much practical advice, it advises the beginner on how to become a geologist. One can read it as a reflection of how Darwin taught himself to become a great master of that discipline. Among other things, Darwin suggests that one should read, then observe, and compare what one has seen with what one has read. This is important, for, contrary to the impression that one might get from the vast amount of factual detail that goes into his works, Darwin believed that theory should be one's guide in the conduct of scientific research. Not everybody shared that view in the early nineteenth century, so the following passage from a letter to Henry Fawcett dated September 18, 1861 is worth quoting: "About thirty years ago there was much talk that geologists ought only to observe and not theorise; and I well remember some one saying that at this rate a man might as well go into a gravel-pit and count the pebbles and describe the colours. How odd it is that anyone should not see that all observation must be for or against some view if it is to be of any service!" (Darwin and Seward, 1903.)

To understand Darwin's geological reasoning we need to consider some of the ideas of Lyell that influenced him. Lyell advocated a "steady-state" view of the world in agreement with his predecessors Hutton and Playfair. Indeed the notion of an eternal world that undergoes cyclical change, coming back to more or less the same condition, goes back to Aristotle's treatise *Meteorologia*. The earth might change through erosion in one place accompanied by deposition in another. That implied that the crust of the earth might move up and down and also that the areas exposed as land might occupy quite different positions with the passage of time. Lyell also thought that the living inhabitants of the earth differ from one another at different times. However, he did not believe that there is any sign of progressive, or unidirectional, change in the fossil record. He took it as a methodological assumption that in reconstructing the history of the past we should begin by invoking only

the sort of causes that are “now in operation,” as he put it. That tended to rule out catastrophes, such as universal deluges, giving the terms “uniformitarianism” and “catastrophism” for the alternative positions. Catastrophes might have occurred, but the progress of science would be more effective if they were invoked only as a last resort. One thing that never changes, however, is the laws of nature. Any reconstruction of the past history of the earth must be consistent with the laws of nature, understood as regularities that must happen irrespective of time and place, such as the laws of gravity. Geology, like other historical sciences, creates explanatory narratives based on a combination of particular facts and nature's timeless uniformities.

Much of what Darwin was doing for South American geology was working out the sequences in which layers of rock (strata) were laid down. The basic intellectual instrument for such historical reconstruction is the “principle of superposition,” which is attributed to the seventeenth-century Danish naturalist Steno. In the case of sandstone, for example, new layers can only be deposited on top of layers that already exist. There is no way in which water carrying sand can slip under a layer of rock and deposit a bed of sandstone in that position. Therefore, the younger strata overlie the older ones. There are all sorts of complications, not the least of which is that a whole series of strata can be overturned. However, there are additional principles for deciding “which way is up.” A temporal succession of strata gives relative times, but it does not give the sort of absolute times that are provided in terms of number of years. Although the plants and animals that are present at any time differ from place to place, the same species often ranges over considerable areas, and the co-occurrence of such a species in deposits at different places is evidence that those deposits are contemporaneous. On the other hand, the fossils in older deposits are increasingly different from those in younger ones. Lyell reasoned that he could date the deposits approximately by determining the proportion of species that are still in existence. The larger the proportion of extant rather than extinct species, the newer the rocks. It was this kind of inference that Darwin was applying in much of his geological research, and understanding that approach makes it much easier to follow his reasoning.

Treating, as noted above, the geology of the voyage in a conceptual order rather than by year of publication, let us now consider its third volume,

Geological Observations on South America, first published in 1846. It treats research that preceded that on islands and reefs and paved the way for it. The grand theme of the whole series is the gradual upheaval and subsidence of the land on a global scale, something that was very much in tune with Lyell's views. We should note at the beginning some later developments in the history of geology of which Darwin was unaware. Firstly, although the land rises and falls much as Darwin believed, so too does the level of the sea, partly as a result of glaciers forming and melting. Secondly, the land moves laterally, not just up and down. That aspect of the history of the earth was not well understood until the emergence of plate tectonics in the second half of the twentieth century. The earth's crust is made up of plates of rock that are continually being formed and destroyed. The subduction of one plate under another is a major reason for the formation of mountain chains, and it also accounts for areas of vulcanism and earthquakes in bands around the world. Darwin could see that there was a causal link between uplift and vulcanism. He explained it in terms of molten lava getting injected under rock. This is not exactly what happened, but it does not affect the correlation that he observed or the legitimacy of his coral reef theory.

Darwin begins with an account of uplift on the eastern coast of South America. He studied series of step-like terraces rising above sea level. These were associated with the shells of marine animals, indicating that they had formerly been at sea level. The shells were very much like those living at the time, but they were sometimes associated with the remains of extinct fossil mammals. The elevation seemed to have taken place gradually. He then discusses similar evidence from the western coast. He was present during the earthquake that rocked the region on February 20, 1835 and therefore was able to document an uplift of several feet. He also drew upon published accounts of a great earthquake in 1822. In a third chapter he discusses the related topic of erosion and deposition of sediment as well as the formation of valleys and salt deposits. The fourth chapter, on the Pampas formations, is of particular interest because it discusses the fossil mammals that helped to convince Darwin that evolution has occurred. The remains of large, extinct mammals were found together with shells of marine animal species that were still living on the nearby coast. Not only were they taxonomically indistinguishable, they seemed to be in the same relative proportions, indicating that the marine environ-

ment had remained much the same.

The fifth chapter deals with the older, Tertiary formations. Darwin established the relative dates of fossiliferous strata both by superposition and by the proportion of living species of shells in them to extinct ones. He gives some rather forced arguments for the temperature not having changed much. The chapter ends with a discussion on the incompleteness of the fossil record, a topic that Darwin discussed at great length in *The Origin of Species*. The sixth chapter discusses the igneous and metamorphic rocks and the topic of cleavage and foliation. The 7th and 8th (final) chapters deal with the geology of the Cordillera of the Andes. Darwin had crossed the Andes in late March and early April of 1835, and during that trip he made extensive drawings. He was able to document both subsidence and elevation over long periods of time. He explains why the fossil record is not as complete as was generally believed. And he urges the point that change has occurred gradually, step-wise, and over long periods of time.

The second volume of the geology of the voyage, published in 1844, was entitled *Geological Observations on Volcanic Islands, with Brief Notices on the Geology of Australia and the Cape of Good Hope*. At many times during the *Beagle* voyage Darwin had opportunity to study volcanic islands. Lyell had opposed the notion of von Buch and others that volcanic craters should be treated as "craters of elevation." According to this view a crater would begin as a sort of blister on the earth's surface and then would collapse leaving a depression at the center. Darwin provided further evidence that the craters had been gradually built up by deposits of lava. Lyell had suggested that coral atolls had formed on the rims of craters. Part of the Admiralty's instructions to FitzRoy had been to study such atolls with the end in mind of investigating such matters. During the course of the voyage Darwin reflected upon subsidence and elevation, and, while still in South America, formulated his own theory of coral formations. This interest helps one to form a more balanced view of his activities while in the Galapagos. The reader who wants to study the development of Darwin's thinking should realize from the outset that his observations are not presented in chronological order, even though St. Jago, the first island he visited and one that was revisited at the end of the voyage, is treated first. Rather the materials are arranged so as to show how volcanic islands are formed. He begins with islands that are close to continents and contain a substantial amount

of sedimentary rock characteristic of such areas, and those that are more distant from the land and consist mainly of volcanic material. The distinction between continental and oceanic islands was fundamental to Darwin's island biogeography but he does not refer to that explicitly here.

ON CORAL REEFS

The first volume of the geology of the voyage, entitled *The Structure and Distribution of Coral Reefs*, was first published in 1842. A second edition, considerably revised, was published in 1876, and a third, posthumous, one in 1889. The second edition includes response to criticisms by various contemporary scientists, reflecting the fact that although the theory was immediately accepted by geologists it later came under fire from all sorts of quarters. It is no coincidence that much of the criticism came from persons, mainly zoologists, who were also critical of Darwin's evolutionary ideas. The debates continued until shortly after the Second World War, when soundings and drilling made it clear that Darwin's basic ideas were correct. Darwin's views, however, were supplemented, especially by the work of James Dwight Dana, Reginald A. Daly and William Morris Davis, and more recently by studies related to the modern theory of plate tectonics.

Coral Reefs begins with a brief introduction that explains the problem and defines his three classes of coral reefs. Fringing reefs are located next to the shore and often surround islands (Fig. 1A). Barrier reefs are separated from shore by a body of water called a lagoon that generally opens into the sea by channels (Fig. 1B). They are often capped by islets of land, and may encircle an entire island. In some cases there is no such island, but just a lagoon surrounded by a reef. Darwin briefly explains that the sequence is a developmental one, the result of corals having grown upward only in shallow water as the land has subsided. He then devotes three chapters to detailed descriptions of the three classes of reefs, beginning with atolls, and ending with fringing reefs. The first of these atolls is Keeling Atoll, which he and Fitzroy studied during the voyage of the *Beagle*. He includes a considerable amount of material on how the corals and other animals grow and interact with one another, and provides evidence that the archipelago has sunk and has the kind of shape that one would expect if corals (and other reef building organisms) had grown up on a sinking island. He compares the other known

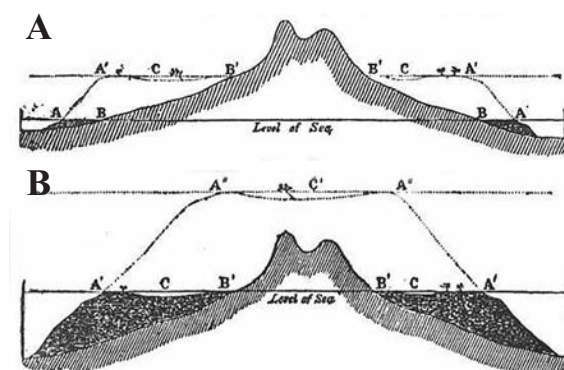


FIGURE 1.

(A) AA'—Outer edge of the reef at the level of the sea. BB'—Shores of the island. A'A'—Outer edge of the reef, after its upward growth during a period of subsidence. CC'—The lagoon-channel between the reef and the shores of the now encircled land. B'B'—The shores of the encircled island. N.B.—In this, and the following woodcut, the subsidence of the land could only be represented by an apparent rise in the level of the sea.

(B) A'A'—Outer edges of the barrier-reef at the level of the sea. The cocoa-nut trees represent coral-islets formed on the reef. CC'—The lagoon channel. B'B'—The shores of the island, generally formed of low alluvial land and of coral detritus from the lagoon-channel. A''A''—The outer edges of the reef now forming atoll. C—The lagoon of the newly formed atoll. According to the scale, the depth of the lagoon and of the lagoon-channel is exaggerated.

examples of atolls before taking up the barrier reefs such as those off New Caledonia and the eastern coast of Australia. The chapter on fringing reefs begins with Mauritius, which Darwin had also visited when on the *Beagle*. He again compares quite a variety of reefs.

A separate chapter is devoted to the conditions that are favorable to the growth and prosperity of corals and reefs, and to their rate of growth and related topics. He was able to establish that reef-forming corals grow only in warm, shallow waters. He knew that they are carnivores, but the fact that reef-forming corals are largely dependent upon symbiotic algae in their tissues for their energy supply was not discovered or fully appreciated until around the middle of the twentieth century. The absence of coral formations in some warmer areas puzzled Darwin. Their limited ability to cope with sediment still seems a valid explanation. He did not however appreciate the effects of *el niño* events and other perturbations that make for the sort of unstable habitat in which corals do not flourish. Darwin's chapter on such physiological and ecological topics provided part of the explanation for the distribution of the reefs. The rest of the distribution pattern was due to the long term geological changes that had been taking place all over the

world. He then relates the two by proposing that what kind of reef occurs in a given place depends upon whether the crust of the earth has been in the process of uplift or subsidence. Given his theory that subsidence is compensated for by uplift due to volcanic activity, the type of reef should correlate with it. Darwin makes this argument strikingly by means of a map in which the different types of reefs are shown to have the properties that this hypothesis predicts. The fringing reefs occur near to areas of volcanic activity, whereas the barrier reefs, and especially the atolls, tend to be located far from such areas. It is a fine example of Darwin's scientific method.

Darwin published some shorter geological papers that deserve mention. These include several in support of his and Lyell's interpretation of the transport of sediments and related topics. The possibility of extensive glaciation and its effects on the level of the sea became an active topic for investigation but Darwin was more or less on the losing side of that debate. His paper on the Parallel Roads of Glen Roy and Lochaber was an effort to explain some bench marks in Scotland. By analogy with what he had found in South America, he tried to explain them as the result of the rise of the land and its occasional erosion by the sea. It turned out that they were the product of lakes that were dammed by glaciers. Another geological topic that attracted his interest was the effects of earthworms in forming the soil and changing the landscape. He returned to that in his last book, supplemented by much later research on the behavior of the worms.

ON BARNACLES

When Darwin finished his geological works in 1846, he planned to write a few short papers on zoology based on specimens that he had collected during his voyage and then prepare his work on evolution for publication. That plan succeeded insofar as he published some short papers on flatworms and one on a little-known pelagic creature, the chaetognath *Sagitta*. One animal that interested him was an aberrant barnacle that did not fit into the existing schemes of classification. To describe it properly he needed to dissect and compare some other barnacles. One thing led to another, and he wound up revising the classification of the entire subclass Cirripedia and devoting a monograph to them well over a thousand pages long. I say "a" monograph in spite of the fact that he was compelled to publish the parts on fossil cirripedes

separately. This was because of the pettiness of the institutions that sponsored the publication.

The barnacle research delayed the publication of Darwin's evolutionary theory for some eight years. Many reasons have been given for the delay. The best of these is that he was obsessive about details in all of his scientific work and wanted to do the job as well as possible. The results are more easy to document. His monograph changed one of the least known groups of animals into one of the best known. It also established his reputation as a comparative anatomist, systematist and paleontologist, one who could speak with authority about all sorts of matters. It was not obvious to all his readers at the time that the *Monograph* was a book on evolutionary comparative anatomy but that is easy to make out in retrospect. Darwin even refers to the genealogical tree of these organisms. However, the evolutionism was only implicit, and the language could be read metaphorically. Darwin showed how the various groups of barnacles could be derived from common ancestors and produced a classification that is roughly consistent with that genealogy. He gave interesting examples, not all of which are now considered correct, of parts changing their function in the course of evolution. In some ways the most remarkable findings were the dwarf males that had evolved within the basically hermaphroditic group. His work on their reproduction led him to realize that hermaphrodites are not, as had been widely assumed, self-fertilizing animals, and consequently that sex is far more important than his contemporaries believed. This initiated Darwin's extensive research on sex, including much comparative and experimental work on plants. He realized that sex is somehow connected with variability, and for him one of the most important results of the barnacle research was the realization that natural populations are highly variable. Variation was exceedingly important for Darwin because it is a necessary condition for evolution by means of natural selection.

Readers of Darwin may reasonably defer, or omit altogether, reading the *Monograph*. It is not an easy book to read, even if one has taken a course on invertebrate zoology. However, one might want to sample some of the more accessible passages. The volume on living Lepadidae (stalked cirripedes) begins with some general material on the comparative anatomy and embryology of the group (pp. 1–66) that gives a fair idea of how Darwin thought that the barnacles originated and evolved. The next two hundred pages or so provide descriptions of various species that are

not of much general interest. One might want to read the parts on the peculiar hermaphrodites, males and females, though the summary on pages 281 to 293 gives the main points and their implications. The section on the genus *Lithotrya* includes material on how these animals burrow that provides an interesting example of Darwin's evolutionary approach to functional anatomy and behavior. It might be best to read these passages after some of the later works in which the evolutionary thinking is explicit. The volume on living Balanidae and other cirripedes begins with an introduction that explains the anatomy. Well worth reading are the discussion on pages 9 to 22 on the general morphology of these animals and the one on their sexual peculiarities that follows on pages 23 to 30. There are further discussions on the females and dwarf males of the burrowing barnacles *Alcippe* and *Cryptophialus*.

EVOLUTION AND NATURAL SELECTION: *THE ORIGIN OF SPECIES*

After completing the barnacle monograph, Darwin began to work up his materials on evolution and natural selection. He gathered new information from the literature, through his own experiments, and by requesting it from his informants. Although most of these informants did not know what Darwin was up to, he did confide in his botanist friend Joseph Dalton Hooker and later in another botanist, Asa Gray of Harvard University. Among the many persons with whom he corresponded was Alfred Russel Wallace, who in September of 1855 published a paper entitled "On the law which has regulated the introduction of new species." Darwin told Wallace that he was working on a theory, but did not say what it was, and added that it would be some time before he published. In June, 1858 Darwin was working on a long book manuscript entitled *Natural Selection*, when a letter arrived from Wallace, along with a manuscript of a paper on evolution by natural selection. This naturally created quite a stir. The upshot was that a joint publication was assembled and read to the Linnaean Society on July 1, establishing Darwin and Wallace as co-discoverers. It appeared in print some time in August. Wallace was in the Malay Archipelago at the time and did not find out about this arrangement until much later. He never objected to it.

Whatever we may think of what took place, the joint publication is readily available and well worth reading. It begins with an introductory letter by Lyell

and Hooker providing a reasonably accurate account of the circumstances. There follows a section of a chapter from Darwin's "Essay" of 1844. It seems to have been edited slightly, but the changes are minor and do not affect the content. At the end there is a paragraph on sexual selection, something that had not occurred to Wallace, and this is important because it establishes that Darwin's theory was somewhat more general than Wallace's. There follows a brief explanation of natural selection that was included with a letter to Gray dated September 5, 1857. It too seems to have been slightly edited but without any substantive changes. At the end is a discussion on the principle of the divergence of character, which explains the diversification of life in ecological terms. Although one commentator suggested that Darwin took the principle of the divergence of character from Wallace's manuscript, there is no trace of it in the original. It was something that Darwin thought of in the 1850s, so it is present in the letter but not in the "Essay." Wallace's section is very well written and easier to follow than Darwin's terse accounts. Wallace emphasized the selection of varieties as well as organisms, and he seems not to have made the distinction as clearly as Darwin did. Both Darwin and Wallace emphasized the analogy between artificial and natural selection. They focused mainly on selection as a mechanism for producing adaptation and said very little about the long-term effects and larger consequences. For that reason, and perhaps others, the paper had little immediate effect on Darwin's contemporaries, other than indicating that something was in the works. The theory had to be fully explicated before it would be understood.

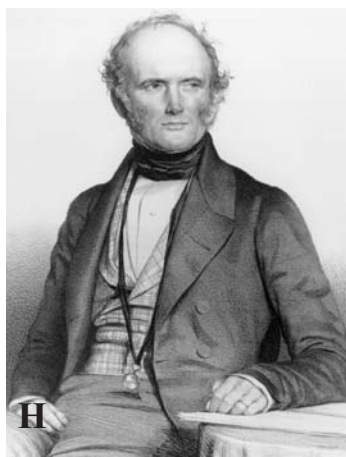
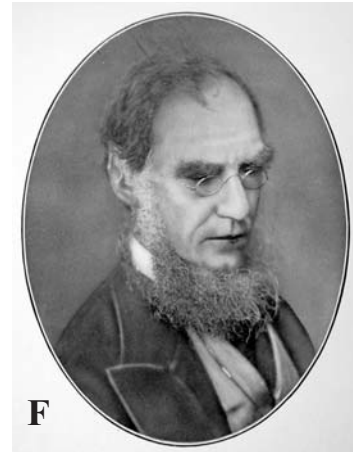
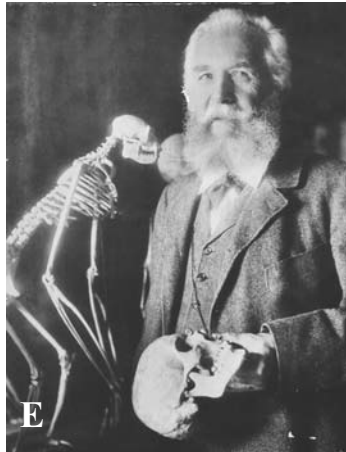
Darwin soon began to write an "abstract" of his unfinished book manuscript. It ultimately became *The Origin of Species*. The first edition of the *Origin* is probably the best choice from the reader's point of view. It is the original statement of Darwin's views, and later editions became complicated as he responded to various criticisms. Therefore we will begin with an examination of the first edition and afterward consider what changes were made in the later ones.

Darwin's claim, in the Introduction, that he worked by patiently accumulating facts before allowing himself to speculate must be taken with a block of salt. Rather than following the "Baconian" approach that was widely popular in his day, he took theory as his guide, using the facts to test hypotheses. The approach that he used was more in line with what has been called the hypothetico-deductive approach, or as

some would say, the argument to the best explanation. The rationale of his "one long argument" is that evolution by natural selection explains a wide range of phenomena that are otherwise inexplicable in scientific terms. Throughout the work he opposes his hypothesis to special creation, but he also provides reasons for rejecting the views of Lamarck and others. The first chapter explains the process of natural selection using the analogy of artificial selection of domesticated animals and plants. The reason for the analogy is not just to make the mechanism seem plausible. Rather it is to establish selection combined with variation as something more than purely conjectural. Selection really does produce change: it is a *vera causa*. (Whether it suffices to account for the diversification of life from one or a few ancestral forms is of course another matter.) In addition to selection Darwin invokes correlated growth or variability, something that later came to be discussed under the rubric of pleiotropy. Darwin knew, for example, that white cats with blue eyes tend to be deaf. So somebody trying to produce a breed of white cats with blue eyes might inadvertently get ones that were deaf as well. This was one of several mechanisms that Darwin invoked in addition to natural selection. (Others are use and disuse, inherited habit, and sexual selection.) He treats the breeds of domesticated animals and plants as analogous to what we would call incipient species.

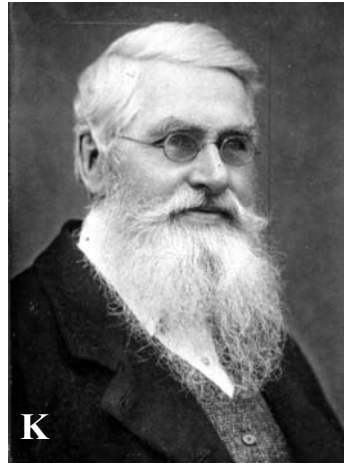
In Chapter II Darwin considers variation in nature, but his main concern is to show that there is no clear break between species and varieties. Speciation as he saw it is a gradual process, and one would only expect an unbroken continuum in the degree of distinctness. As he put it, there would be no "essential" difference between species and varieties. This discussion can be confusing to the reader and for more than one reason. We now distinguish between 1) the species category, in other words, "species" in the abstract, and 2) particular species taxa, such as *Homo sapiens*, which are generally considered concrete populations, composite wholes or, in other words, individuals in a technical philosophical sense. In discussing whether taxonomic groups are "real" it makes an enormous difference whether we are talking about the distinction between species and subspecies on the one hand, or something like *Homo sapiens* or *Drosophila pseudoobscura* on the other. Furthermore, in this section, Darwin is discussing the species concepts of other authors, whereas his own view of such matters is expounded in a later chapter. The fact that

Some of the principals who played leading roles in
Darwin's scientific career



(A) Louis Agassiz; (B) Asa Gray; (C) Anton Dohrn; (D) George Rolleston;
(E) Ernst Haeckel; (F) Joseph Hooker; (G) Thomas Huxley; (H) Charles Lyell; (I) Richard Owen

Some of the principals who played leading roles in
Darwin's scientific career



(J) Adam Sedgwick; (K) Alfred Russel Wallace; (L) Robert Fitz-Roy; (M) John Stevens Henslow;
(N) Jean Baptiste Lamarck; (O) John Gould; (P) Herbert Spencer; (Q) Étienne Geoffroy Saint-Hilaire;
(R) Thomas Robert Malthus

genera, species and varieties have the same hierarchical pattern of diversity of groups within groups makes sense if and only if they are all stages in a single process.

Darwin explains what he calls the struggle for existence, in other words, competition in Chapter III. He takes care to point out that what really matters is reproductive success. In order to do that he develops the basic principles of modern ecology, which is hardly surprising given that he founded that science in its modern form. (The word *ecology* was coined by Darwin's German follower Ernst Haeckel.) One of the more important points that he makes is that the competition will be most severe between close relatives.

Darwin explains natural selection, sexual selection, and evolution in the long term in Chapter IV. Natural selection leads organisms to diversify and to occupy different places in the natural economy. Darwin's notion of a place in the economy of nature is roughly equivalent to that of a niche in the sense that the term was used by such later ecologists as Elton and Gause, who derived much of their thinking from him. In a very important passage, Darwin notes that natural selection cannot modify the structure of one species solely for the good of another. That kind of "altruism" he argues does not and cannot exist. One merit of a good theory is that it makes strong predictions like that, ones that may have been quite unexpected. Sexual selection is only briefly discussed, but it is crucial to the argument. If all that really matters is out-reproducing organisms of one's own species, then it makes sense that some features would have no other function, and even be deleterious to the welfare of that species. Darwin saw the combat between males and efforts to woo the females as examples of precisely such maladaptation. Again, this is a crucial move, and one that has often been misunderstood. Darwin believed that there are three kinds of selection: artificial, sexual and natural. His theory made different predictions for each of these, and sexual selection was therefore compelling evidence for selection theory in general. He gives a few details about natural selection that are developed in later works on pollination and other topics, including the previously unexpected vast amount of sexuality in the natural world. Then he proposes that competition over long periods of time will cause organisms to diversify while the intermediate forms will often become extinct. The result is a pattern that relates the taxonomic hierarchy with its groups within groups

and the gaps that often separate them to the competitive process. The tree diagram makes sense of taxonomy in a way that creation does not.

In Chapter V, Darwin discusses the laws of variation. One of the philosophical points that he seeks to make in this chapter is that variation is not (as is often said) random, in the sense that one change is just as likely as any other. It displays its own laws, or perhaps it would be better to say rules. Among these regularities he gives the principle of the correlation of growth mentioned above. He shows how natural selection makes sense out of rudimentary organs and throwbacks or atavisms. This chapter is really about embryology, though that may not be obvious. Modern genetics, with its notions of pleiotropy and the like, did not come into existence until after the rediscovery of Mendel's work around 1900. Darwin's way of approaching these matters looks remarkably like the kind of "evo-devo" that became popular around 1980.

Darwin considers what he calls difficulties with respect to his theory in Chapter VI, and indeed continues the same theme in the next four. We need to avoid getting the impression that he was immunizing his theory from criticism or explaining away unpleasant facts. On the contrary, the difficulties in question played an important strategic role in his argument. Much as he argued that there were indeed phenomena that his theory could not explain but that such do not exist, he showed that the difficulties in question were more apparent rather than real. Indeed, he was often able to turn an argument against his theory on its head, thereby converting an argument against it into one in favor of it. Raising objections and shooting them down was an effective rhetorical ploy. He gives the stock example of the vertebrate eye. He says that his theory would break down if such an organ could not have been formed by small steps, again denying the claim. He explains why not all characters are adaptive.

In the sixth edition of the *Origin*, Darwin added another chapter to allow for extensive rebuttal of his critics, but the order of the chapters remained the same. Chapter VII (VIII in the 6th edition) deals with instincts, phenomena that some of his contemporaries had regarded as miraculous. Darwin shows for instance that a bee does not have to be a mathematician to create a hexagonal cell of wax. But the most compelling example is that of the neuter castes of social insects such as ants, bees and termites. How could such colonies evolve through natural selection when the workers are sterile? Under ordinary circum-

stances natural selection should not favor sterility. Darwin reasoned that in social insects the unit that gets selected is the family. He also invokes breeding from the same stock, or what later came to be called "kin selection." Chapter VIII deals with the sterility of hybrids. Any degree of sterility would tend to decrease an organism's reproductive success, and natural selection would therefore prevent it from evolving. Darwin answers that by maintaining that such sterility is not an adaptation, but rather an incidental byproduct of some other change. Chapters IX and X address the imperfection of the fossil record. As a leading geologist and an expert on fossil barnacles Darwin was able to speak with great authority on that topic. Negative evidence in general is to be viewed with skepticism, and in the case of missing fossils Darwin provides reasons for thinking that the fossil record is even more fragmentary than had been believed. Fossils are formed only under favorable conditions and they often get destroyed. As it turned out, the point that the evidence was negative created a strong incentive for paleontologists to search for more specimens, and the fossil record became considerably less fragmentary even in Darwin's lifetime. Darwin also shows how the fossil record makes sense in view of his diversity model and argues that his theory explains the apparent progress that has occurred in the organization of plants and animals in geological time. Such progressive trends were something that Lyell had denied.

Darwin proceeds in Chapters XI and XII to consider a much less fragmentary body of evidence: biogeography. It was biogeography that first convinced Darwin that evolution has in fact occurred, and biogeography was the most compelling evidence for it in his day. It remains so in ours. The kind of biogeography that was practiced by Alexander von Humboldt attempted to relate distribution patterns to climate and other physical conditions of life and that perspective has never been abandoned altogether by biogeographers and ecologists. But that approach was ahistorical, whereas descent with modification, with taxonomic groups conceived of as branches of a genealogical tree, provided the basis for an evolutionary approach to the subject. Animals and plants have moved about as they have diversified, and their ability to do so has been limited by barriers. Terrestrial animals and plants find it difficult to cross bodies of water, deserts and mountain ranges. Marine ones would be blocked by land masses. By analyzing the different kinds of barriers and relating these to the

ability of the animals and plants to move about, that aspect of the history of life could be reconstructed. Species could be traced to their point of origin. Darwin considers the means by which organisms may have crossed barriers. He had experimented on the effects of seawater on the seeds of terrestrial plants, and found that many of them could survive for long periods. His discussion on the glacial period accounts for many distribution patterns in terms of changes in the climate. Darwin's delay in publishing resulted in Edward Forbes getting credit for some ideas about glaciation and plant distribution.

It is particularly in Chapter XII that Darwin shows how many facts make sense only in terms of evolution. The fresh water and marine organisms show characteristic patterns of distribution as a result of their mechanisms of dispersal. But the peculiar biotas of oceanic islands provide perhaps the most compelling evidence. Frogs and other amphibians, he points out, have very little capacity for surviving in seawater either as eggs or adults, and they are absent from oceanic islands. And the older islands and island groups are often inhabited by groups of closely related species that occur nowhere else (endemics). Thus, for example, his observations on the Galapagos birds are easily explained. This chapter marks the beginnings of insular biogeography, a topic that was pursued to great effect by Darwin's supporters, especially Joseph Hooker and Alfred Russel Wallace.

In Chapter XIII Darwin argues for his version of evolutionary theory by showing how it makes sense of classification and the data upon which it had been based. His biogeographical arguments depended upon uniting the data of distribution with the existing classification systems, which his predecessors had not interpreted as having evolutionary significance. He proposes that the Linnean hierarchy with its groups within groups is intelligible on the basis of each group being derived from a common ancestor. He explains why characters important in classification are not necessarily the ones that are most important in the life of the organisms, and why larger groups of animals seem to be derived from a common plan. He likewise explains why embryology provides so much valuable evidence for classification at higher levels. In this connection he discusses how natural selection affects the modification of the entire life cycle of the organisms, and in so doing created the approach to evolutionary developmental biology that was taken up by Fritz Müller, Ernst Haeckel and many others. The idea that evolution occurs by a modification of devel-

opmental processes is one of Darwin's most important contributions to biology. More than just a way of reconstructing evolutionary history, it is fundamental to his views on variation. In discussing rudimentary organs such as the teeth in the embryos of whales that are toothless as adults, Darwin argues again that these at last become plainly intelligible as traces of earlier conditions.

In Chapter XIV Darwin briefly recapitulates his main arguments, dismissing the objections and emphasizing the explanatory value of the theory. The attentive reader may note that although natural selection has been explained, the arguments for evolution are the more compelling ones. Darwin suggests that the dead weight of tradition is apt to create much resistance to his views. Then he switches his argument strategy and predicts a major revolution in the life of the intellect. Psychology, he says, will be based on a new foundation. This follows what is perhaps the greatest understatement in the history of English literature: "Light will be thrown on the origin of man and his history." Finally he ends with an eloquent passage implicitly comparing his accomplishment to that of Newton.

The first edition of the *Origin* was published late in 1859 and immediately sold out. The second, which appeared a few weeks later, was not much changed, although some minor errors were corrected. Darwin also added a reference to the Creator. It is uncertain whether he personally considered this particular emendation an improvement. The book of course created an immense uproar. In later editions, Darwin responded to criticisms and incorporated much new material. The details of the emendations are perhaps of minor interest to the readers of this *Guide*, but it seems a good idea to discuss some of the most important changes that Darwin made in later editions. Not the least reason for doing so is that it shows how the book itself evolved.

To the third edition of the *Origin*, finished in early 1861, Darwin added an "Historical Sketch" discussing his predecessors. It was modified in later editions, and the total number of these predecessors was brought up to thirty. Some of them are more than dubious, for example Aristotle and Lorenz Oken, both of whom believed in spontaneous generation. Erasmus Darwin, Lamarck, both Étienne Geoffroy Saint-Hilaire and his son Isidore, Herbert Spencer, and their followers were committed to evolution. Others, as Darwin points out, made statements that were vague or noncommittal. A few, such as Patrick

Matthew, seem to have thought of natural selection, but they neither perceived its significance nor worked out its implications. Darwin says much about Richard Owen, some of whose claims, he believed, were misleading and indeed downright dishonest. It is clear from his publications that Owen straddled the fence about various issues and was not always forthright in his arguments. The "Sketch" was somewhat revised in the fourth and fifth editions. There were quite a number of other changes in the third edition. One of the most interesting is Darwin's response to objections to the use of the term "natural selection." Much understanding had arisen because of his language, he says, but metaphor ought not to be taken literally. He also clarified his views on progress.

The fourth edition of the *Origin*, written in early 1866, was extensively revised. A great deal had happened in the six years that had passed since the first was published. Evolution had become a very popular topic of discussion and not just among the scholarly community. The book had been translated into several languages and was well known all over the world. But most important, Darwin had attracted an enthusiastic following, and one that included many able scientists as well as informants who were happy to provide him with the information he needed. Darwin now incorporated the work of Wallace on geographical distribution and of Bates on mimicry in butterflies. He revised and enlarged the section on embryology in the light of the contributions of Fritz Müller and John Lubbock. And he filled in many details. Darwin was now taking the offensive.

The fifth edition of the *Origin*, finished in early 1869, was the first to use Herbert Spencer's expression "the survival of the fittest." It is also the first to discuss Ernst Haeckel's notions about phylogeny. By this time Darwin had a strong following in Germany. He was also getting help from paleontology, and cites the contributions of Gaudry and of Huxley. The fossil record was becoming less and less of a problem. So far as the scientific community was concerned, the battle for evolution was over. The question was no longer whether evolution has happened, but how and why.

To the sixth (1872) edition, which was the last, Darwin appended a glossary. It was not written by Darwin himself, but by William S. Dallas, and to what extent Darwin approved of it is not quite clear. A more important addition was an entire chapter (Chapter VII) on "miscellaneous objections" to natural selection. Although some of this chapter is revised

from the previous edition, much of it is new. Darwin answers objections that had been raised by several eminent scientists. But most of the chapter is directed against the arguments of St. George Mivart, especially in his book *On the Genesis of Species*. Mivart, an able vertebrate anatomist, was a Roman Catholic convert. He tried to come up with a version of evolutionary biology that to some extent accommodated his own philosophical and religious opinions. Ultimately he was excommunicated. Darwin's strategy was to take Mivart very seriously indeed, portraying him as one who had marshaled every argument against natural selection that he and others had thought of, and with "admirable art and force." He then proceeded to demolish all of Mivart's arguments. Darwin and his followers could now proclaim victory and another edition of the *Origin* would not be needed.

ON ORCHIDS

Darwin's next book, entitled *On the Various Contrivances by which British and Foreign Orchids are Fertilised by Insects, and on the Good Effects of Intercrossing*, was published in 1862. A second, significantly revised, edition, with a slightly different title, appeared in 1877. Since completing the *Origin* Darwin had become increasingly active in research on various aspects of floral biology, the outgrowth of his interests in pollination, fertilization, hybridization and sex, and had begun publishing shorter papers on such topics. *Orchids* was the first of several books on the reproduction and physiology of plants. The book deals with the symbiosis and coadaptation of flowers and the insects that pollinate them. As such it was very important in establishing the science of pollination ecology, for the book inspired a great deal of empirical research. It has considerable relevance from the point of view of scientific methodology, for it provides good examples of how a biologist can ascertain the functions of parts by experimenting and showing how the flowers are minutely adjusted with the effect of transferring pollen from one organism to another. It also suggests how an historical approach to such questions can facilitate investigation. But it has deeper philosophical significance for it addresses the very notion of teleology, or purposefulness, in organic beings that Darwin overthrew. Discussion of that topic has been confused in the philosophical literature, and we need to make some important distinctions. The notion of "teleology" or "purpose" makes sense where something results from the activities of

an agent with intentions, especially conscious ones. Before Darwin it seemed perfectly reasonable to attribute the marvelous adaptations of plants and animals, including ones that we now know do not really exist, to God. Indeed, such adaptations served as the basis for the "argument from design," which was thought to justify our belief in Him. Natural theology, as distinct from revealed theology, was an important part of a clergyman's training when Darwin was preparing for that vocation. He was much impressed by William Paley's exposition of it in his book on natural theology, in which it was argued that if one finds a watch, it implies the existence of a watchmaker. By analogy, one has to draw the same conclusion for animals and plants. As Paley put it, there cannot be contrivance without a contriver. The title of Darwin's book is, in fact, ironic, for he shows how natural selection can produce a marvelous range of adaptations so that no contriver is necessary. Indeed, the contrivances look more like contraptions. Darwin compared his book to the series of works on natural theology called the Bridgewater Treatises (*On the Power, Wisdom and Goodness of God, as Manifested in the Creation*), after the nobleman who endowed them. Of course it had the opposite intent. At the present time it is unfortunate that many authors still use such terms as "contrivance" and "design" when speaking of organic adaptations. In so doing they may have an excuse, insofar as such terms might be used metaphorically. But such language confuses lay persons and using it is intellectually irresponsible unless one really believes that supernatural agency is somehow responsible for the data of biology.

The other philosophical problem has to do with ambiguities in the way that philosophers have used the word "teleology." That term has come down to us from pre-Darwinian times, and has served as a rubric for all kinds of things, including intentional behavior, adaptation, function in the sense of how mechanisms work, and function in the sense of the role a part plays in the life of an organism. It now seems reasonable to speak of the function of a part as the role it currently plays in the life of an organism, and of adaptation as the process of attaining fitness, through natural selection or perhaps other mechanisms. The notion of a function as being what was selected for in the past does not work very well. Organs change their functions quite readily, and organisms are always evolving new ways to put them to work.

In Darwin's day, there was a controversy as to whether anatomists should explain the properties of

organisms in terms of formal or final causes as Aristotelians have called them. One faction, which included the poet Goethe and the German *Naturphilosophen*, maintained that the only thing that matters is purely formal properties of animals and plants, such as their symmetry. The other faction, which is associated with Georges Cuvier and his many followers, maintained that what really matters is the final causes, which Cuvier defined not in terms of purpose but in terms of the conditions of existence. It was a kind of physiological necessity according to which, for example, a carnivorous animal has to have the wherewithal to subdue prey. There is obviously no reason why an anatomist cannot study organisms from both points of view. But the term “teleologist” in this connection, meant somebody who explained anatomy only in terms of “final” causes. It has sometimes been said that Darwin was a “teleologist” on the ground that he studied function as well as form. But in terms of the original controversy he definitely was not, and in view of his own philosophy the discussion is anachronistic. Darwin produced a new approach to anatomy, in which the versions of Platonism of the formalists and Aristotelianism of the finalists were both deprived of scientific legitimacy. Darwin firmly and explicitly rejects the interpretation of homology in terms of ideal types, archetypal patterns and the like, and says that the goal of comparative anatomy is the reconstruction of common ancestors that really existed in the natural world. A remark on rudimentary organs (*Orchids*, ed. II p. 203) is well worth quoting in this connection: “At a period not far distant, naturalists will hear with surprise, perhaps with derision, that grave and learned men formerly maintained that such useless organs were not remnants retained by inheritance, but were specially created and arranged in their proper places like dishes on a table (this is the simile of a distinguished botanist) by an Omnipotent hand ‘to complete the scheme of nature.’” (Incidentally, the botanist was Alphonse de Candolle.)

Darwin changed his views on form and function significantly by the time he did his work on orchids. Although he had included a lot of functional thinking in his barnacle monograph, he went along with the notion that classification is based largely on “trifling” characters as he put it. But in *Orchids* he takes pain to show that what appears to us to be of no physiological significance may be of crucial importance in fertilization. Therefore one must not presuppose that a part has no function, merely because none is obvious.

On the other hand, Darwin was not a Panglossian adaptationist, who, like Leibniz and the philosopher Dr. Pangloss in Voltaire’s *Candide*, believed that this is the best of all possible worlds. Again, the contrivances look more like contraptions. Darwin showed that the properties of orchid flowers are the result of a long, historically contingent process. What has happened has depended upon the nature of the ancestors and the accidents of history. Organs have changed their functions, while often retaining vestiges of their former ones. Studying organisms from that point of view was a great novelty in Darwin’s approach to anatomy and physiology. It led to his follower Anton Dohrn proposing the principle of the succession of functions (*Funktionswechsel*) as an investigative tool.

Aside from such philosophical background, *Orchids* is a straight-forward description of the flowers and the means by which pollen is transferred from one of them to another of the same species. Darwin discusses his predecessors, including Christian Conrad Sprengel, whose book *Das Entdeckte Geheimniss der Natur im Bau und in der Befruchtung der Blumen* (*The Mystery of Nature Revealed in the Structure and Fertilization of Flowers*) he felt had received insufficient recognition. Evidently the book was called to his attention by the botanist Robert Brown soon after Darwin’s return from the *Beagle* voyage. The first edition of *Orchids* created an immense amount of interest, especially among botanists, and gave rise to a vast literature devoted to the biology of pollination. Those who helped to develop that branch of knowledge included a disproportionate number of those scientists who were exceptions to the rule that Darwin’s contemporaries accepted evolution but not natural selection. These included Fritz Müller and his brother Hermann, as well as Joseph Hooker and Asa Gray. The burgeoning literature led Darwin to publish a supplementary review in 1869, and a second edition in 1872. This edition provided much additional descriptive material and corrected some of Darwin’s earlier interpretations. However, the basic treatment of the subject remained the same. Because it suggests how Darwin’s ideas developed, perhaps the second edition is the best choice for most readers.

FERTILIZATION IN PLANTS AND RELATED TOPICS

Although the next of Darwin’s books to be pub-

lished (in 1868) was *The Variation of Animals and Plants under Domestication*, it seems best to follow a conceptual order rather than a chronological one, and discuss two of his botanical works that, like *Orchids*, have to do with fertilization and related topics. These appeared at about the same time (November 10, 1876 and July 9, 1877) and again, for conceptual reasons it seems best to reverse the chronological order. This sequence is further justified because Darwin's book *The Different Forms of Flowers on Plants of the Same Species* (1877) was preceded by quite a number of shorter publications on the same range of topics, and the book reiterates much of that already-published material. *The Effects of Cross and Self Fertilisation in the Vegetable Kingdom* (1876) presents the results of an experimental investigation carried out over a period of about eleven years.

The Different Forms of Flowers on Plants of the Same Species was first published in 1877. A second edition appeared in 1880. Whereas *Orchids* emphasizes adaptations that facilitate getting pollen from one flower to another, *Flowers* is mainly about adaptations that favor outcrossing. Darwin's work on barnacles, which are hermaphroditic animals, led him to the conclusion that self-fertilization is deleterious and that hermaphrodites at least occasionally cross with other animals of the same species. For some reason outbreeding is advantageous. He compared some of the sexual arrangements in barnacles to those of plants. When he began to study plants he realized that outbreeding is even more important than he had realized. Before we go on, however, we need to explain some of the technical terminology. In zoology, an hermaphrodite is an animal that has the reproductive organs of both the male and the female sex in a single organism. Sometimes male and female organs are functional and present at the same time, in which case the animal is said to be a simultaneous hermaphrodite. If it changes sex, it is a sequential hermaphrodite. If male first, then female, it is a protandrous hermaphrodite; if female first, then male, it is a protogynous hermaphrodite. An animal with separate sexes, like ourselves, is a gonochorist. Some animals, such as oysters, switch back and forth, and are called alternating hermaphrodites. But sex life gets much more complicated in colonial animals and plants, where each zooid or flower may have one sex or two, and so too may the entire animal colony or flowering plant. The picturesque and metaphorical nomenclature, which, as Darwin remarks, goes back to Linnaeus, is based on treating the plant as a house and the flowers

as beds. A monoecious plant is one that is both male and female, but the flowers are either male or female; the male and female parts live in the same house but occupy different beds. A dioecious plant is one in which all the flowers of a given plant are either male or female; the male and female parts occupy separate beds in different houses. An hermaphroditic plant is one in which all the flowers are both male and female; the male organs occupy the same beds with the female ones, and they all live in the same house. Things can get very complicated, because, for example, a species can consist of hermaphrodite plants together with some that have only male flowers in which case it is androdioecious (males in different houses).

This terminology reflects the complexity of nature. But Darwin found that reproductive biology in plants is even more complicated than that. Whether or not an hermaphrodite is able to self-fertilize, a separate-sexed animal or flower is unable to fertilize itself. Darwin discovered that in certain plants each flower has both male and female parts (anthers and pistils) but these parts are so arranged that crossing can only take place with flowers that have a different anatomy, so that there is something analogous to two sexes among the hermaphrodites. The plants are dimorphic. Then he found that there may be three different anatomical arrangements, such that we have something like three sexes in the same hermaphroditic species (trimorphic plants).

The arrangement was such that it favored a flower of each of the two or three morphs fertilizing a plant of a different morph. However, by accident or by experimental design, pollen could be transferred to a plant of the same morph. The former Darwin called "legitimate" crosses, the latter "illegitimate" ones. He undertook a long series of experiments in which he produced illegitimate crosses by transferring pollen to the adaptively inappropriate place. The goal was to find out to what extent an illegitimate cross might have an adverse effect, such as fewer or smaller seeds or offspring that were small in size or of low fertility. He showed that the illegitimate crosses were much like those between different species, sometimes producing no offspring at all. Darwin did not believe however that such sterility was an adaptation. Rather, he considered it an incidental consequence of the arrangement that furthered crossing. He was unable to conceive of a way in which selection could favor sterility as such, for it would lead to a reduced number of offspring.

Another case of floral dimorphism that interested Darwin was cleistogamic flowers. The Greek roots from which this term was coined literally mean "closed marriage." The flowers do not open up and admit pollen or pollinators, but fertilize themselves, and seem to be specially adapted to reproducing in this manner. However, they occasionally open up, and therefore some outcrossing does take place. Darwin took this as another example of the fact that on occasion, at least, hermaphrodites cross with conspecific organisms. It confirmed the "Knight-Darwin Law" according to which "Nature abhors perpetual self-fertilization."

The Effects of Cross and Self Fertilisation in the Vegetable Kingdom was published in November of 1876. Although it was reprinted several times, the book never appeared as a second edition. As he explains in the introduction, Darwin began his experiments on inbreeding as a result of work carried out for another purpose. He was surprised to observe that the offspring of self-fertilized plants of *Linaria vulgaris* were smaller and less vigorous than those that resulted from outcrossed ones. He then compared self-fertilized and cross-fertilized carnations (*Dianthus caryophyllus*) and other plants and got the same result. Therefore he carried out experiments over a period of eleven years, in which he compared the results of cross-fertilization and self-fertilization in a wide variety of plants (fifty-seven species, in fifty-two genera and thirty families). The experiments clearly showed that the products of cross-fertilization were larger and more vigorous than those of self-fertilization. Further experiments showed that the outcrossed plants were competitively superior. They also tended to live longer, and were more fertile.

In Chapter X, Darwin considers how plants are structurally and physiologically adapted so as to further cross-fertilization. Often this involves interaction with insects or birds, and Darwin shows how much of floral anatomy is explicable in terms of attracting such pollinators. The flowers also have many adaptations that ensure their being fertilized by pollen from a different plant. These include dioecy (male and female flowers on different plants) and dichogamy (sequential hermaphroditism, either protandry with the male flowers functioning first or protogyny with the female flowers functioning first). And then there is prepotency, which means that a flower is disposed to be fertilized by pollen from another plant and perhaps self-fertilizes only as a last resort. Plants that have switched to pollination by wind have flowers

that are quite different from those which are pollinated by insects. In general then, comparative biology points in the same direction that the experiments do.

Strengthening the comparative treatment, Darwin devotes Chapter XI to the biology of the insects that serve as pollinators. This chapter might be read as if it were a separate essay by those who are not inclined to read the whole book. A particularly interesting topic from an evolutionary point of view is the "flower constancy" of bees. When a bee starts foraging she tends to continue visiting flowers of the same species. This habit benefits the plants, for pollen from another species would be of no use to them. Yet Darwin emphasizes the point that this benefit to the plants is not the reason for the bees having flower constancy. Darwin explains the phenomenon in terms of the principle of the division of labor. Although not mentioning Adam Smith, who explained such matters in *The Wealth of Nations*, Darwin suggests that the bees, like humans, save time by not switching from one task to another. Another topic discussed in this chapter is the bees obtaining nectar by chewing holes in the flowers. The result is that the flowers are not pollinated, in spite of having presented the bees with a reward for their services.

Given what was later learned about genetics, we now understand why it is advantageous to plants and other organisms to avoid self-fertilization and other causes of inbreeding. Among other things, inbreeding leads to the expression of deleterious recessive genes. Darwin of course had no knowledge of genetics. Nonetheless he was able to come up with a close approximation by observing the effects of cross and self-fertilization. One of his major conclusions is that self-fertilization is advantageous insofar as it maximizes the number of offspring produced. Another is that cross-fertilization is advantageous because it brings together parents that have become different as a result of having lived under different conditions or varied spontaneously. And finally, "the injury from self-fertilisation follows from the want of such differentiation in the sexual elements." Darwin's thinking was affected by his belief in the direct action of the environment in producing evolutionary change. He thought that breeders of domesticated animals and plants could obtain the benefits of outbreeding by keeping their stock in different localities. His remarks on the effects of inbreeding in human beings are particularly interesting, given that he and his wife were first cousins. He thought that people having different habits of life would tend to offset the effects of mar-

rying close relatives. The shortcomings of Darwin's treatment of hermaphroditism also are apparent from hindsight. He thought that hermaphroditism exists because it allows self-fertilization, and gonochorism because it prevents it. And yet, as he points out, other arrangements would do the job better. Twentieth century researchers developed an elaborate body of economic theory that predicts the conditions under which the sexes are separate or combined, and when it is advantageous to switch from one sex to the other.

As a parting shot, Darwin discusses fertility and sterility in relation to species concepts. He maintains that there is no essential difference between species and varieties. Crossing two organisms and finding that they produce no offspring or ones that are sterile had been used as evidence that they are of different species. But Darwin was very critical of that criterion. His work on dimorphic and trimorphic plants showed that the same kind of block to reproduction occurs within species. And whether a cross between two species or morphs is fertile may depend upon which species or morph produces the pollen. In modern biology reproductive barriers are understood to keep species separate. But it is not a simple matter of whether various organisms can or cannot cross. Rather, the species are reproductively isolated. So Darwin's insights here remain valuable, even though the modern view is that species differ qualitatively, not just quantitatively, from varieties.

VARIATION OF ANIMALS AND PLANTS UNDER DOMESTICATION

The Variation of Animals and Plants under Domestication was first published on January 30, 1868. A second printing, with some changes was published in February. A second edition, substantially revised in some places, appeared in 1875. In the *Origin* Darwin had used the analogy between artificial selection and natural selection to lend plausibility to his theory and to make it easier to understand. This theme is still present in the *Variation* and Darwin develops it in considerable detail. Likewise, variability is a necessary condition for selection, whether artificial or natural, to effect change. In his introduction Darwin states that he intended to produce a book on variability in a state of nature. That plan never materialized. The *Variation* was partly made up of chapters that Darwin had written of his long book entitled *Natural Selection* that was in progress when Wallace's more or less independent discovery forced

a change in plans. At the time when the introduction to the first edition of the *Variation* was written, Darwin had not yet abandoned his plan to write a series of books expanding upon the *Origin*. In the introduction to the second edition, Darwin says he still hopes to write a book on variation in nature, but he quietly dropped the plan for later volumes in the series. This analysis is based on the first edition but in passing discusses some interesting changes that were made in the second. Which edition one chooses will probably make little difference for most readers. The book is over nine hundred pages long, and often quite tedious.

Darwin's interest in variation was much deeper than the need to document its existence. Rather, he sought to understand variation as a process, to explain its mechanisms, and to get at its underlying causes. These causes were basically embryological ones and his approach owed a great deal to the work of Étienne Geoffroy Saint-Hilaire and his son Isidore Geoffroy Saint-Hilaire on developmental abnormalities (teratology). The idea was that normal and abnormal development are variations on the same theme and obey the same laws. A survey of the diversity that had arisen through selection of animals and plants would show how structure has been modified by changes in the underlying developmental processes. It also offered to reveal what causes such changes to occur in the first place and cast some light on such topics as inheritance. Although Darwin's efforts to come up with a mechanism for inheritance were not very successful, he did remarkably well at dealing with later stages in the chain of causality. To the extent that we can compare Darwin's work with modern genetics, we can say that he made a splendid contribution to developmental genetics but was largely stumped by transmission genetics. At the end of the book Darwin proposes a theory called "pangenesis" that accounts, among other things, for the inheritance of acquired characters. Because that phenomenon turns out not to exist and the theory that he proposed turned out to be far from the mark, the book has largely been neglected and often its merits have been overlooked.

The introduction provides a brief summary of Darwin's main ideas about evolution, including his philosophical position with respect to scientific method. Most of the first volume consists of a survey of selected groups of domesticated animals and plants. It is full of Darwin's original observations and material supplied by his many informants as well as citations of the scholarly and popular literature. From

the fact that he passes systematically from one group of organisms to another, one might get the impression that Darwin is simply cataloguing observations that relate to his theory. A careful reading, however, shows that he introduces new topics as he proceeds from one group to another. Some groups are more appropriate than others for addressing a particular problem and Darwin structures his exposition accordingly.

Chapter I deals with domestic dogs and cats. Dogs are the first animals to have been domesticated and they have a wide variety of breeds. They therefore provide excellent materials for discussing such problems as whether the various breeds have been separately derived from different wild ancestry. He notes that, like many other domesticated breeds, the "turnspit" dog owes its characteristic short legs to a kind of mutation, or monstrosity, which is widespread among domesticated animals and even occurs in man. And he finds much evidence that selective breeding has brought about significant changes. Cats have long existed as domesticated animals, but they tend to breed freely unless kept in strict confinement and there are as one would expect fewer breeds of them locally and they have been less modified. Horses and asses, treated in Chapter II, have also long been domesticated and they have been subjected to intensive artificial selection. They provide excellent examples of breeds having been selected for a variety of purposes. Darwin uses them to illustrate some of his notions about variation including the idea that striped horses are atavisms, or cases of reversion to an ancestral condition.

Chapter III passes on to the Artiodactyla and deals with pigs, cattle, sheep and goats. Darwin concludes that pigs, like dogs, have descended from several non-domesticated forebears. He discusses the remarkable ways in which the skeleton has been modified and relates those changes to embryology via teratology under the rubric of "semi-monstrous breeds." Cattle are highly diverse. In this section Darwin discusses the niata cattle, which he compares to bull dogs and pugs. He had seen these semi-monstrous animals in South America and discussed them in his *Journal*. The difficulty they have feeding explains what keeps wild animals from having such anatomy. Sheep, he thinks, provide good examples of what he calls the direct influence of the environment, especially in response to hot climates. He argues however that intense selection counteracts such changes. He relates how short-legged breeds had been formed by breeding from mutant individuals. Goats he uses as

examples of a group with a remarkable variety of domesticated breeds.

Chapter IV is on rabbits, another group that has long existed in domestication and has produced a large number of breeds. Darwin did much original research on these animals, in addition to gathering material from breeders and other informants. He studied them alive and he also examined specimens and made anatomical preparations of their skeletons. He found that the proportions of the various parts of the body have changed under domestication. He attributes such changes as reduced size of the brain to disuse of the organs. This is one of the "Lamarckian" mechanisms that he believed in, and he invokes it here even though relaxed selection pressure would also have explained the facts.

Darwin devotes two entire chapters—V and VI—to pigeons. These 93 pages provide much more detail than do the eight and one-half in the *Origin*. In that work he emphasizes the point that although the various breeds are all descended from the rock-pigeon, breeders were convinced that they came from separate species of wild ones. In the *Variation* he explains that he chose pigeons as study animals partly because the evidence for the monophyletic origin of the group is clear and unequivocal, partly because the literature allows one to trace the history of the various breeds, and finally because the group is highly variable. Darwin begins by describing the various groups, using a diagram that crudely approximates a phylogenetic tree but also attempts to show how much the various races, subraces and breeds have been modified. He repeatedly makes the point that had these birds been taken from the wild, they would be ranked much higher: as distinct species and genera. He then proceeds to discuss variability within the breeds, something that argues for the possibility of continued modification by selection. Supporting that view is that the characters most valued by breeders are highly variable. The extreme variants seem also to be male individuals.

As with rabbits, Darwin devotes considerable attention to the characteristics of the skeleton. Because the differences in the skeletons are of no interest *per se* to the breeder, who selects only on the basis of external appearances, one should expect little divergence, but it nonetheless occurs. Darwin takes this opportunity to discuss his principle of the correlation of growth, a phenomenon that would be called a kind of pleiotropy by modern geneticists. The point is that variations are causally linked, so that when one

selects for one character others increase in frequency as well. He gives many examples. Then he discusses the effects of disuse, explaining the reduction in size of various parts. Again he might have tried to explain this in terms of natural selection, but fails to do so.

Chapter VI attempts to reconstruct the evolutionary history of domesticated pigeons. Darwin argues that the rock-pigeon is the only known candidate having the properties such as sociability that would make it a plausible ancestor. Then he gives six different arguments against the alternative hypothesis that the different races might each be descended from different stocks. Next he discusses what was known about pigeons from the historical record, going back to the ancient Egyptians. And finally he speculates how the breeds might have evolved through a combination of artificial selection and other mechanisms. His scenario invokes change in the conditions of life inducing greater variability, a mechanism that he discusses later in the book. His main mechanism, however, is artificial selection, and he explains how this would have worked.

Chapter VII is on fowls. Again, Darwin includes a large amount of his own observations, experiments and measurements on the animals in this chapter. He also drew heavily upon the expertise of informants. Fowls were good materials for various topics that interested him. They had been bred as game-cocks and the results were of interest in relation to changes in the time of life at which various characters appear and how they relate to the properties of the two sexes. Darwin's discussion on how the game-cock chicks fight at an early age provides an example of how selection can have deleterious consequences. It is also a very insightful exercise in developmental behavioral genetics. And the various breeds show different patterns in the expression of sexually dimorphic characters. Darwin recounts how he studied the skeletons and skulls of many breeds of fowl, following up his discussion on the birds' external characters. The breeders would have selected for external characters and the internal ones would be modified as a result of correlated effects on development. Chapter VIII completes the survey of the animals: miscellaneous birds, gold-fish, hive-bees and silk-moths.

Chapter IX through XI are on plants, which have a very different anatomy than animals, so different structures have been subjected to selection. Naturally the parts used for food are shown to be the most variable and the most modified. Darwin takes the opportunity to rebut the notion that important organs are not

variable. As he says in the *Origin*, those who make that claim argue in a vicious circle — they decide which organs are important for classification by screening out the ones that vary. In the same vein he notes that some of the flowers characteristic of varieties would have led botanists to rank them as genera or even orders. He notes that flowers have been selected mainly for their beauty, something that has little scientific interest. What is interesting is that monstrous forms of the flowers have been selected, ones in which the stamens are converted into petals and so-forth. Again, modification in structure has resulted from developmental changes. Chapter XI is mainly on bud variation, or changes that appear in the somatic tissues of the plant rather than the germ. Darwin also considers how grafting might produce a kind of hybridization and how the pollen supposedly affects the somatic tissues of female plants. These phenomena were of considerable theoretical interest to him, but they led him astray because they seemed to indicate that external influences produce variation.

Passing now to Volume II, Chapters XII to XIV are about inheritance. The study of domesticated organisms provided Darwin with valuable materials on this topic for many reasons, not the least of which was that breeders often kept extensive pedigrees. Inheritance or heredity posed serious problems for Darwin, and it was not just because so little was known about it. Indeed, many of the challenges he faced resulted from outright misconceptions about heredity rather than just ignorance. Much of what we now know to be error was widely accepted as fact, with a substantial amount of what looked like perfectly good scientific evidence in its favor. The "Lamarckian" notions of use and disuse, the inheritance of acquired characteristics, and the direct action of the environment were generally taken for granted by scientists and lay persons alike, and Darwin was no exception. Darwin was among the skeptics with respect to particular cases, but it was only toward the end of Darwin's lifetime that August Weismann began to challenge such notions. Darwin wrote a preface to an English translation of one of Weismann's early books. Darwin thought of heredity as a conservative influence—something that keeps populations from changing unless something forces them to change. That implied that the breed or species would inevitably tend to return to the ancestral state. We now know that in the absence of selection, mutations will accumulate, making evolution, in this case a kind of degeneration, inevitable.

Another conceptual problem for Darwin was the notion of blending inheritance. If one takes a bucket of white paint and mixes it with a bucket of red paint, one gets two buckets of pink paint. Something similar seems to occur when different organisms are crossed. The result of crossing plants with white flowers with plants with red flowers may be plants with pink flowers. The offspring display a blend of the parents' characteristics. Everybody who knows some elementary genetics can analyze such a cross and suggest that a pair of homozygotic parents produced heterozygotic offspring with less red pigment. But Darwin did not know about such goings on, and that was the problem he had to deal with. What he needed was a particulate theory of inheritance and a clear distinction between genotype and phenotype. Under blending inheritance, any new variant that is selected will get washed out by crosses with the original type. This point was drawn to Darwin's attention by a Scottish engineer, Fleeming Jenkin, and Darwin responded by making important changes in later editions of the *Origin*. Darwin suggested various ways in which the number of variant individuals might be increased, thereby offsetting the tendency to revert to the original state. But he also realized that not all characters blend. In the early chapters of the *Variation* he makes this point and tries to come up with a more sophisticated treatment of inheritance. Given the complexity of the subject it is remarkable how well he did.

In Chapter XII Darwin introduces the problems of inheritance, relying heavily upon the experience of breeders and medical men. The evidence consisted largely of pedigree data and efforts to modify domesticated animals and plants. He considers the possibility that amputation of a part in a parent might be passed on to the offspring. Although he notes that such amputations have been done for many generations without clear effect, he gives anecdotal evidence that accidental injury sometimes seems to produce similar changes in the offspring. Darwin believed that changes in the environment have a direct effect on the properties of the organism, changing them in an adaptive direction in some cases and in others causing them to vary. The whole of Chapter XIII is devoted to reversions or atavisms. He had already mentioned that children often resemble their grandparents or even more remote ancestors. Darwin again was in no position to discuss this topic in terms of recessive genes going unexpressed, but he did have some idea of the traits being unexpressed, or as he put it "latent." In the case of sex-limited inheritance, he had a

straight forward example of such latency. A son might inherit traits that are only present in males from his grandfather via his mother. He suggests situations in which such atavisms might be produced. In the first situation a character somehow gets effaced through variation and then reappears. He gives examples of domesticated organisms in which the ancestral part reappears, sometimes in vestigial condition, at very low frequencies. In a second, he suggests that crossing two different, modified breeds might lead to the sudden reappearance of the ancestral trait. He backs up his notion of characters remaining latent by experimental evidence showing that secondary sexual characters can appear in the opposite sex. And finally he observes how monstrosities, viewed as developmental abnormalities, can often be treated as atavisms. Chapter XIV deals with prepotency, sex-limited inheritance and developmental timing. Prepotency means a relatively strong tendency to affect the character of later generations. As a property of traits, it might reasonably be compared to dominance. However, Darwin also treated it as a property of entire organisms. He noted that when individuals of two different breeds or species are crossed, the offspring may tend to resemble one parent much more than the other. The notion of prepotency relates to that of sex-linked and sex-limited inheritance. Parents may transmit characters only to offspring of their own sex or only to those of the opposite sex. Enough was known about color blindness and haemophilia at the time to recognize such patterns, but not enough to understand what was going on at a cellular or molecular level. Variation occurs at a particular time in the life cycle of the organism, and is the result of a change in developmental processes. The time at which such a change occurs is generally the same in the offspring as it is in the parent. Referring back to the *Origin*, Darwin reiterates the point that variation that occurs later in life has no effect on earlier stages of development. Having used that principle to explain why the younger developmental stages of distantly related organisms are more similar to each other than are the adults, he now applies it to various characteristics of domesticated organisms, and to human inherited diseases.

The next five chapters, XV through XIX, deal with crossing. One might conjecture that crossing between two different groups of organisms would tend to produce a kind of mixture. Given what we know about chromosomes the notion of a "mixture" is not very appropriate, for the hereditary material is

highly organized, in a way that limits the kind of crosses that give rise to viable and fertile offspring. Darwin could only study the effects of crossing between more and less closely related animals and plants and speculate as to what goes on physiologically. Nonetheless he realized that if two breeds of domesticated animals or plants are allowed freely to cross, the result will tend to obliterate the differences between them. So breeders had to keep them segregated. Darwin expands somewhat on what he said in the *Origin* about all organisms, including hermaphrodites, at least occasionally crossing. That implies that whatever its role may be, crossing must be important. He notes that some characters do not blend. In Chapter XVI Darwin considers what tends to prevent free intercrossing among domesticated breeds or "varieties" as he often calls them. They tend, he says, to cross or mate within their own breed. On the other hand domestication tends to reduce the sterility that is characteristic of species, and it may also lead to increased fertility.

Chapter XVII makes the point that outbreeding (crossing) is beneficial, whereas inbreeding has deleterious effects. He provides clear evidence for both of these phenomena. Darwin interpolates a brief discussion on the possible effects of inbreeding in man. He says that he is "unwilling to enter on this subject, as it is surrounded by natural prejudices." He does not mention that he was married to his first cousin and was much concerned about the possible consequences for his own children. But he does consider the literature and discusses the possibility of instinctive avoidance of inbreeding. Chapters XVIII and XIX explain why crossing with unrelated organisms is not necessarily beneficial. Darwin reasoned that organisms would be modified by any change in the conditions of existence. In some cases that produces sterility. On the other hand it causes divergence. The sterility of hybrids results from differences in the reproductive system. Incipient species living under different conditions would tend to diverge in their reproductive systems and gradually become incapable of producing offspring. Darwin reasoned that this divergence was not the result of selection for sterility *per se*, for sterility would not be advantageous to its possessor. Rather, he thought, the sterility arises as an incidental byproduct of some other change. Such a result of selection for some other trait would be what we now call pleiotropy and Darwin called correlated variability. However, Darwin also included the direct action of the environment, the effects of which, as we now

see it, would not be inherited.

Chapters XX and XXI are on selection, the former being on artificial selection, the latter on natural selection among domesticated organisms. Chapter XX, therefore, is concerned with how human beings function as selective agents. Darwin subdivides artificial selection into methodical on the one hand and unconscious on the other. Methodical selection is purposeful: the breeder intends to get a particular result. Unconscious selection has nothing to do with the notion of an unconscious mind, but simply means unintentional. Methodical selection is a specialized technology and is very effective in producing improved breeds of animals or ones that appeal to the tastes of pigeon-fanciers and dog-lovers. Although associated with the industrial revolution, such practice goes back to antiquity. Unconscious selection goes back even earlier and is practiced by primitives. In either case, Darwin argues, the parts that are "most valued by man" are the ones that have changed the most. This is evidence that man has in fact been the selective agent. At the end of this chapter he rebuts a notion that has long been popular with anti-evolutionists — that it is hard to imagine how complex changes involving the body as a coordinated whole could have come about. Darwin responds that change has been slow and gradual. He gives examples from domesticated animals showing how that actually has happened. Chapter XXI then turns to natural selection as it affects domesticated animals and plants. One of the main points is that artificial selection is often opposed by natural selection, sometimes frustrating the efforts of the breeder. Darwin closes with a philosophical discussion on the different roles of variation on the one hand and selection on the other. He compares variation to what happens when pieces of rock break off from a precipice, and selection to a builder choosing among such pieces and creating a building made up of them. As he sees it, variation is strictly a law-like process. But what really counts is selection, the analogue of what the builder does. This analogy is invoked again at the end of the book.

Chapters XXII and XXIII deal with the causes and kinds of variability. Darwin's basic position is that groups of organisms become variable when they are exposed to new conditions of life. The mechanisms of such modification remained a mystery to him. Something was acting upon the organisms, and he thought that it could be on the gametes, the embryos, the young or the adults. We now know this to be true, but given an inability to distinguish effects

upon the germ from effects upon the soma (or genotype from phenotype) crucial pieces of the puzzle were missing and remained so until the rise of modern genetics. Chapter XXIII considers what Darwin calls the “direct and definite” effects of external conditions. He alludes to the notions of Étienne Geoffroy Saint-Hilaire and his followers about direct action of the environment producing hereditary changes (Geoffroyism), which are often confused with those of Lamarck. Here the idea is that mere variation, without selection, would suffice to produce a new breed or species. Geoffroyism, like the mutationism that flourished early in the twentieth century, ascribed evolutionary change to what Darwin called the primary causes of structure. Darwin freely admits that changes in a particular direction may be evoked by change in the environment. However, he concludes that for the most part the organisms simply become more variable.

The next three chapters, XXIV through XXVI, are about the laws of variation. Darwin believed that everything that ever happens in the universe occurs in strict conformity with the laws of nature. Therefore it would be grossly misleading to say that he attributed evolution to chance, or that the variations that are necessary for selection to take place cannot be explained in terms of laws like those of physics and chemistry. Those laws predict which variations will occur, but they do not tell us what the evolutionary outcome will be, for that depends upon historically contingent conditions such as the selection pressures that happen to be active in the environment in which the organisms occur. The process of selection also has its own laws of nature, and these too must be supplied if the history of life is to be properly explained. Many people have maintained that the “real” explanation for evolution is laws of nature and that those laws of nature are laws of embryological development. However, the laws in question do not predict evolution, but only set certain limits to what changes are possible. Such efforts to replace natural selection with embryology have failed. Ironically, Darwin showed remarkably well how such laws and constraints can be accommodated within his theory. Darwin conceived of evolution as a process in which there is a succession of modified ontogenies or “comings-into-being” of organisms.

Chapter XXIV begins with a discussion of the *nisus formativus*. This was an old-fashioned, vitalistic notion that supposedly explained how regeneration occurs. Darwin restricts it to mean that the developing

organism is organized into a coordinated whole. He then considers the evolutionary effects of use and disuse of parts and the acclimatization of domesticated animals and plants to new environments. Developmental abnormalities were often attributed to the arrest of development: a part fails to go beyond the early stages of development. The same kind of change would explain the occurrence of “rudimentary” structures such as the remnant of a tail in human beings. Parts that no longer function would get reduced in size. Darwin does not provide a clear answer to the question of to what extent such reduction is the result of use and disuse on the one hand and natural selection on the other. Chapter XXV continues the search for laws of variation by expanding upon Darwin’s ideas about correlated growth and correlated variability. A change in one part of the body is often accompanied by a change in another part. Darwin shows how some of these correlations have a causal basis in the mechanisms of development and in physiological interdependency. His experience with pigeons was a great help here. The increase in number of tail-feathers in one breed led to a tail with larger and more numerous vertebrae. Chapter XXVI adds further patterns of variation that make sense in terms of embryology as then understood. These include what Darwin calls “analogous variation,” in which the same kind of variation occurs in separate species or breeds. He thought that some kind of developmental potential gets realized independently in distinct populations.

Chapter XXVII presents Darwin’s “provisional hypothesis of pangenesis.” The word “provisional” may seem superfluous, for all scientific hypotheses are supposed to be open to future refutation and modification. It serves, however, to underscore its speculative and character, which Darwin freely admitted. The Greek roots of “pangenesis” indicate that the entire organism generates, or gives rise to, the next generation. Although pangenesis had much to do with heredity, Darwin himself considered it a theory of generation. This older term included embryological development and regeneration as well as inheritance. In the second edition Darwin added a long footnote in which he points out that the hypothesis had been widely criticized, though it had found a few supporters. The critics whom he takes seriously are Federico Delpino and G. H. Lewes, both of whose criticisms he considers both fair and useful, and Francis Galton, who had performed some experiments with negative results. Some of the others, such as Mivart, Bastian

and Wigand were quite hostile, but it was not just pangenesis to which they were opposed. Part I of this chapter summarizes the phenomena that the hypothesis was designed to explain. These include: budding, regeneration, metamorphosis, graft hybridization, inherited effects of use and disuse, variability, reversion and latency.

Part II explains the hypothesis. The cells of the body give rise to minute particles, called gemmules, which circulate throughout the body, multiply and ultimately may develop into cells like those from which they derive. They may, however, be transmitted in the latent state and develop into cells in some later generation. They may combine with other gemmules and with partially developed cells. And they have an "affinity" for one another such that they aggregate into buds or into the gonads. In a footnote, Darwin notes some of his predecessors, whose views were, however, not entirely like his own. These include Buffon, Bonnet, and Richard Owen. One other writer, Herbert Spencer, in his *Principles of Biology*, had suggested something vaguely similar, and Darwin quotes it at length. After it was published Spencer wrote Darwin a letter, explaining that in his own theory the "physiological units" within a single organism are homogeneous (all alike), whereas Darwin's gemmules are heterogeneous. In the second edition Darwin revises the footnote. Owen had claimed that Darwin's hypothesis was no different from his own. In the light of the documents and from the perspective of what we know in the 21st century Owen's reaction can be viewed with much irony. In the first place, his theory was very different from Darwin's, which we now know not to be correct. In the second place, Owen's theory was rather like Weismann's, which ultimately prevailed!

The gemmules, Darwin explains, are diffused throughout the body, and therefore they can come together and produce a whole organism in a bud, replace a limb that has been lost, or regenerate the missing portion of an animal that has been cut in half. The gemmules have an "elective affinity" for certain kinds of cells and that helps to explain how they control development. The term "elective affinity" was an old-fashioned chemical term. Darwin even explains what we now call heterotopic development, such as an arthropod's antenna developing where one would expect to find an eye. To us moderns this looks very much like what is now called evo-devo, but with a different mechanism. The capacity of the gemmules to remain latent explains the reappearance of ances-

tral traits, and their transmission from a parent to an offspring of the opposite sex. The problem of blending inheritance is eliminated because the gemmules do not blend. Darwin had come up with a particulate theory of inheritance, and one that explained much more than just the inheritance of acquired characters.

Chapter XXVIII provides a general overview of variation as discussed in the earlier parts of the book. It ends with a philosophical discussion aimed at those who would maintain that variation, rather than selection, is the real cause of evolution. Referring back to Chapter XXI, he reiterates his analogy of blocks of stone falling from a precipice. Strictly speaking, he says, the shape of the blocks is not accidental, for everything occurs according to laws of nature. An architect might create a building by selecting stones from the bottom of the precipice and fitting them together. One would not, however, say that the properties of the building are not explained unless one can explain the shape of the stones of which it was built. Having exposed the fallacy of what has been called "structuralism" Darwin discusses Asa Gray's notion of what John Dewey called "design on the installment plan." God, so to speak, has ordained the pattern of variation and thereby affected the overall pattern of evolution. But God would have ordained all sorts of other things, like the variations that have produced grotesque ornamental poultry. Darwin's is a *reductio ad absurdum* argument.

ON THE DESCENT OF MAN

The Descent of Man, and Selection in Relation to Sex first appeared in 1871. A second edition, somewhat revised, was published in 1874. It is not easy to decide which edition to recommend to the reader. The first edition is the one that had the greatest impact on contemporary readers, but the second edition includes some replies to critics. Here we follow the first edition. In the *Origin* Darwin only alluded to human evolution in a single sentence. That sufficed, and human origins were a major consideration in the controversies that immediately followed. By the time that the *Descent* was published, the scientific community as a whole no longer seriously contested the fact of evolution, though the mechanisms were still controversial and long remained so. In the *Descent* Darwin treats human evolution from the point of view of both genealogy and mechanisms. He documents the relationships of our species to other animals, emphasizing the transitions, especially in those features that might be considered uniquely human. He also provides an

expanded treatment of his ideas about evolutionary mechanisms, especially sexual selection. Another important theme is the relationship between evolution and ethics.

In the first chapter Darwin briefly reviews the anatomical features that indicate our descent from other primates. The detailed agreement in structure is straight forward comparative anatomy, and Darwin adds some physiological features as well. He also compares the manner of embryological development, showing the sort of common features that indicate common origin. His discussion of rudimentary organs is particularly detailed, showing many features that are evidently useless in human beings but are fully functional in other animals. Evolution provides a straight-forward explanation for these parts.

Darwin then extends the comparison to mental powers. He argues that the mental differences between human beings and other animals are, albeit real, not fundamental ones. Darwin obviously overestimated the differences between primitive and civilized persons. Likewise he tended to overestimate the intellectual prowess of other animals. On the other hand he provides much evidence that they have emotions and feelings, much like our own, and that they possess a capacity for reasoning as well. He discusses the use of tools and the beginnings of communication. The presence of articulate speech in human beings then as now was taken by many persons to indicate some kind of unbridgeable gap between our species and other ones, but Darwin counters that such a transition is not impossible. He turns up the heat, going on to trace the origin of religion to precursors in other species.

Darwin then breaks even more radically with tradition by treating morality from a strictly naturalistic point of view. He was familiar with the ethical writings of philosophers, including the economist Adam Smith, on such topics as the conscience and the moral sense. Darwin treated human morality as a more refined development of phenomena that could be observed in other social animals. But it was a major challenge to his ingenuity to show how such behavior could evolve through natural selection, which, on the face of it at least, seems to depend upon self-interest of the most unenlightened sort. Darwin's solutions to such problems include essentially all of those that have been proposed by subsequent authors. These include reciprocity and concern for the welfare of relatives. He points out that the social virtues originally had only to do with relationships within the group.

Their refinement and extension would come later.

In the next two chapters Darwin works out the details of how this might have taken place. In the second edition he changes the order, so that the physical and the moral are treated together. Chapter IV (II in the second edition) applies the theory of natural selection to the human species, beginning with a discussion on how extremely variable it is. He considers the possibility of direct action and then of use and disuse, and provides examples of developmental abnormalities, atavisms and correlated variability. All of these are intended to show that we fit the general pattern of variability seen in other animals. Then to demonstrate that we are liable to natural selection, he discusses our reproductive rates. And then he considers how natural selection could have affected our ancestors. He presents an adaptive scenario involving upright posture, increased brain size, and increased sociality.

Chapter V (III in the second edition) develops his ideas about intellectual and moral evolution. His basic model is the differential survival of family groups and tribes. In the modern literature this form of selection is often called "group selection." He also briefly mentions what is called "kin-selection" analogizing it with breeding from the same stock of domesticated animals and plants. He maintains that ordinary natural selection would tend to eliminate those who sacrifice themselves for the benefit of others. Lastly, he discusses the conditions of progress and the question of whether we should expect our species to advance or to degenerate. The section is long and complicated, and full of unanswered questions.

Chapter VI attempts to locate the human species in the genealogical tree and to give an idea of the series of changes that our ancestors have undergone, working downward to the origin of the vertebrates. He begins by criticizing the habit of treating us as belonging to a distinct order, class, or even phylum on the grounds that we are very different from our relatives. This approach to ranking came under heavy fire late in the twentieth century as genealogical (phylogenetic) classification became more popular. One of Darwin's main antagonists was Richard Owen, who had a famous argument with Thomas Henry Huxley over man's place in nature. Darwin argues that we ought to be placed with our closest relatives, and makes it clear what that means. He tries to determine where our species originated. Then he traces our lineage farther back, ultimately to the tunicates. He suggests that our early ancestors were, like tunicates, hermaphroditic.

Chapter VII deals with human races. Darwin rejects the notion that humanity consists of more than one species in spite of great geographical diversity. He rules out quite a number of causes of their diversification. These even include natural selection, for he could see no obvious advantage to the differences. He then suggests that sexual selection may be the explanation. The second edition has a note by Huxley on the structure of the brain in this chapter.

The second, and much larger, part of the book is on sexual selection. This part is subdivided in the second edition so as to make a third, dealing with sexual selection in man. The topic of sexual selection is difficult enough, and Darwin's writing sufficiently obscure, that we should reiterate what has been said about the three modes of selection: natural, artificial, and sexual. All three depend upon differential reproduction among organisms within the same population. In natural selection reproductive success results from being better able to cope with the conditions of existence. In artificial selection what counts is the choice, whether deliberate or not, by a breeder to have one organism rather than another procreate. Sexual selection is like artificial selection, in that an organism's reproduction is controlled by an organism. It is a matter of pure reproductive competition and does not lead to an increased reproductive potential of the species. In that sense its results are non-adaptive. The mechanism of sexual selection was not invented in order to explain away difficulties in the theory of natural selection, but to provide a compelling argument in favor of selection theory in general.

Darwin devotes a chapter (VIII) to how sexual selection works. He distinguishes between primary and secondary sex characters, the latter of which are not "directly" concerned with reproduction. He points out that this definition leaves it open how direct the connection is. Should they include the organs that subserve copulation and egg-laying? If we exclude these, then only the ovaries and testes remain. So he includes them, and some others, such as mammary glands and brood pouches. By secondary sexual characters he means those that are involved in such activities as attracting mates and defeating rivals. A third class of sex characters, for which he does not provide a name, are those that have no direct connection with reproduction as such, but are the result of males and females living in different places or eating different food. In effect, though he is not particularly clear about it, Darwin means by a secondary sex character one that is produced by sexual selection. All other dif-

ferences between males and females are the products of natural selection.

Sexual selection, he explains, is a matter of reproductive competition pure and simple, and does not result from being better fitted to survive in the struggle for existence. But he goes on to say that it may be difficult to distinguish between the effects of natural selection and sexual selection. Later he explains how they interact. He says that when gamecocks are selected they become improved and that the same occurs in nature. And he points out that an animal may select a mate that is more healthy or vigorous, suggesting a kind of natural eugenics, though this was not as important a consideration with him as it became a century later. Be this as it may, it would be natural, not sexual selection. A skewed sex ratio or polygamy ought to further sexual selection, but Darwin shows that that is by no means necessary. He then considers the behavioral differences that are responsible, in particular the greater eagerness of males to mate. He notes that the adaptations that are used in sexual combat or in attracting mates may be deleterious to their possessors, but concludes that the advantages outweigh the disadvantages. There follows a discussion on what would now be called the developmental genetics of secondary sex characters: such topics as sex-limited inheritance. At the end of this chapter, there is an appendix on the proportion of males to females. Darwin deserves credit for having realized that the sex-ratio is an important problem. Why should the number of males be approximately equal to the number of females, and how could selection account for that? The solution that we now accept was proposed by R. A. Fisher early in the twentieth century. Basically, the answer is that we derive just as much of our ancestry from females as we do from males.

Darwin then develops and tests his theory by going through the animal kingdom, one taxonomic group after another, showing how an enormous mass of factual information can be explained in terms of his hypothesis. If sexual selection is to occur, certain conditions have to be met. For example, if it is the result of females choosing between males with different color patterns, the females must have the ability to see the males. When sexual selection does occur, it is accompanied by anatomical and behavioral features that make it possible. Darwin also had to consider a variety of alternative hypotheses, including Wallace's notion that sexual dimorphism in color results from the female needing more protection than the male

does. In surveying the “lower” animals Darwin argues that brilliant coloration is probably not involved in courtship. When he gets to arthropods, however, he finds copious evidence of sexual competition among male crustaceans. In Chapters X and XI, he discusses the insects, animals in which competition among the males had been well documented. He had good material on their courtship and on the sexual combat of the males. He recognizes causes of brilliant coloration other than sexual selection, and takes these into account. Among these are mimicry and warning coloration, and Darwin discusses both of these phenomena toward the end of Chapter XI.

Chapter XII deals with fishes, amphibians and reptiles, i.e., all vertebrates other than birds and mammals. Combat between the males in some fishes had been studied, and Darwin provides examples of the behavior and the anatomical modifications that go with it. In amphibians and reptiles he finds indications of sexual combat between the males. Darwin devotes four whole chapters to secondary sexual characters of birds. This emphasis on birds can in part be explained by the amount of attention that had been paid to them by naturalists. But the reason Darwin gives is that secondary sexual characters are especially pronounced and diverse among birds. We might add that they provide good examples of both male combat and female choice and that they have both the physical and mental qualities that are conducive to sexual selection. Yet another reason is that Darwin was interested in rebutting Wallace’s efforts to explain sexual dimorphism in terms of natural, rather than sexual, selection.

Chapter XIII gives a general picture of sexual selection in birds. Darwin notes that some of the sexual dimorphism is not due to sexual selection but rather to males and females having different ways of life. He then discusses the combativeness of many male birds, and its correlates, such as larger body size. He provides a long discussion on their vocalizations and other sounds as well as miscellaneous behaviors that serve to attract the females, and also their “decoration” as he puts it. Chapter XIV treats such topics as courtship and the psychology of female choice. Sexual selection by female choice will work only if the females are attracted to the males by their ornaments and behavior, and only if the males do have different degrees of reproductive success. Darwin gives evidence that birds have something comparable to our own esthetic tastes, and that the females prefer certain individual males. To reinforce his claim that selection

could modify the sexual characters, he shows that they are highly variable. The chapter culminates in a discussion on how the patterns that resemble eyes (“ocelli”) on the tails of certain birds have evolved. Something like them occurs in butterflies as well, and Darwin shows how they have been modified from less striking patterns. They are also particularly well developed in peacocks and related birds, and a graded series of intermediate forms can be observed. In the Argus pheasant, they are particularly well elaborated and arranged in a way that precisely maximizes the visual effect when the male displays his plumage to the female.

Chapters XV and XVI deal with sex-limited inheritance in relation to the evolution of sexual dimorphism in color and ornamentation. The reasoning presupposes the ideas about the relationship between embryology and evolution that Darwin developed in *The Variation of Animals and Plants under Domestication*. He had only a limited understanding of the relevant physiology and genetics. He did not know that the sex of birds is determined by chromosomes, or how various kinds of genes affect color patterns or other characters, for science had not yet advanced that far. The expression of sexual characteristics is under the control of both male and female sex hormones, but the science of endocrinology as it existed at the time could tell him little more than what happens when the gonads are defective or get removed and whether they are active or not. However, the developmental patterns that interested him had been worked out in some detail. Darwin reasonably assumed that sexual coloration and ornaments had evolved as a consequence of their advantages to the adult birds. Because the juveniles do not mate, having those characters would be of no advantage to them. The variations that provide the basis for selection of those characters could occur in either the juveniles or in the adults and they could be present in just one sex or in both of them. Originally the juveniles and adults would have the same patterns, and selection would then superimpose adult male and female characteristics. Selection could change either sex or both, depending upon whether the variation that is favored by selection occurs in just one sex or in both. If restricted to one sex, the character would evolve in the sex in which it is selected. If not so restricted, selection on either sex would cause it to evolve in both.

Darwin enunciated a series of rules that relate avian color patterns to the sexes and state of maturity

of the animals. The juveniles would not have breeding plumage, because it is not functional, and the adults would have it expressed at the time when it is functional, and in the sex in which it is advantageous. If the variation is sex-limited, then the sexual characters should be present in the sex in which it is advantageous, and individuals of the opposite sex should retain the juvenile pattern. If not so limited, the variation should appear in both sexes, especially when the animals are in breeding condition. In that case the juveniles would most likely retain the primitive pattern. However, a variation that occurs quite early might affect the juveniles as well, and they might evolve a distinct plumage of their own. Darwin related this complex of patterns to the mating habits and other aspects of the reproductive biology of the animals. A good example is those birds in which the usual gender roles have been reversed. Where it is the males instead of the females who care for the young, the males are smaller, less ornamented, and less pugnacious than the females, and it is they whose plumage resembles that of the juveniles.

Chapters XVII and XVIII are on mammals, a group in which sexual selection by male combat is pronounced, and in which female choice is less important than it is in birds. Darwin establishes that males do fight, using their horns and other weapons. Although the horns of males are used in defense against predators, they are sometimes better adapted for combat with other males. The females generally lack such organs, he says, and when they have them they are less developed. Darwin gives evidence for the females preferring particular males. He also reviews the "ornaments" that occur in various male mammals, and occasionally in the females. There follow two chapters, XIX and XX, on the secondary sexual characters of man. Darwin makes it clear that the differences between male and female human beings are much like those that occur in non-human primates. The manner of development of these differences as well as the kinds of them (such as strength and bodily size) indicate that there is nothing extraordinary about us in this respect. Again, the secondary sexual characters, especially those of males, are highly variable. And the various "races" differ greatly in such features as hairiness. Darwin, as was noted earlier, thought that the traits that characterize various groups of human beings are not the sort of adaptive ones that are produced by natural selection. He invoked sexual selection as an alternative.

Darwin maintains that combat among male

humans explains their greater bodily strength than that of the females, and their psychological differences as well. Darwin suggests that intellectual qualities selected in the males are also present in the females because they are transmitted to both male and female offspring. It would appear that Darwin underestimated the subtleties of feminine thinking. He suggests that women could be made more nearly the intellectual equals of men by a combination of education and the inheritance of acquired characters. To establish the plausibility of an aesthetic basis for sexual selection, Darwin gives evidence for musical appreciation in other animals as well as in primitive human beings and proceeds to discuss various forms of ornamentation. On the other hand, tastes vary, and different groups of people, both primitive and civilized, have quite diverse preferences. Selection would tend to accentuate those differences. Darwin concludes that sexual selection has been the most important. In the last chapter (XXI) he draws the general conclusion that sexual selection has been responsible for the acquisition of both our bodily and our mental powers, which in turn depend upon the development of the brain. The notion that the brain plays an active role in evolution is likewise fundamental to Darwin's other works on evolutionary psychology.

ON THE EXPRESSIONS OF EMOTIONS IN MAN AND ANIMALS

The Expression of the Emotions in Man and Animals, first published in 1872, was originally planned as a single chapter in *The Descent of Man*. Darwin's son Francis edited a posthumous second edition with some new material based upon Charles Darwin's notes. In 1998 Paul Ekman brought out a third, or "definitive" edition with excellent commentary in addition to more material by Darwin himself. Here we will assume that the reader will use the first edition, which is the most widely available, mainly as reprints of the American edition.

Darwin's work on human psychology, like that on other animals and on plants, began very early in his career. Indeed, some of the observations in the *Expression* evidently go back to the time when he was a student at Cambridge University. (He bet some other young men that they could not sneeze by taking snuff and they all had to pay up!) After he got back from the *Beagle* voyage he opened a series of notebooks on evolution, but soon split the series into two, one of which dealt with what he called "metaphysi-

cal" (largely psychological) topics. When his first son, William, was born Darwin began to keep detailed notes on the behavior of his children. Some of this material is incorporated in the *Expression*. In 1877 he published, in the journal *Mind*, an article entitled "A Biographical Sketch of an Infant" based on his observations of young William. It is one of the classics of developmental psychology.

It is hardly surprising that the greatest biologist who ever lived was also a psychologist of the first rank. The correlation is a causal one, for as Darwin put it in the *Origin*, "Psychology will be based on a new foundation, that of the necessary acquirement of each mental power and capacity by gradation." The *Expression* illustrates how this program might be put into effect. In the introduction Darwin discusses the work of his predecessor Charles Bell. His own research was largely motivated by a desire to refute Bell's notion that certain muscles in the human face had been created by God in order to express our emotions. However, Darwin intended to accomplish much more than that. He hoped that facial expression would provide a window through which we could view the mind. Darwin rejected traditional mind-body dualism and in this he may be contrasted with his friend Thomas Henry Huxley, who sided with Descartes. Darwin has been accused of thinking too anthropomorphically, and therefore interpreting the behavior of other animals as too much like our own. These charges are to some degree justified. However, his approach was an objective one, and he backed up his conclusions with comparative and experimental data. The reader should not be misled by Darwin's language. His figure 6 (Fig. 2) is entitled "Cat in an affectionate frame of mind." One behaviorist commentator suggested changing the caption to "Dermal stimulation." That seems silly, though someone who takes a cynical view of cat behavior may suspect that what the creature really had in mind was getting fed.

People who think teleologically are apt to assume that the *raison d'être* of facial expressions is communication. This mistake continues to be made in spite of Darwin having refuted it along with teleology in general. In Darwin's view, emotional expressions may indeed be used communicatively, but they did not originate as adaptations that further communication, any more than the nose exists because it supports spectacles. As Darwin showed in his other works, structures change their functions. He does seem to have carried this line of reasoning too far, however, for he does not provide any examples of natural selec-



FIGURE 2. "Cat in an affectionate frame of mind."

tion causing an expression to convey a different emotion. The smile, we now know, formerly expressed fear; Darwin's figure 17, shows a baboon "pleased by being caressed," but that seems unlikely.

The *Expression* has been criticized as Darwin's most "Lamarckian" work and it has seemed problematic why he did not more often invoke natural selection. This "Lamarckism" however is a matter of the inheritance of habits, not use and disuse or other evolutionary mechanisms that are ordinarily associated with Lamarckism. Darwin believed that natural selection is the main mechanism of evolution, but he also believed that several minor mechanisms are also effective. In this case he elevated minor ones to a more important role. Since he thought he could explain the facts one way or another, he may not have felt it necessary to decide which mechanism to invoke.

Darwin took great pains to show that facial expressions are inherited and are not mere customs. His views were ignored or rejected by anthropologists and others who tried to attribute every aspect of

behavior to culture. Things did not change until Paul Ekman, beginning with the assumption that Darwin was wrong, found out that his own field data showed that Darwin was right. The result has been a flourishing of experimental and comparative research on facial expression, much of it cross-cultural.

In the introduction Darwin discusses his predecessors and explains evolutionary rationale of his work. He also explains his methodology. One of the strengths of that methodology is that he uses a wide variety of evidence, including a questionnaire that he had printed off and distributed.

Chapters I through III explain the three general principles that Darwin invokes in explaining emotional expression. At the beginning of Chapter I he says that he arrived at these only at the close of his observations. Manuscripts suggest that this claim is not true. It resembles the claim that he makes at the beginning of the *Origin* about having patiently gathered facts and then finally allowed himself to speculate. The first of these is the *principle of serviceable associated habits*. When a certain state of the mind is produced there is a tendency to bring a particular group of muscles into play, producing a pattern which, though adaptive (serviceable) when taking action, is otherwise useless. When one thinks about doing something, even if one does not intend to do it, one may go through some of the motions. Such actions have been called "intention movements" but as Darwin notes they occur when nothing is actually intended, as when people are observing an athletic contest. Darwin's theory has been compared to the associationism advocated by earlier psychologists and philosophers. He and Herbert Spencer have been categorized as "evolutionary associationists." Chapter II deals with the *principle of antithesis*, which is more difficult to understand than that of associated habits. This is shown by two figures, reproduced here, of a dog that is hostile (Fig. 3A) and friendly (Fig. 3B). Darwin thought that emotional states occur as opposites. One pair of these opposites is expressed by the action of a set of muscles that produces a serviceable (again, adaptive) action on the part of the animal. The opposite emotion brings the same set of muscles into play, producing an action having the opposite form, but one which is not serviceable, except perhaps when the expression is used as a signal. Chapter III deals with the *principle of the direct action of the nervous system*. When we get excited or are afraid, we become aroused, and the nervous system causes our bodies to be made ready

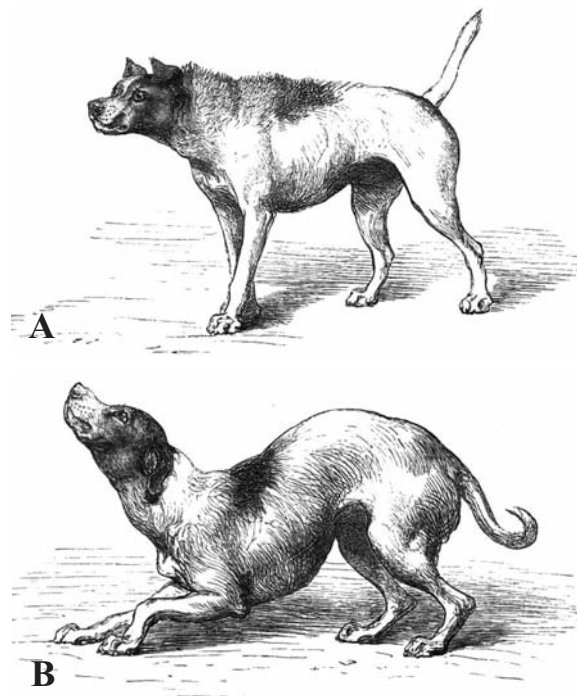


FIGURE 3. (A) "Dog approaching another dog with hostile intentions." (B) "The same in a humble and affectionate frame of mind."

for action. Some of the effects are serviceable, but others, such as trembling, are not.

Chapter IV then discusses the mechanisms by means of which emotions are expressed, such as by producing sound or erecting the hairs or the feathers on the surface of the body. Chapter V treats a variety of "special expressions" such as those associated with anger and affection in domesticated animals and also in primates in captivity. His observations include some experiments made at the London zoo. There follow a series of chapters (VI through XIII) in which the "special expressions" found in human beings are treated systematically according to the emotions that these are thought to express. The term "emotion" is not quite appropriate for some of these. Shyness is generally considered a personality trait, but then again a shy person has characteristic emotions that do get expressed under certain circumstances. The various expressions are analyzed according to how the muscles, glands and other bodily parts are brought into play when a particular emotion is being expressed. A considerable amount of anatomical detail is presented along with both physiological and behavioral experiments. As may be seen especially in Chapter VI, Darwin studied children extensively. One reason for doing so was that they would be less apt to

have the spontaneous form modified by learning or the effects of observation. There are also observations made upon the insane, as in Chapter X and XII, part of the rationale being that such persons may become highly aroused and therefore show the expression to an extreme degree. He made cross-cultural comparisons, especially to be seen in Chapter XI, designed to separate the effects of custom and thereby establish that the expressions are inherited. These were partly based upon a questionnaire that he had printed up and sent to informants. Because the congenitally blind are at first unaware of being observed, Darwin utilized observations on them, many of which are discussed in Chapter XIII. Especially useful were observations made by his informants on Laura Bridgeman, who was both blind and deaf from a very early age. Chapter XIV provides a summary and some general conclusions about the derivation of emotional expressions from those of our remote ancestors.

ON PLANT PSYCHOLOGY

Insectivorous Plants was first published on July 2, 1875. It was the first of Darwin's three books on plant psychology, the other two being *Climbing Plants* and *The Power of Movement in Plants*. Classifying these publications as psychology may offend some persons. After all, plants don't have souls or minds, and that is what psychology is supposed to be about. But many years have passed since most psychologists defined their field that way. It is the science of behavior. Darwin's work on plant behavior might also be viewed as ethology, and one might even say that he invented that field many years before its supposed founders, von Fritsch, Tinbergen and Lorenz. One objection to calling it ethology has been that plants do not behave, on the grounds that behavior is muscular movements. But this definition of 'behavior' seems a bit arbitrary, and not just because many animal movements are produced by cilia rather than muscles. Plant movements are based upon the action of a hydraulic system combined with differential growth. Plants do react to stimuli, and this fact created serious difficulties for the philosophers who wanted to deny a "sensitive soul" to them. Such semantic quibbles do not affect Darwin's claims that plants share quite a number of faculties that seem characteristic of animals and, more importantly, that these faculties have gradually evolved by natural selection.

The book itself is rather long and tedious and few

readers will want to read it from cover to cover. However, it does provide some fine examples of Darwin's experimental work. Darwin tells us that his work on insectivorous plants began in July of 1860. That would have been during a vacation in Hartfield. He was surprised to observe the capture of large numbers of insects by the leaves of the common sun-dew, *Drosera rotundiflora*. That led him to investigate the physiology and adaptive significance of the phenomenon. Most of his experimental results are on that species, and about 60% of the book (Chapters I through XI) is devoted to it. The first chapter describes the structure of the plants and explains how they capture insects with their tentacles, which are very sensitive and secrete a sticky material. The second chapter shows that the plants respond much more readily to materials of animal origin than to mere mechanical stimulus. In the third chapter the results of observations of what goes on at a cellular level are described. A wide range of stimuli were tried and the plants were found to be very sensitive indeed. The fourth chapter is devoted to the effects of temperature on the reactions of the plants. In the fifth chapter the results of screening a wide range of substances are presented; it seems that the plants are responding preferentially to materials that contain nitrogen. This finding suggested that the plants might actually be able to digest their prey, something that had not been discovered in plants before. This hypothesis is supported by the experimental results presented in the sixth chapter. The plants digest their prey using an enzyme that functions only under acidic conditions, much like the gastric secretion of many animals. The seventh chapter documents the remarkable sensitivity of the plants to various salts of nitrogen. The results of screening a wide variety of compounds that might provide a clue to the mechanisms are presented in the eighth chapter. As in animals, the effect is not strictly correlated with the chemistry of the materials that were tested. The ninth chapter goes on to explore the effects of various other chemicals, especially those that affect animal nervous systems. These include various alkaloids, cobra venom, cyanide, alcohol and anaesthetics. In the tenth chapter the manner in which stimuli, which originate in the tentacles, are transmitted to the rest of the plant is explored. Darwin was looking for something like nerves, and for a while he thought he had found them in the vascular bundles in the leaves. But his experiments ruled that out.

The eleventh chapter provides a summary of the material on *Drosera latifolia*. It is followed by a brief

one on other species of the same genus. They all catch insects in much the same way. They live in habitats such as bogs where there is plenty of water but other nutrients are in short supply. And they all are adapted to obtaining nutrients not through their roots, but from the insects that they capture. Then Darwin expands the discussion to the rest of the family Droseraceae, which provide a broader range of variations on the same basic theme (in chapters XIII through XV). The thirteenth chapter is devoted to just one of these, the Venus' fly-trap, *Dionaea muscipula*. It differs in having a much different, and more spectacular, way of capturing insects and in the details of how these are digested. But the trap is, like that of *Drosera*, a modified leaf. *Aldrovanda vesiculosa*, treated in the fourteenth chapter, is treated as a miniature, rootless, *Dionaea*, which lives submerged under water and captures crustaceans and insect larvae. In the fifteenth chapter three more genera are briefly discussed, together with some supplemental materials on the physiology of related, but non-insectivorous plants. One important point is that plants in general are able to take up nutrients through their leaves. The chapter ends with an effort to reconstruct the evolutionary history of the group, in which the origin of the ability to react to stimulus, to digest animal matter, and to absorb the material that has been digested are explained. The scenario, which traces the novel features to plausible predecessors, is much like those that Darwin presents in other works.

The rest of the book (chapters XVI through XVIII) deals with insectivorous plants from another family (Lentibulariaceae), implying that the habit has evolved separately. *Pinguicula*, discussed in the sixteenth chapter, captures insects with its leaves. Experiments give results much like those on *Drosera* and its allies. The plants secrete a sticky fluid and digest and absorb the animal remains. The other genus, *Utricularia*, discussed in the last two chapters, has a somewhat different manner of capturing prey, as do some of its relatives. *Utricularia* is aquatic, and has bladders equipped with valves that allow crustaceans and other small animals to get in but not to get out. But these plants do not digest the animals that they capture. Rather they die and rot and the plants absorb the nutrients that are formed as breakdown products.

The Movements and Habits of Climbing Plants was first published as a journal article in 1865. It appeared as a book in 1875, shortly after *Insectivorous Plants*, as a "second edition" with a

new preface and somewhat revised. Discussing it after *Insectivorous Plants* and before *The Power of Movement in Plants* makes it easier to understand the conceptual relationships between the latter two works. The former is a comparative study of the ability of plants to respond in an adaptive manner to stimuli, the latter an experimental analysis of the mechanisms by which they do so. In the first chapter of *Climbing Plants* Darwin divides almost all of these organisms into two major groups. The first is twining plants, which simply wind around a support; these he considers the simpler and more primitive. The second are those that grasp their support with various organs, which are modified leaves and other plant parts. The twining plants are shown to execute circling movements as they grow. As a result the plants are brought into contact with sticks or other objects and then wind around them, obtaining support. The circling movements, or nutations, result from differential growth and are easily produced. Sweeping a larger area makes it more likely that the plant will find a support. It is a random, or better undirected, search process. Later evolutionary stages elaborate upon this basic mechanism by adding the ability to respond to stimuli followed by further adaptations. The second chapter deals with leaf-climbers. The leaves revolve and are sensitive to stimuli. When they encounter a support the petioles may wind around it and grasp it. Or attachment may be provided by means of modified ribs. The third and fourth chapters are on tendril-bearers. Tendrils are modified leaves together with their petioles, the peduncles of flowers and other structures. They too revolve spontaneously, and they respond to touch. Some plants are transitional between leaf-climbers and tendril-bearers. The tendrils may simply twine around their support, but often there are adhesive organs that allow the plant to hang on. After attachment the tendrils may then contract into a pair of spirals thereby shortening the tendril and pulling up the stem of the plant. The spirals have the additional effect of making the tendril into a kind of spring with considerable elasticity, making it difficult to dislodge the plant from its support. The fifth chapter discusses a few other mechanisms of climbing. Root-climbers attach themselves to trees by putting forth roots and secreting an adhesive. In his concluding remarks Darwin explains what he thinks is the adaptive significance of climbing and the more advanced mechanisms of doing so. The climbing plants do not have to support themselves by heavy branches and that saves valuable resources. Twining

would have been the original mechanism, and leaf-climbers and tendril-bearers would be the modified descendants of twiners. These plants could climb directly upward, economizing on resources by virtue of the much shorter stems. By reference to the classification of the group Darwin shows that the ability to climb has evolved independently in unrelated forms. The power of movement occurs in a wide diversity of plant organs, and it is coupled with the ability to respond to stimuli including light, gravity and touch. In conclusion Darwin remarks that plants do not differ from animals in lacking the power of movement, but only manifest it when it is advantageous for them to do so.

The Power of Movement in Plants, published on November 22, 1880, justifies Darwin's reputation as a plant physiologist of the first rank. It inspired a vast literature on plant growth hormones and related topics. It is a logical development of the book on climbing plants in which Darwin questioned some of the interpretations of Julius Sachs. When this book was published Sachs was much annoyed. The result was extended controversy. Darwin enlisted the assistance of his son Francis in this research and the fact that the younger Darwin was really a co-author is underscored by the use of the first person plural in the introduction. The book is long, technical, and full of experimental detail. In fact, this one is the least readable of Darwin's books. For most readers, it would seem reasonable, following its authors' advice, to read the introduction first, then go to the back of the book and read the last chapter. Then one might want to read at least some of the parts that are set in larger type.

The book is about the evolution of behavior. Plants grow by the expansion of their cells. The growing parts undergo spontaneous circling movements called "circumnutation" due to uneven expansion of the cells. By evolving an ability to respond to stimuli, plants have become able to grow in a particular direction, either toward or away from a given stimulus. These directed movements are called "tropisms" and have parallels in the "taxes" of animals. The movements are classified according to the type of stimulus and whether it is away from, or toward the stimulus. Thus the leaf of a plant might grow toward the light, and that would be a case of positive heliotropism. If it grew away from the force of gravity that would be negative geotropism, or, as Darwin put it, apogeotropism. Plants could also react to touch and humidity. The different parts of the plant, such as leaves and

roots, would react in different ways, producing adaptive movements that lead them toward the light or water and nutrients. All this fitted in quite well with Darwin's theory of natural selection, for the movements would vary in amplitude and direction and selection would favor having the plants move in the appropriate direction. Because circumnutation occurs spontaneously in all growing parts of the plant, the problem of where the movements came from in the first place was solved.

Darwin's experiments show that the stimulus is received at the tip of the root or the shoot and then somehow transmitted to a point somewhat distant from it where the bending takes place. He draws an analogy with "lower" animals, which of course have nervous systems though plants do not. He ends the book as follows: "The course pursued by the radicle in penetrating the ground must be determined by the tip; hence it has acquired such diverse kinds of sensitiveness. It is hardly an exaggeration to say that the tip of the radicle thus endowed, and having the power of directing the movements of the adjoining parts, acts like the brain of one of the lower animals; the brain being seated within the anterior end of the body, receiving impressions from the sense-organs, and directing the several movements."

WORMS

The Formation of Vegetable Mould, through the Action of Worms, with Observations on their Habits was published on October 10, 1881. It was the last of Darwin's books to be published. It appealed to a broad audience and sold very well. Worms are familiar objects, but most people haven't given them much thought. The reader is fascinated by obscure details and curious facts. The book is replete with outstanding experimental work that doesn't require much background to understand. It even has a philosophical message: the humble and industrious worm turns out to be a major shaper of the landscape.

Darwin got interested in earthworms soon after his return from the voyage of the *Beagle*. The topic evidently attracted his attention when he was visiting the home of his uncle Josiah Wedgwood II at Maer in Staffordshire. Darwin's initial interest in them was mainly geological, and his thinking about such matters must have been affected by his work on coral reefs. He read a paper on that topic to the Geological Society of London on November 1, 1837 and it was published in their *Transactions* in 1840. He published

a note on vegetable mould in 1844, and seems to have taken up the study of worms again around 1869, when he published another short paper. During the 1870s he made observations on their biology and their geological significance. When he took up the study of their behavior and habits Darwin had already achieved greatness as an evolutionary physiologist and psychologist through his research on the behavior of plants and “higher” animals such as bees and vertebrates. From a neurophysiological point of view at least, earthworms are quite simple animals. *Worms* helps to fulfill the prediction that Darwin made in the *Origin*: “Psychology will be based on a new foundation, that of the necessary acquirement of each mental power and capacity by gradation.”

The book, however, is structured so as to put most of the geology last, because it is easier to understand the geology if one already knows about the biology of the worms. So Darwin begins, in Chapter I, with a discussion of their sensory capacities and feeding, based largely on his own experiments. In Chapter II he describes some surprising results. Worms seem able to exercise a kind of intelligence when they draw leaves into their burrows. ‘Intelligence’ has often been defined as the ability to benefit from experience and this was the concept that Darwin applied. Darwin backs up this view with many experiments. The leaves are drawn in partly as a means of plugging up the burrows, and partly as food. That topic leads naturally to considerations of how the worms burrow and how they ingest soil and extract food from it and deposit castings at the surface. They bring up a lot of material, some of it from considerable depth. Chapter III addresses the question of how much is brought up, and the quantity is most impressive. So too are the effects, for objects on the surface are buried, including large stones, which are undermined. Among the most impressive effects is the burial of ancient buildings, which is the subject of Chapter IV. Darwin studied several ancient ruins from this point of view. The first of these that he considers was a Roman villa at Abinger Hall, in Surrey. It was on the property of Thomas Henry Farrer, the husband of one of Darwin’s Wedgwood cousins. Farrer undertook a methodical excavation of the site. Darwin was present when the excavation began, and made use of Farrer’s notes. Darwin’s sons William, Francis and Horace visited other sites and made observations for him. Worms are also important agents of erosion, or, as Darwin puts it, the “denudation of the land,” and he devotes two chapters (V and VI) to that topic. With numerous

observations and much quantitative data, Darwin establishes the fact that earthworms are responsible for the removal of an enormous amount of material from the soil, most of which ultimately makes its way to the sea and forms sedimentary rock. In the final chapter Darwin compares the effects of worms to those of corals. The corals are noteworthy for building things up, the worms for tearing them down. In either case we have a theme that often recurs in Darwin’s work. Major changes in the earth and its inhabitants take place gradually, by small steps, and over vast periods of time.

SECONDARY LITERATURE AND OTHER SOURCES

The major purpose of this *Guide* is to enable the reader to understand and appreciate Darwin by reading his works. Those publications and his other writings such as his notebooks, unpublished manuscripts, and correspondence are what historians call “primary sources.” Commentary written about him by historians and others is considered “secondary” source material. Often the distinction breaks down, as when a letter by Darwin is published together with scholarly notes and commentary. The additional sources both primary and secondary can be of considerable use to anyone interested in Darwin and his accomplishments. This *Guide* would not have been written had it not been felt that the reader might benefit from a certain amount of exegesis. However, the secondary literature is as variable in quality as it is vast in quantity. My first book on Darwin, written when I was a very young scientist, was evoked as a reaction to the secondary literature that fell into my hands. I asked myself why somebody who understands evolution hadn’t read all of Darwin and explained what he was up to. This I did, and, although the work has become somewhat dated, the basic point that Darwin was a very philosophical scientist with a unitary way of thinking became at least an implicit premise in Darwin studies ever since.

The authors of secondary sources have their own agendas. There is nothing wrong with that, especially if an author’s agenda is to set the record straight. Yet even with the best of intentions a certain amount of distortion is inevitable. The problem may or may not be obvious when somebody produces an abridged edition of a book, or assembles an anthology. On the other hand, Darwin has been the subject of a vast literature written from a hostile point of view and often

intended to discredit him, his science, and even science in general. Such hostility often has religious motives. But much of it is generated by political sentiment. The competitive world that Darwin revealed may seem repugnant, and some persons feel that by denying such aspects of the natural world they will go away. Others, mixing up religion with politics, maintain that the struggle for existence is the will of God, and use that as an argument for *laissez-faire* economic ideology and the kind of reactionary politics that so often goes with it. So we have advocates of various kinds of political ideology, left, right and center, battling with one another about what has often been called Social Darwinism, with science caught in the cross-fire. And there is a long tradition of trying to make evolutionary biology into a kind of secular religion.

The historiography of Darwinism and Darwinism itself have been the products of the times that have given rise to them. To understand that literature we need to place it in its historical context. By the time of his death Darwin and his followers had convinced the scientific community that evolution has indeed occurred. But his thesis that natural selection has been the main, albeit not exclusive, mechanism that has caused it, although respectable, was only held by a minority of biologists, such as Henry Walter Bates, Fritz Müller and August Weismann. The historian Peter Bowler has written of a “non-Darwinian revolution.” Soon after Darwin’s death there was a worldwide reaction against Darwinism and against the rationalism that had given rise to it. For that reason idealistic philosophy became popular. Among scientists alternatives to natural selection flourished, including various notions often called Lamarckian. Some of these were vague claims that ultimately evolution would be explained as a result of as yet unspecified laws of nature. The notion that evolution is like the development of an embryo, headed toward a definite ultimate condition, was also very popular, especially among those who wanted to believe that evolution is necessarily progressive and that progress is always a good thing. There were, indeed, some serious problems with Darwin’s theory. For one thing he had not ruled out “Lamarckian” mechanisms. For another, he did not have a good theory of heredity. The theory that had been published during Darwin’s lifetime by Gregor Mendel was ignored until 1901.

One might think that the discovery of Mendel’s laws would have immediately vindicated natural selection. Nothing of the sort happened however. The

early Mendelians such as Thomas Hunt Morgan were vehemently opposed to natural selection. It took decades before genetics was fully assimilated into evolutionary theory. During that period, Darwin’s followers remained a minority. They became a majority among scientists only as the alternatives gradually became untenable. Naturally, the historical accounts that were written at the time reflected that very situation. The genetical objections to natural selection were disposed of in the 1920s. During the late 1930s and up to around 1950 a “synthetic theory” of evolution emerged. It put together the results of genetics, systematics, paleontology and other disciplines into a modernized version of Darwin’s theory. Important books accomplishing that were written by the Russian-American Theodosius Dobzhansky, the German-American Ernst Mayr, the Englishman Julian Huxley, the German Bernhard Rensch, the Russian Ivan Ivanovich Schmalhausen, and the Americans George Gaylord Simpson and G. Ledyard Stebbins.

When the centennial of the publication of *The Origin of Species* was celebrated in 1959, a large number of scientists as well as others had occasion to reconsider what Darwin had accomplished. The shortcomings of much of the old historiography were painfully apparent. One consequence was a new historiography. The impetus was provided by four zoologists: Gavin De Beer, Sydney Smith, Ernst Mayr, and Michael Ghiselin. De Beer looked at Darwin’s early notebooks and published them with commentary. Smith studied and organized the materials that were preserved at the Cambridge University Library and showed how to use them. Mayr wrote several influential papers and an introduction to a re-issue of *The Origin of Species*. He was also a post-doctoral sponsor of Ghiselin, whose book, *The Triumph of the Darwinian Method*, put Darwin’s accomplishment into a modern philosophical perspective. Mayr encouraged the work of other young Harvard Darwin scholars, such as Mary P. Winsor, Jonathan Hodge and Frank Sulloway. A new generation of historians got interested in Darwin and the history of evolutionary biology and the Cambridge archives increasingly gave important results. The science of evolutionary biology continued to advance, and Darwin’s ideas about sexual selection and related topics were rediscovered. One consequence was the debate about “sociobiology” that arose in the 1970s and created much commentary, some of it well informed.

To write intelligent commentary about science,

one needs to understand the science itself. This helps to explain why a movement called “externalism” arose as an alternative to the history of ideas. At its worst it was an effort to show that evolutionary biology is a capitalist plot. When one starts looking at science from the point of view of the religious and political climate of the times, one may come up with valuable results. On the other hand, there has been an unfortunate failure among some historians to appreciate the originality of Darwin and other scientists. Professional historians have made a magnificent contribution to Darwin studies by the editing and publishing of texts. The complete correspondence of Darwin is being published with excellent commentary. Philosophers have also contributed a great deal to the Darwin literature. Regrettably, the tradition in that discipline has been to consider oneself an expert on things in general, and to write about the philosophy of a subject without knowing much about it and therefore get the fundamental premises wrong. Things began to change when the philosophy of biology became a distinct specialty thanks largely to the efforts of David L. Hull. There has also been a lot of input from the practitioners of other disciplines, such as anthropology, psychology, and geology, to which Darwin made important contributions, and from historians of those subjects. Such commentary can be valuable, especially when an author puts specialist expertise to good use. But such authors are not always aware of their own limitations. Perhaps the best advice that can be offered to the users of this guide and its bibliography is *caveat emptor*.

Having said that does not relieve me of the responsibility of giving the reader some pointers about what items listed in the bibliography might be worth reading. The standard work on Darwin's life remains the *Life and Letters* written by his son Francis (1887) and supplemented by a work called *More Letters of Charles Darwin* by him and A. C. Steward (1903). Any such work has the drawback of the editor having to select one item in favor of another; this one suffers from certain sensitive materials having been suppressed. *The Correspondence of Charles Darwin* published by Cambridge University Press beginning in 1985 with Frederick Burkhardt and Sydney Smith as founding editors gives unabridged versions of both sides of the correspondence and an enormous amount of supplementary material as well. Volume 16 (2008) covers 1868 and it will be years before the work is completed. One of Darwin's daughters, Henrietta Litchfield, edited a

fine contribution to the “life and letters” genre entitled *Emma Darwin: a Century of Family Letters* (1915). One of his grand-daughters, Gwen Raverat, wrote a charming family memoir entitled *Period Piece: A Cambridge Childhood* (1952). Also providing the same kind of materials are the lives and letters of Darwin's friends and supporters. Thomas Henry Huxley's son Leonard produced the *Life and Letters of Thomas Henry Huxley* (1900) and *The Life and Letters of Sir Joseph Dalton Hooker* (1918).

Many biographies of Darwin have been published, including a few good ones. Among the more recent biographies, Janet Browne's 2-volume work (1995–2002) is particularly good, but many readers will prefer something shorter like Ernst Mayr's *One Long Argument* (1991) which reflects the views of one of the architects of modern evolutionary theory. Someone looking for a good introductory overview might well read Peter Bowler's *Charles Darwin, the Man and His Influence* (1990).

Quite a number of biographical works focus upon just a part of Darwin's life and work. We give a few good examples. Ralph Colp, Jr., M.D. went into Darwin's mysterious ailment in great depth in his *To Be an Invalid* (1977) and concluded that it was largely of psychosomatic origin. We may note that other possibilities have been entertained, most recently that he had an allergy to wheat. John Bowlby goes over the same problem from somewhat different psychological point of view in his *Charles Darwin, a New Life* (1990). Frank Sulloway considers the effect of birth order on the mentalities of Darwin and other scientists in his *Born to Rebel* (1996). Gruber and Barrett present some ruminations on the fascinating topic of Darwin's creativity in their *Darwin on Man* (1974). Sandra Herbert's *Charles Darwin, Geologist* (2005) is a fine piece of scholarly writing that goes well beyond geology in its scope. For coral reefs the classic study by Davis entitled *The Coral Reef Problem* (1928) is a bit technical for most readers and largely outdated, but still invaluable. Mea Allen's *Darwin and his Flowers: the Key to Natural Selection* (1977) is good for a general audience.

A number of books, many of them multi-authored, that relate Darwin to various larger themes. We here give a few interesting examples. Thomas Glick has edited a volume that considers the impact of Darwinism on various groups of people including national cultures entitled *The Comparative Reception of Darwinism* (1972). Also along the same lines is *Disseminating Darwinism: the Role of Place, Race,*

Religion and Gender, edited by Ronald L. Numbers and John Stenhouse (1999). Giuliano Pancaldi's *Darwin in Italia* (1983) has appeared in English translation (1991). The Russians have been considered by Alexander Vucinich in his *Darwin in Russian Thought* (1988) and by Daniel Todes in his *Darwin without Malthus* (1989). The Russians found Darwinism attractive from the outset and remained enthusiastic about it. It had some important followers in the nineteenth century but interest lapsed until the 1950s. Why Darwinism has fared so badly in France has been considered extensively, for example by Yvette Conry in her *L'Introduction du Darwinisme en France au XIXe Siècle* (1974). We should also mention Cynthia Russett's *Darwin in America: the Intellectual Response 1865–1912* (1976). *The Descent of Love* by Bert Bender (1996) is about the impact of Darwin's theory of sexual selection in American fiction, providing a good example of Darwin's wider impact on literary culture in his own time. Another interesting study along such lines is *Darwin and the General Reader: the Reception of Darwin's Theory of Evolution in the British Periodical Press, 1859–1872* by Alvar Ellegård (reprinted 1990).

Multi-authored books that consider Darwin's accomplishments in general or a particular one of them might be viewed as a separate genre. They have often been assembled for the purpose of commemorating events such as Darwin's birth or death or celebrating the publication of one of his works. A classic example is *Darwin and Modern Science: Essays in commemoration of the Centenary of the Birth of Charles Darwin and of the Fiftieth Anniversary of The Origin of Species*, edited by A.C. Seward (1909). More useful as a survey of recent opinion about

Darwin than for understanding Darwin himself is the ponderous *The Darwin Heritage* edited by David Kohn (1985). Paul Ekman has edited a fine volume on *Darwin and Facial Expression: a Century of Research in Review* (1973). A similar effort that is not quite so accessible is Bernard Campbell's *Sexual Selection and the Descent of Man 1871–1971* (1972).

There are several reference works and guides that readers of Darwin should know about. Particularly valuable is the three-volume *Dictionnaire du Darwinisme et de L'Évolution* edited by Patrick Tort (1996). It deals with a vast range of topics and there is nothing like it in English. *The Cambridge Companion to Darwin*, edited by Jonathan Hodge and Gregory Radick (2003), is less what its title indicates than a series of essays that provide a sample of contemporary philosophical commentary on him. For a good introduction to Darwin as a philosopher see *Darwin* by Tim Lewens in the *Routledge Philosophers* series (2007). R.B. Freeman has published two very useful little manuals: *The Works of Charles Darwin: an Annotated Bibliographical Handlist* (1965) and *Charles Darwin: a Companion* (1978). The latter contains all sorts of fascinating trivia. Although not exactly a reference work, *The Collected Papers of Charles Darwin*, edited by Paul H. Barrett (1977), contains just about all of Darwin's journal articles and other minor publications.

A great deal of material is being made available online. Although this move increases the availability of both manuscripts and published sources, interpreting them remains as formidable a task as ever. To cope with that plethora of resources, it is all the more important to read Darwin's works, and read them with understanding.

Charles Darwin Chronology

This chronology has been assembled from miscellaneous sources, most of which are cited in the bibliographies. Among these, Darwin's own publications and the many volumes of correspondence that have been published are critical. Other sources include Darwin's personal diaries and those kept by his wife. The various sources sometimes give different dates for the same event. CD is an abbreviation for Charles Darwin.

Note: CD → J.D. Hooker (or others) indicates a letter from Darwin to the recipient.

1765 JANUARY 3, Susannah Wedgwood (mother of CD) born	1820 JANUARY 29, George the Third died JULY, horseback tour with Erasmus Alvey Darwin
1766 MAY 30, Robert Waring Darwin (father of CD) born	1821 JULY 19, George IV crowned
1798 APRIL 7, Marianne Darwin (sister of CD) born	1822 OCTOBER, began chemical experiments with Erasmus Alvey Darwin
1800 SEPTEMBER 14, Caroline Darwin (sister of CD) born	1825 JUNE 17, left Shrewsbury school OCTOBER 22, matriculated at Edinburgh University
1803 OCTOBER 3, Susan Darwin (sister of CD) born	1826 FEBRUARY 9, note on <i>Aphrodita aculeata</i> recorded JUNE 15, walking tour to North Wales NOVEMBER 6, to Edinburgh NOVEMBER 10, elected to Plinian Society (a student group) DECEMBER 5, elected to Council of Plinian Society DECEMBER 16, attended meeting of Wernerian Society
1804 DECEMBER 29, Erasmus Alvey Darwin (brother of CD) born	1827 MARCH 24, R. Grant publicly discussed Darwin's research MARCH 27, read paper to Plinian Society LATE MAY, trip to Dublin, Portran, London and Paris with Josiah Wedgwood II SEPTEMBER, met Sir James Mackintosh at Maer OCTOBER 15, matriculated at Cambridge University
1808 MAY 2, Emma Wedgwood (cousin, later wife, of CD) born	1828 Much insect collecting JANUARY, began studies at Cambridge SUMMER, trip to Barmouth DECEMBER 20, from Cambridge to Shrewsbury for Christmas
1809 FEBRUARY 12, Sunday, Charles Darwin born (Shrewsbury)	1829 JANUARY 9, CD → W.D. Fox, remarks that he is reading Adam Smith and Locke (probably <i>An Essay Concerning Human Understanding</i>) for his "Little Go" examination FEBRUARY 19–24, trip to London where he stayed with Erasmus Alvey Darwin and visited the entomologists Hope and Stephens FEBRUARY 23, tea with Stephens OCTOBER, enrolled in J.S. Henslow's botany course DECEMBER, 3 weeks in London with Erasmus Alvey
1810 MAY 10, Catherine Darwin (sister of CD) born	
1811 FEBRUARY 5, Regency began	
1812 JUNE, War of 1812 began	
1814 Treaty of Ghent ended War of 1812	
1815 JUNE 18, Napoleon defeated at Waterloo	
1817 SPRING, CD began to attend Mr. Case's school JULY 15, his mother died	
1818 Began to attend Dr. Butler's school in Shrewsbury	
1819 MAY 24, future Queen Victoria born	

Darwin, visited Hope and Stephens, dined with Sir James Mackintosh

1830

JANUARY 1, returned to Cambridge
 JUNE 26, King George IV died; succeeded by William IV
 MARCH 24, took "Little Go" examination
 AUGUST, entomological tour with Hope and Eyton
 OCTOBER, enrolled in Henslow's botany course again

1831

JANUARY 22, passed examination for B.A.
 FEBRUARY, read Herschel's *Preliminary Discourse*
 APRIL 26, completed requirements for B.A., but because of residency rules it was not conferred until 1832
 APRIL–JULY, preparations for trip to Tenerife
 MAY, received (anonymous) gift of microscope from Herbert
 JULY 10, received clinometer
 AUGUST 3 or 4, began geological tour with Sedgwick
 AUGUST 5, left Shrewsbury with Sedgwick for Llangollen
 AUGUST 6, Velvet Hill to Ruthin
 AUGUST 7, Sunday, Ruthin to Denbigh
 AUGUST 8, Denbigh to Abergele
 AUGUST 9, Abergele to Conwy
 AUGUST 10, Conwy, Llanbedr, Penwaenmawr
 AUGUST 11, Aber Falls, Penrhyn
 AUGUST 12, Anglesey to Holyhead, parted company with Sedgwick at about this time
 AUGUST 13, returned from Anglesey
 AUGUST 14, Sunday, Cwm Idwal to Capel Curig
 AUGUST 15, Moel Siabod
 AUGUST 16, Capel Curig to Festiniog
 AUGUST 17, Festiniog to, probably, Barmouth
 AUGUST 18–28 (Sunday), Barmouth, with Whitley
 AUGUST 24, date of Henslow letter about position of naturalist on *Beagle*
 AUGUST 26, formal invitation letter to participate
 AUGUST 29, received Henslow letters on return to Shrewsbury
 AUGUST 30, CD → Henslow, saying he cannot participate
 AUGUST 31, to Maer, consulted with his uncle Josiah Wedgwood II
 SEPTEMBER 1, CD → Henslow from Shrewsbury, accepting offer
 SEPTEMBER 2–5, Cambridge
 SEPTEMBER 5–11, London, preparing for voyage
 SEPTEMBER 11–16, trip to Devonport with FitzRoy to see the *Beagle*
 SEPTEMBER 17–20, London, preparing for voyage
 SEPTEMBER 21, Cambridge
 SEPTEMBER 22, Shrewsbury
 OCTOBER 2, left home for voyage, via London
 OCTOBER 24, reached Plymouth, began diary
 DECEMBER 10 and 21, sailed but driven back
 DECEMBER 27, sailed for South America

1832

JANUARY 4, passed Madeira
 JANUARY 6, quarantine prevented landing at Tenerife
 JANUARY 10, began use of plankton net
 JANUARY 11, observations on *Sagitta* and other planktonic animals
 JANUARY 16, landed at St. Jago; collected dust at sea
 JANUARY 28, observations on living *Octopus*
 JANUARY 30, observations of flatworms
 FEBRUARY 8, left St. Jago
 FEBRUARY 14, studied pelagic gastropods, other plankton
 FEBRUARY 15, St Paul Rocks, one day on shore
 FEBRUARY 16, crossed equator
 FEBRUARY 17, collected plankton at 1°30'S
 FEBRUARY 20, Fernando de Noronha, one day on shore
 FEBRUARY 28, arrived at Bahia
 FEBRUARY 29, landed at Bahia
 MARCH 18, left Bahia
 MARCH 26, observations on the pelagic gastropod *Janthina* at sea
 MARCH 27–28, Abrolhos
 MARCH 28, observations on *Sagitta* at sea
 APRIL 4, landed at Rio de Janeiro; first mail from home
 APRIL 8, left for Sosego and elsewhere
 APRIL 9, Mandetiba
 APRIL 12–19, Sosego, with side-trip to Lennon estate
 APRIL 17–18, collected terrestrial invertebrates, including flatworms
 APRIL 25–JUNE 27, lived at Botafogo (Rio de Janeiro); extensive collecting of terrestrial animals
 MAY 1, worked on freshwater invertebrates
 MAY 6, observations on the sea-hare *Aplysia* and terrestrial animals
 MAY 15, observations on feather-stars and nudibranchs
 JUNE 4, First Reform Act passed
 JUNE 17, discovered terrestrial flatworms
 JUNE 28, moved back on board *Beagle*
 JULY 5–26, by boat to Montevideo
 JULY 19, observations on pelagic coelenterates
 JULY 26–AUGUST 19, Montevideo
 AUGUST 15, observations on pulmonate slugs together with terrestrial flatworms
 AUGUST 22, arrived at Punta Alta near Bahia Blanca
 AUGUST 24, more observations on *Sagitta* at sea
 AUGUST 30, observations on ctenophores at sea
 SEPTEMBER 2–4, observations on *Sagitta* (and other animals) at sea
 SEPTEMBER 6–OCTOBER 17, Bahia Blanca area
 SEPTEMBER 22, OCTOBER 8, Punta Alta (near Bahia Blanca) fossils
 SEPTEMBER 27–29, observations on *Sagitta* at sea off Bahia Blanca
 OCTOBER 8, *Trigonocephalus* recorded
 OCTOBER 8, found what he thought was a *Megatherium* fossil
 OCTOBER 17, observations on *Virgularia* at Bahia Blanca

OCTOBER 17 (ca.), notes on *Rhea americana*
 OCTOBER 26–30, Montevideo
 OCTOBER 30, departed on *Beagle* for Buenos Aires
 OCTOBER 31, first observations on gossamer of spiders
 NOVEMBER 2–10, Buenos Aires
 NOVEMBER 11, arrived at Montevideo
 NOVEMBER 14–28, Montevideo and environs; Darwin's annotations in Lyell's *Principles*, vol. 2 date from this month
 DECEMBER 1, south of Cape Corrientes, crustacean anatomy
 DECEMBER 3, *Beagle* anchored near San Blas
 DECEMBER 15, studied marine flatworm
 DECEMBER 16, reached coast of Tierra del Fuego
 DECEMBER 17, entered Le Maire Straits, anchored at Bay of Good Success
 DECEMBER 18, landed to encounter Fuegians
 DECEMBER 19, exploration on land
 DECEMBER 21–22, south of Wollaston Island and Cape Horn

1833

Late JANUARY and early FEBRUARY, some observations on Fuegians, exploration of that vicinity
 FEBRUARY 26, departed Tierra del Fuego for Falklands
 MARCH 1–APRIL 6, East Falkland Island
 MARCH 7, impressed by the fecundity of a nudibranch
 MARCH 31, first detailed work on barnacle anatomy; struck by their similarity to crustaceans rather than mollusks
 APRIL 11, CD → Henslow; first mention of interest in coral reefs
 APRIL 28, arrived at Maldonado
 APRIL 29, began residence at Maldonado (with excursions)
 MAY 14, notes on Pampas woodpecker
 JUNE 28, Queen Victoria crowned
 JULY, engaged Syms Covington as servant
 JULY 24, departed on *Beagle* from Maldonado; *Adventure* now functional
 AUGUST 3–11, Rio Negro
 AUGUST 4, Barrancas al Sur
 AUGUST 5–7, El Carmen
 AUGUST 8, trip to salt lake
 AUGUST 11–SEPTEMBER 20, overland trip from Rio Negro to Buenos Aires
 AUGUST 13, reached camp of General Rosas
 AUGUST 15, meeting with General Rosas
 AUGUST 24, arrived at Bahia Blanca
 AUGUST 25–28, visit to *Beagle*
 AUGUST 29–SEPTEMBER 6, Punta Alta fossil collecting
 SEPTEMBER 8, continued land journey; *Beagle* sailed
 SEPTEMBER 20–26, Buenos Aires
 SEPTEMBER 27–NOVEMBER 4, expedition to Santa Fe and return to Montevideo
 OCTOBER 1, Parana River fossils
 OCTOBER 3–4, sick in bed in Santa Fe
 OCTOBER 5, crossed river to Parana
 OCTOBER 12, headed down Parana River by boat, with delays
 OCTOBER 23–NOVEMBER 2, Buenos Aires

NOVEMBER 4–DECEMBER 6, Montevideo
 NOVEMBER 14–28, expedition to Mercedes
 NOVEMBER 29–DECEMBER 4, on shore in Montevideo
 DECEMBER 6, sailed from Rio Plata
 DECEMBER 23–JANUARY 4, 1834, Port Desire; geological field work on shore

1834

JANUARY 9, arrived at Puerto San Julian
 JANUARY 26, entered Strait of Magellan
 FEBRUARY 2, Port Famine
 FEBRUARY 6, climbed Mount Tarn
 FEBRUARY 13, observations on tunicate larva
 FEBRUARY 25–26, studied anatomy of holothurian
 FEBRUARY 28, anchorage at Wollaston Island
 FEBRUARY 28, at entrance to *Beagle* Channel
 MARCH 1, began observations on ectoproct bryozoans
 MARCH 5, sailed from Tierra del Fuego
 MARCH 10–APRIL 7, East Falkland Island (second visit); first letter from Henslow received on arrival
 APRIL 16, *Beagle* arrived at Santa Cruz River
 APRIL 16, *Beagle* laid up on shore for cleaning; Darwin collected specimens from it
 APRIL 18–MAY 8, expedition up Santa Cruz River; read third volume of Lyell's *Principles* after return
 MAY 12, left Patagonia for Strait of Magellan
 JUNE 1–8, Port Famine
 JUNE 10, departure from Tierra del Fuego via Magdalen channel for west coast of South America
 JUNE 28–JULY 13, Chiloé Island
 JULY 23, landed at Valparaiso, two letters from Henslow reached him
 JULY 24, CD → Henslow
 AUGUST 2–NOVEMBER 10, resided in Valparaiso with R. H. Corfield
 AUGUST 7, letter from Caroline Darwin arrived
 AUGUST 14, New Poor Law enacted
 AUGUST 14–27, geological excursion to base of Andes
 AUGUST 28–SEPTEMBER 6, Santiago
 SEPTEMBER 6–26, traveled back to Valparaiso
 SEPTEMBER 27–end of OCTOBER, stayed with R.H. Corfield; sick in bed, *Beagle's* departure delayed until fit to travel
 NOVEMBER 10, sailed for Chiloé
 NOVEMBER 21, arrived in Chiloé

1835

JANUARY 7–15, Low's Harbor
 JANUARY 8, discovered the aberrant barnacle *Cryptophialus* and made detailed drawings of its anatomy
 JANUARY 18, return to Chiloé
 JANUARY 19, observed eruption of Orsono volcano
 JANUARY 22–28, land excursion
 FEBRUARY 4, left Chiloé
 FEBRUARY 8–22, Valdivia
 FEBRUARY 20, earthquake
 MARCH 4–6, Conception; studies effects of earthquake

MARCH 5, observations on red snow
 MARCH 11, Valparaiso, with R. H. Corfield 12^h–14^h
 MARCH 14–18, Santiago; visited Alexander Caldcleugh
 MARCH 18–APRIL 10, crossed Cordillera of the Andes
 MARCH 26, bitten by *Triatoma*; possible infection with Chagas' disease
 APRIL 10–15, Santiago
 APRIL 15–17, traveled to Valparaiso
 APRIL 17–27, with R.H. Corfield
 APRIL 27–JULY 1, journey from Valparaiso to Coquimbo and Copiapo, rejoined *Beagle*
 JULY 2–3, in Copiapo at Mr. Bingley's house
 JULY 6, sailed on *Beagle* from port of Copiapo
 JULY 12, arrived at Iquique, Peru
 JULY 19–SEPTEMBER 6, Callao and Lima
 JULY 19, arrived at Callao
 JULY 29, departed by coach for Lima, spent five days there
 SEPTEMBER 7, *Beagle* sailed for Galapagos
 SEPTEMBER 15–OCTOBER 20, Galapagos
 SEPTEMBER 15, *Beagle* surveyed Chatham (San Cristobal) Island
 SEPTEMBER 16, landed near Wreck Point, Chatham Island
 SEPTEMBER 17, landed at Stephens Bay, Chatham Island
 SEPTEMBER 18, landed at Terrapin Road, Chatham Island
 SEPTEMBER 19–20, *Beagle* went to Fresh Water Bay and back
 SEPTEMBER 21–22, explored craterized district
 SEPTEMBER 23, sailed for Charles Island
 SEPTEMBER 24, arrived at Charles Island, collected near Post Office Bay, met the governor, Nicholas Lawson
 SEPTEMBER 25–26, trip to highlands via Black Beach
 SEPTEMBER 27, climbed Saddle Mountain
 SEPTEMBER 28, left Charles Island, passed Brattle Island
 SEPTEMBER 29, arrived at Albemarle Island
 SEPTEMBER 30, arrived at Banks Cove, Albemarle Island
 OCTOBER 1, on shore at Tagus Cove, Albemarle Island
 OCTOBER 2, *Beagle* departed for James Island
 OCTOBER 8, *Beagle* reached Bucaneer Cove, James Island
 OCTOBER 8–17, James Island, camped on shore
 OCTOBER 9, trip to interior, observed tortoises
 OCTOBER 11, visited James Bay salina and environs
 OCTOBER 12–13, trip to interior
 OCTOBER 14–17, Bucaneer Cove, observed land iguanas
 OCTOBER 18, finished survey of Albemarle Island
 OCTOBER 19, to Abingdon Island, then Culpepper and Wenman
 OCTOBER 20, headed for Tahiti
 NOVEMBER 9, off Tuamotus, saw first atolls
 NOVEMBER 15–26, Tahiti (visit to reef off Matavai)
 NOVEMBER 16, paper read to Cambridge Philosophical Society
 NOVEMBER 18, paper on South American Geology read to Geological Society of London
 NOVEMBER 25, Queen Pomare was entertained on board *Beagle*
 DECEMBER 21–30, New Zealand

1836

JANUARY 12, arrived in Australia (Sydney Cove)
 JANUARY 16–27, journey to interior
 JANUARY 16, Paramatta
 JANUARY 17, Emu Ferry, crossed Nepean River
 JANUARY 19, Govett's Leap, Wolgan
 JANUARY 20, Wallerawang to Bathurst
 JANUARY 21, Bathurst
 JANUARY 22, began return journey, via O'Connell
 JANUARY 24, sick in bed
 JANUARY 26, Emu Ferry, met Captain King; to Dunheved
 JANUARY 27, to Paramatta with King, on to Sydney
 JANUARY 30, left Sydney for Tasmania
 FEBRUARY 5–17, Tasmania
 FEBRUARY 7, day in Hobart, collected terrestrial flatworms
 FEBRUARY 11, climbed Mount Wellington
 FEBRUARY 12, met George Frankland, the Surveyor-General
 FEBRUARY 16, to New Norfolk for a day
 FEBRUARY 17, sailed from Hobart
 MARCH 4–5, observations on "confervae" at sea
 MARCH 6–14, King George's Sound, Australia
 APRIL 1–12, Cocos-Keeling Islands
 APRIL 29–MAY 9, Mauritius
 MAY, Red Notebook begins around this time
 MAY 31–JUNE 15, Cape of Good Hope
 JUNE 3, first meeting with Sir John Herschel
 JUNE 8–15, socialized with Herschel and others
 JUNE 28, FitzRoy/Darwin paper on Tahiti written at sea
 JUNE 29, crossed Tropic of Capricorn
 JULY 8–14, St. Helena
 JULY 19–23, Ascension Island
 AUGUST 1–6, Bahia, Brazil
 AUGUST 12–17, Pernambuco
 AUGUST 21, crossed equator
 SEPTEMBER 4, St. Jago
 SEPTEMBER 9, crossed Tropic of Cancer
 SEPTEMBER 20–24, Azores
 OCTOBER 2, arrived at Falmouth
 OCTOBER 4, reached Shrewsbury (absence 5 years, 2 days)
 OCTOBER 14, London
 OCTOBER 15, Cambridge
 OCTOBER 17, Dined at Henslow's, met Charles Cardale Babington
 OCTOBER 20, London, stayed with his brother, Erasmus Alvey Darwin
 OCTOBER 29, Lyells had Richard Owen to dinner to meet Darwin
 NOVEMBER, elected member of Geological Society of London
 NOVEMBER 1, attended meeting of Linnean Society, introduced by Yarell as visitor
 NOVEMBER 5, dinner at Roderick Murchison's; Richard Owen and Charles Babbage were there
 NOVEMBER 12, Maer
 NOVEMBER 16, Shrewsbury
 DECEMBER 2, London

DECEMBER 13, Cambridge

DECEMBER 16–MARCH 6, 1837, lived in lodgings, Fitzwilliam Street, Cambridge

1837

JANUARY, in Cambridge arranging specimens, finished last part of *Journal* manuscript

JANUARY 3, visited London and probably consulted with Richard Owen about fossils

JANUARY 4, read paper on elevation of Chile to Geological Society of London

FEBRUARY 17, attended Geological Society meeting

FEBRUARY 27, discussed fused sand tubes at meeting of Cambridge Philosophical Society

MARCH 6, moved to London

MARCH 7–12, Frank Sulloway's date for "conversion" to evolution

MARCH 13, took up residence at Great Marlborough Street

MARCH 13 to end of SEPTEMBER, worked on *Journal* full time

MARCH 14, Tuesday, read paper on *Rhea* to Zoological Society

APRIL 11, important meeting at Owen's apartments, with Owen and A. Farre

APRIL 19, Owen read paper on *Toxodon* to Geological Society

MAY 3, read paper on extinct Mammalia to Geological Society

MAY 10, read paper on Galapagos finches to Zoological Society

MAY 31, read paper on coral formations to Geological Society; Owen was present

End of JUNE, Red Notebook probably completed

JUNE, text of *Journal* completed (sent to printers in August)

JUNE 20, King William IV died; succeeded by Victoria

JUNE, began notebook A

JULY, began notebook B (1st on transmutation)

JULY 7–13, ca., met with Owen to work on fossils

AUGUST 25, awarded grant for *Zoology* of voyage

SEPTEMBER 20, experienced palpitations of heart

SEPTEMBER 22, finished proofs of *Journal*, to Shrewsbury

OCTOBER, NOVEMBER, finished proofs of *Journal*, began *Volcanic Islands*

OCTOBER 21, returned to London

NOVEMBER 1, paper on worms read before Geological Society

NOVEMBER 14, finished paper on worms for Transactions of Geological Society

NOVEMBER 20–21, visited W. D. Fox at Isle of Wight

1838

Work on *Volcanic Islands* continues to early June, work on zoology

JANUARY 17, finished geology of Galapagos and Ascension

FEBRUARY, Owen on fossil mammals part 1 published

FEBRUARY 5, elected Vice-President of Entomological

Society

FEBRUARY 16, elected Secretary of Geological Society; served until FEBRUARY 19, 1841

FEBRUARY 25, finished account of St. Helena

MARCH, began Notebook C (2nd on transmutation)

MARCH 7, read paper on continental elevation to Geological Society

MARCH 18, read paper on earthquake to Geological Society

MARCH 28, observations on primates at London zoo

APRIL 16, began geology of Cape of Good Hope, Sydney

APRIL 25, attended Geological Society meeting

MAY, ended Notebook B

MAY, first part of Waterhouse on *Mammalia* published

MAY 1, health began to decline

MAY 10–13, visit to Henslow at Cambridge

MAY 15, began work on geology of Tasmania and New Zealand

MAY 22, began work on geology of St. Jago and Cape Verde

JUNE 21, elected to Athenaeum

JUNE 23, finished Notebook C

JUNE 23, departed for Scotland

JUNE 28–JULY 5, field work on Glen Roy

JUNE 28, coronation of Queen Victoria

JULY, began Notebook D (3rd on transmutation); first part of *Birds* by Gould published

JULY 13, reached Shrewsbury

JULY 15, began Notebook M

JULY 29, to Maer

AUGUST 1, to London

AUGUST 1–SEPTEMBER 6, wrote Glen Roy paper

FALL, read Whewell's *History of the Inductive Sciences*

SEPTEMBER, 2nd part of *Mammalia* published

SEPTEMBER 6, finished Glen Roy paper

SEPTEMBER 28, began to read Malthus on population

OCTOBER 2, completed Notebooks M and D, and began Notebooks N and E (4th on transmutation)

OCTOBER 3, finished Malthus on population, Lavater on physiognomy

OCTOBER 5, began "paper" on coral reefs—became a book

OCTOBER 12, finished *Discourses* by Joshua Reynolds

OCTOBER 25, to Windsor for two days

OCTOBER 27, *Journal*: wrote preface and addenda

NOVEMBER, 3rd part of *Mammalia* published

NOVEMBER 9, to Maer with Hensleigh & Fanny Wedgwood

NOVEMBER 11, Sunday, engaged to marry Emma Wedgwood

NOVEMBER 13, CD → Lyell on Comte

NOVEMBER 14, Shrewsbury

NOVEMBER 19, back to London, saw FitzRoys

NOVEMBER 21, Wednesday, attended Geological Society meeting

NOVEMBER 24, Saturday, dined with Lyells; conversed about geology and economics

NOVEMBER 25, Sunday, went with Erasmus Darwin for tea at Carlyles'—their first meeting

DECEMBER 6, hunting for housing in London with Emma;

she returned home on the 21st
 DECEMBER 19, attended meeting of the Geological Society
 DECEMBER 31, took possession of house at 12, Upper
 Gower Street

1839

JANUARY, *Birds, Zoology* 3(2) published
 JANUARY 1, Dinner at Erasmus Darwin's, with Carlyles,
 Hensleigh Wedgwoods; occupied house at 12, Upper
 Gower Street
 JANUARY 11, to Shrewsbury
 JANUARY 15, to Maer
 JANUARY 18, to London
 JANUARY 20, Sunday, Lyells called on him
 JANUARY 22, dined at Lyells'
 JANUARY 24, elected Fellow of the Royal Society of London
 JANUARY 28, to Maer
 JANUARY 29, Tuesday, married Emma Wedgwood at Maer
 Church
 FEBRUARY & MARCH, some species work, corals
 FEBRUARY 5, began to study German
 FEBRUARY 7, 21, 28, Glen Roy paper read, published soon
 thereafter; resumed work on coral reefs
 MARCH, 2nd part of *Fossil Mammalia, Zool.* 1(2) published
 MARCH, elected Fellow of the Zoological Society
 MARCH 10, ill for several days
 MARCH 20, finished Blumenbach's essay on generation
 MARCH 26, finished Spallanzani's essay on animal repro-
 duction, Wells on instinct, Cline on instinct, Erasmus
 Darwin's *Zoonomia*, Volume I, Moore on pigeons
 MARCH 28, Adam Sedgwick called
 APRIL, MAY, distributed questionnaire on animal breeding
 APRIL 1, Monday, gave party for Henslows, Lyells,
 L. Horner, Dr. W. H. Fitton, and Robert Brown
 APRIL 26, to Maer
 MAY, *Fossil Mammalia, Zoology* 1(3) published
 MAY 13, to Shrewsbury
 MAY 18, finished Stanley on birds, Mackintosh on ethical
 philosophy, Bell on the hand, Lamarck's *Philosophie
 Zoologique*
 MAY 20, to London
 MAY 27, Alphonse de Candolle probably at dinner
 JUNE 1, *Journal of Researches* published; finished King's
 and FitzRoy's contributions to the same work
 JUNE 30, finished Walker on intermarriage
 JULY, *Birds, Zoology* 3(3) published
 JULY 10, finished Notebook E
 AUGUST 15, *Journal of Researches* issued separately
 AUGUST 23, to Maer
 AUGUST 26, to Birmingham for British Association meeting
 SEPTEMBER, *Mammalia, Zoology* part 3, published
 SEPTEMBER 12, to Shrewsbury
 SEPTEMBER 25, finished Prichard's *Physical Researches*
 SEPTEMBER 29, finished Hume's *Dialogues on Natural
 Religion*, Swainson on biogeography
 OCTOBER 2, to London
 NOVEMBER, *Birds, Zoology* 3(4) published

NOVEMBER 14, attended Geological Society meeting;
 Buckland contradicted Darwin's views
 NOVEMBER, note on rock seen on an iceberg published
 DECEMBER 24 or 25, became ill, remained so for about two
 months
 DECEMBER 27, William Erasmus Darwin born; Darwin's
 notes on his children's behavior begin on this day and
 end in July, 1856

1840

Penny Post introduced
 Ill much of the time, did a lot of work on species, at some
 time (early?) read Holland's *Medical Notes*
 JANUARY 6, read Koelreuter papers
 JANUARY 16, finished Vol. I of Müller's *Physiology*
 JANUARY, *Fish, Zoology* 4(1) published
 FEBRUARY 7, finished Brougham on natural theology
 FEBRUARY 10, finished Blackwall on zoology
 FEBRUARY 15, finished Henslow on botany
 FEBRUARY 24, skimmed Whewell's *Bridgewater Treatise*
 again
 MARCH 4, read Agassiz on glaciers
 MARCH 24, wrote Geological Society, resigning as
 Secretary for reasons of ill health
 MARCH 26, began work on coral reef book
 APRIL, *Fossil Mammalia, Zoology* 1(4) published
 APRIL 3, trip to Shrewsbury
 APRIL 6, finished Isidore Geoffroy Saint-Hilaire's *Zoologie
 Generale*
 APRIL 20, read Erasmus Darwin's *Phytologia*
 APRIL 24, read Spallanzani's essays on generation,
 Mandeville's *Fable of the Bees*
 APRIL 28, or soon thereafter, end of Notebook N
 JUNE, *Fish, Zoology* 4(2) published
 JUNE 10–NOVEMBER 14, went to Maer; reading list includes
 Bell's *Anatomy of Expression*, Buffon, Tournefort,
 Haller's physiology, Buckland's *Bridgewater Treatise*,
 and many works of travel and literature
 AUGUST 4, became seriously ill; correspondence ceased for
 five months
 AUGUST, "Mould," elevation papers published
 NOVEMBER 14, to London
 DECEMBER 15, began last part of *Birds for Zoology*
 DECEMBER 15, finished Fleming's *Philosophy of Zoology*
 DECEMBER 17, finished Humboldt's *Personal Narrative*
 DECEMBER 21, finished Guillemin's article on hybrids

1841

FEBRUARY 20, *Birds, Zoology* 3(5) completed
 MARCH, *Birds, Zoology* 3(5) published
 MARCH 2, Ann Elizabeth Darwin ("Annie") born
 APRIL, *Fish, Zoology*, 4(5) published
 APRIL 4, finished paper on boulders and till
 APRIL 14, paper on erratic boulders read to Geological
 Society
 MAY 13, read Linnaeus ("Biberg") on economy of nature
 MAY 16, read Prévost and Dumas on zoosperms

MAY 28, went to Maer, then Shrewsbury
 JULY 23, back to London
 JULY 26, resumed work on coral after more than 13 months
 AUGUST 21, Humble-bees paper in *Gardeners' Chronicle*
 SEPTEMBER, observations on castings of worms
 OCTOBER, Pernambuco bar paper published
 OCTOBER 25, finished Youatt on sheep
 OCTOBER 31, had breakfast at Owen's
 NOVEMBER 10, finished Sprengel's *Entdeckte Geheimniss*;
 Richard Owen and his wife visited
 NOVEMBER 21, finished Liebig on agricultural chemistry
 DECEMBER 4, finished Godwin on population
 DECEMBER 14, paper on ancient glaciers read before the
 Geological Society
 DECEMBER 18, finished Hooker's *Botanical Miscellany*

1842

Very poor health in 1841 and 1842
 General strike in Britain
 JANUARY 3, *Coral Reefs* sent to publishers; first draft of
 work on species ("Sketch")
 JANUARY 3, finished Waterhouse on marsupials
 JANUARY 29, met Alexander von Humboldt at Murchison's
 house in London
 FEBRUARY 11, appointed by Council of the British
 Association to committee on zoological nomenclature
 FEBRUARY 20, read *Botanic Garden* and *Temple of Nature*
 by his grandfather, Erasmus Darwin
 FEBRUARY 28, finished Bechstein's *Naturgeschichte*
 MARCH 7, to Shrewsbury for 10 days
 APRIL 9, finished second volume of Müller's *Physiology*
 APRIL 24, finished Smellie's *Philosophy of Natural History*
 MAY 6, finished proofs of *Reefs*, published the same month
 MAY 7–17, trip to Shrewsbury
 MAY 18, left for Maer
 MAY 26, manuscript note on worms burying things
 JUNE 10, finished Miller's *Old Red Sandstone*
 JUNE 13, manuscript notes on worms
 JUNE 15, left for Shrewsbury, "Sketch" of species theory
 JUNE 18, left on trip to Capel-Curig, Bangor, Carnavon,
 back to Capel-Curig
 JUNE 27, nominal date for signing of report on nomencla-
 ture written by Strickland
 JULY 18, returned to London
 JULY 19, AUGUST 7, and AUGUST 21, observed bees polli-
 nating flowers (see *Cross and Self Fertilization*)
 AUGUST, Bell's *Reptiles, Zool.* V (1) published
 AUGUST 15, read first volume of Lamarck's invertebrates
 AUGUST 18, began to revise *Volcanic Islands*
 SEPTEMBER 14, Emma Darwin moved to Down House
 SEPTEMBER 17, Charles Darwin moved to Down House
 Sept. 23, Mary Eleanor Darwin born
 OCTOBER 14, began work on *Volcanic Islands*
 OCTOBER 16, Mary Eleanor Darwin died

1843

Continued work on volcanoes and species
 JANUARY, reply to Maclaren's review of *Reefs* published
 JANUARY 15, skimmed Adam Smith's *The Theory of Moral
 Sentiments*
 MAY 3, read Kirby & Spence's *Entomology*
 MAY 16, read Paley's *Natural Theology*
 MAY 20, finished Carlyle's *Past and Present*
 JUNE 16, Hume's *History of England* to Elizabeth
 JULY 8–15, week at Maer and Shrewsbury
 JULY 12, Josiah Wedgwood II died
 JULY 26, began correspondence with George Waterhouse on
 principles of classification
 SEPTEMBER 7, J.D. Hooker returned from Antarctic expedi-
 tion
 SEPTEMBER 9, paper on double flowers in *Gardeners'
 Chronicle* published
 SEPTEMBER 14, finished first four volumes of Gibbon
 SEPTEMBER 25, Henrietta Emma Darwin born
 OCTOBER 18–29, trip to Shrewsbury
 OCTOBER, *Reptiles, Zoology* 5(2) published, completing
 zoology of the voyage
 OCTOBER 12, to Shrewsbury for twelve days
 DECEMBER 3 or 17, CD → G.R. Waterhouse on taxonomy,
 including quarianism

1844

JANUARY, paper on *Sagitta* published
 JANUARY 5, *Volcanic Islands* finished, published in March
 JANUARY 11, CD → J.D. Hooker, informing him of evolu-
 tionary views
 JANUARY 31, attended Geological Society Council meeting
 FEBRUARY 13, finished species essay
 FEBRUARY 21, attended Geological Society Council meeting
 MARCH 20, attended Geological Society Council meeting
 APRIL 6, "Origin of Mould" published
 APRIL 17, attended Geological Society Council meeting
 APRIL 23–MAY 30, to Maer and Shrewsbury
 JUNE 8, "Manures and steeping seeds" published
 JULY 5, CD → Emma Darwin, giving instructions for possi-
 ble posthumous publication of species essay, which he
 had just completed
 JULY 5, read Owen's lectures on invertebrates
 JULY 17, to London with Emma
 JULY 18, visited Kew Gardens with Emma
 JULY 27, began *South America*
 SEPTEMBER 14, "Variegated leaves," "Salt" published
 OCTOBER, paper on flatworms "Planariae" published
 OCTOBER 1, finished Owen on *Myiodon*
 OCTOBER 14, CD → Leonard Jenyns, informing him of evo-
 lutionary views
 OCTOBER 18–29, trip to Shrewsbury
 OCTOBER 20, finished Fothergill on philosophy of natural
 history
 NOVEMBER 20, read Robert Chambers's (anonymous)
Vestiges, attended Geological Society Council meeting

DECEMBER 7–8, J.D. Hooker's first visit to Down House
 DECEMBER 18, attended Geological Society Council meeting
 DECEMBER 30, J.D. Hooker → CD; remarks on *Vestiges*

1845

JANUARY 7, CD → J.D. Hooker; gives negative reaction to *Vestiges*
 JANUARY 8, attended Geological Society Council meeting
 JANUARY 27, CD → J.D. Hooker, saying Forbes has forestalled CD on alpine plants
 FEBRUARY 5, attended Geological Society Council meeting
 MARCH 12, attended Geological Society Council meeting
 MARCH 31, CD → J.D. Hooker; says he has just finished Isidore Geoffroy Saint-Hilaire on animal monstrosities
 SPRING, joined Philosophical Club of Royal Society
 APRIL 2, attended Geological Society Council meeting
 APRIL 24, completed first draft of *South America*
 APRIL 25, began second edition of *Journal of Researches*; preface signed in June
 APRIL 29–MAY 10, to Shrewsbury
 MAY 28, attended Geological Society Council meeting
 JUNE 4, "Dust" paper read to Geological Society
 JUNE 11, attended Geological Society Council meeting
 JUNE 8, read A.P. de Candolle's article on plant biogeography
 JULY 2, attended Geological Society Council meeting
 JULY 9, George Howard Darwin born
 AUGUST 5, finished Lyell's *Travels in North America*
 AUGUST 25, Erasmus Alvey Darwin arrived for a week's visit
 AUGUST 26, completed 2nd edition of *Journal of Researches*
 SEPTEMBER 15–OCTOBER 26, to Shrewsbury and elsewhere
 OCTOBER 29, resumed work on *South America*
 NOVEMBER 5 or 12, Wednesday, CD → J.D. Hooker, saying that he will finish geology, do a little zoology, and then proceed to species work
 NOVEMBER 19, attended Geological Society Council meeting
 NOVEMBER 24, returned to Down from London
 DECEMBER 6, visit from J.D. Hooker; Waterhouse, Forbes and Falconer also there
 DECEMBER 10, attended Geological Society Council meeting

1846

JANUARY 7, attended Geological Society Council meeting
 FEBRUARY 4, attended Geological Society Council meeting
 FEBRUARY 6, finished Bronn's *Geschichte der Natur* vol. 2
 FEBRUARY 20, attended Geological Society Council meeting
 FEBRUARY 21–MARCH 3, trip to Shrewsbury
 MARCH 13, CD → J.D. Hooker; says he just finished A. St. Hilaire's lectures, praises Moquin-Tandon's book on monstrosities
 MARCH 20, read A. Saint Hilaire on botanical morphology
 MARCH 25, read paper on geology of the Falklands to

Geological Society; attended Council meeting
 MARCH 31, Elizabeth Allen Wedgwood (CD's mother in law) died
 APRIL 10, CD → J.D. Hooker; praises Owen's *Archetype*
 APRIL 22, attended Geological Society Council meeting
 APRIL 24, read Steenstrup on alternation of generations
 MAY 9, read Moquin-Tandon on vegetable teratology, Owen's *British Fossil Mammalia*
 MAY 20, attended Geological Society Council meeting
 JUNE 3, attended Geological Society Council meeting
 JUNE 6, repeal of Corn Laws
 JUNE 17, attended Geological Society Council meeting
 JULY 31–AUGUST 9, trip to Shrewsbury
 AUGUST, "Saliferous deposits" published
 SEPTEMBER 9, departed with Emma for Southampton
 SEPTEMBER 10–11, attended meeting of British Association for the Advancement of Science at Southampton
 SEPTEMBER 12, to Portsmouth and Isle of Wight coast
 SEPTEMBER 13, to Winchester
 SEPTEMBER 14, to Netley Abbey & Southampton
 SEPTEMBER 17, returned home
 SEPTEMBER 22, to Knole Park
 OCTOBER, two trips to London
 OCTOBER 1, finished proofs of *South America*
 OCTOBER 1, began paper on "Arthrobalanus"
 OCTOBER 9, finished Playfair's biography of Hutton
 OCTOBER 10–12 ca., Sulivans and Hooker visited
 OCTOBER, 28, CD → FitzRoy, on dissecting *Cryptophialus*
 NOVEMBER 18, attended Geological Society Council meeting
 DECEMBER 2, attended Geological Society Council meeting
 DECEMBER 15, finished Burton's biography of Hume
 DECEMBER 18, CD → John Gray; first record of plan to do barnacle monograph

1847

JANUARY, review of Waterhouse book on mammals published
 JANUARY 2, worked on *Conia*
 JANUARY 6, attended Geological Society Council meeting
 JANUARY 7, visited Owen at home, discussed osteology and archetypes
 JANUARY 16, visit from Lyells and J.D. Hooker; Hooker left on JANUARY 23, probably taking a copy of 1844 "Essay" with him
 JANUARY 30, read Milne-Edwards on crustacean biogeography
 FEBRUARY, worked on *Balanus*
 FEBRUARY 19–MARCH 5, trip to Shrewsbury
 MARCH, worked on *Acasta* and *Clisia* (= *Verruca*); later this year on *Tubicinella* and *Coronula*
 MARCH 4, J.D. Hooker → CD, on natural groups
 MARCH 6, paper on salt published
 MARCH 15, finished Owen's lectures on fish
 APRIL 7, reread Malthus on population
 APRIL 18, CD → J.D. Hooker on having met Robert

Chambers; considers him author of *Vestiges*
 APRIL 23, finished Burmeister on trilobites, Lawrence on man
 APRIL 28, attended Geological Society Council meeting
 MAY 12, attended Geological Society Council meeting
 MAY 12, finished Owen's *Pearly Nautilus*
 MAY 26, attended Geological Society Council meeting
 JUNE 9, attended Geological Society Council meeting
 JUNE 22–30, attended British Association meeting at Oxford, met Milne-Edwards; some travel after meeting
 JULY 1, returned to Down House
 JULY 8, Elizabeth Darwin born
 AUGUST 14, finished Flourens on animal intelligence
 AUGUST 16, Bernhard Studer visited; finished 6th edition of *Vestiges* and third British Association report
 SEPTEMBER 8, CD → Lyell; resists ice lake theory of Glen Roy parallel roads
 SEPTEMBER 13, finished Sismondi on political economy
 SEPTEMBER 20, CD → David Milne; staggered by ice lake theory
 SEPTEMBER 24, finished Oken's *Physiophilosophy*
 OCTOBER 22–NOVEMBER 5, trip to Shrewsbury
 NOVEMBER 1, finished first part of Goethe's autobiography
 NOVEMBER 10, finished vols. 3–5 of Pritchard on mankind
 NOVEMBER 11, J.D. Hooker left for Himalaya expedition
 NOVEMBER 17, attended Geological Society Council meeting
 NOVEMBER 18, CD → Milne-Edwards; their first letter
 NOVEMBER 24, finished Hooker on Antarctic botany
 NOVEMBER 26, finished Pictet's book on paleontology
 DECEMBER 1, attended Geological Society Council meeting
 DECEMBER 7, finished Roget's Bridgewater Treatise
 DECEMBER 15, attended Geological Society Council meeting
 DECEMBER 18, began anatomy of pedunculated cirripede

1848

Very ill from July to end of year
 JANUARY 1, noted that he had read all British Association Reports up to and including 1847
 JANUARY 5, attended Geological Society Council meeting
 FEBRUARY 2, attended Geological Society Council meeting
 FEBRUARY 12, visit from Richard Owen, Edward Forbes, Andrew Ramsay (departed FEBRUARY 14) and Lyells (departed FEBRUARY 15)
 MARCH 5, completed reading of volumes I–XX of *Annales* of the Paris museum
 MARCH 20, finished chapter on geology for scientific voyagers and paper on boulders
 APRIL, CD → Owen, commenting on archetype report
 APRIL 1, CD → Henslow; had "just these last few days" discovered separation of the sexes in cirripedes (*Ibla*)
 APRIL 19, attended Geological Society Council meeting; read paper on erratic boulders
 MAY, read Buckland's *Bridgewater Treatise*
 MAY 10, CD → J.D. Hooker; complementary males discov-

ered (*Scalpellum*)
 MAY 17, attended Geological Society Council meeting
 MAY 17–JUNE 1, trip to Shrewsbury
 MAY 31, attended Geological Society Council meeting
 JUNE 7, read supplements to Müller's *Physiology*
 JUNE 14, attended Geological Society Council meeting
 JULY 22–29, trip to Swanage and elsewhere
 AUGUST 16, Francis Darwin born
 OCTOBER 5, finished Gould on Australian birds
 OCTOBER 10–25, trip to Shrewsbury
 OCTOBER 22, CD → Louis Agassiz, on cirripedes
 NOVEMBER 1, ca., began systematic work on pedunculated Cirripedes
 NOVEMBER 13, Robert Waring Darwin died at 8:30 A.M.
 NOVEMBER 17–26, trip to Shrewsbury
 NOVEMBER 18, attended his father's funeral
 DECEMBER 25, finished *Mémoires* of the Paris museum through Volume IX

1849

JANUARY 13, finished work on *Anatifera*
 JANUARY 31, attended Geological Society Council meeting
 FEBRUARY 15, Strickland → CD; fine letter on types
 MARCH 8, departed for Malvern
 MARCH 10 to JUNE 30, at Malvern for hydropathic treatment
 Late MARCH, read J.D. Hooker's Galapagos papers
 JUNE 30, finished Lyell's book on second visit to America
 JULY 15, resumed systematic work on pedunculated cirripedes
 JULY 20, read Agassiz & Gould's *Principles of Zoology*
 AUGUST 12, CD → Dana; their first letter on cirripedes
 SEPTEMBER 11–21, attended British Association meeting at Birmingham, where he made remarks on cirripedes reported in *Athenaeum*, met with Milne-Edwards
 SEPTEMBER 21, first CD → Hancock; letter, remarks and *Athenaeum* paper mentioned
 OCTOBER 15–18, Lyells visited
 Late OCTOBER, read Lovén's paper on *Alepa* = *Anelasma*
 NOVEMBER 2, visited by William Darwin Fox
 NOVEMBER 7, attended Geological Society Council meeting
 NOVEMBER 12, read Sedgwick's *Discourse on Study*
 DECEMBER 4, CD → Lyell; had just read Dana on reefs
 DECEMBER 7, CD → Lyell, commenting on Dana's criticisms
 DECEMBER 10, finished Dana on geology of U.S. Exploring Expedition

1850

JANUARY 15, Leonard Darwin born
 FEBRUARY 6, attended Geological Society Council meeting
 FEBRUARY 24, CD → Dana; oviduct diagnostic of cirripedes
 MARCH 23, finished Owen's *Parthenogenesis* and *The Nature of Limbs*
 APRIL 10, attended Geological Society Council meeting
 APRIL 28, began systematic work on sessile cirripedes
 APRIL 18–30, visit by Lyells

MAY 20, CD → J.J.S. Steenstrup, expressing interest in his paper on hermaphroditism, as yet unread
 JUNE 5, paper on fossil Lepadidae read to Geological Society
 JUNE 11–18, to Malvern
 JUNE 13, CD → J.D. Hooker, on variation of cirripedes
 AUGUST 10–16, to Leith Hill Place (Wedgwood home)
 OCTOBER 14–22, trip to Hartfield and Ramsgate
 NOVEMBER 28, read Steenstrup on hermaphroditism
 DECEMBER 18, attended Geological Society Council meeting
 DECEMBER 30, finished *Balanus* and *Pachylasma*

1851

FEBRUARY 22, Charles Lyell visited
 MARCH 24, took Annie with Henrietta to Malvern
 MARCH 28–MARCH 31, back in London
 MARCH 30, Darwins visited Allens in London; Carlyle there
 MARCH 31, returned to Down
 APRIL 5, finished Lyell's *Manual of Geology*
 APRIL 16, departed for Malvern
 APRIL 17, arrived at Malvern
 APRIL 23, Anne Elizabeth Darwin died at Malvern
 MAY 13, Horace Darwin born
 JUNE, *Fossil Lepadidae* published
 JULY 17, CD → Huxley, thanking him for note and discussing views of Huxley on individuality and zooids
 JULY 30–AUGUST 10, visit to London; attended Great Exhibition, which impressed him favorably
 AUGUST 18, began proofs of *Living Lepadidae*
 OCTOBER 22–25, Charles Lyell visited
 NOVEMBER 12, finished proofs of *Living Lepadidae*, began work on sessile cirripedes with genera *Conia* & *Elminius*
 DECEMBER 17, attended meeting of Geological Society Club
 DECEMBER 30, finished *Balanus* and *Pachylasma*

1852

Worked on sessile cirripedes: *Acasta*, *Coronula*, *Platylepas*, *Tubicinella*, *Xenobalanus*, *Chelonoibia*, *Chthamalus*, *Chamaesipho*, *Octomeris*, *Catophragmus*, *Balanus*, and *Verruca*
 JANUARY 19, note on ropes for wells published
 JANUARY 29, to London
 FEBRUARY 15, CD → Dana; sends two *Lepadidae* volumes; more letters follow discussing their disagreements on limbs
 FEBRUARY 24, finished Humboldt's *Aspects of Nature*
 MARCH 24, visited William Darwin at Rugby School, then to Shrewsbury, returning to Down on April 1
 APRIL 17–26, J.D. and Frances Hooker visited
 MAY 8, CD → Dana, on homologies of larvae
 JUNE, *Living Lepadidae* published (nominally 1851)
 JUNE 2–5, to London
 JUNE 10, finished Gould on Australian birds
 JUNE 17, CD → Richard Owen, expressing thanks for praise of barnacle anatomy

AUGUST 5–9, Lyells visited
 SEPTEMBER 11–16, to Leith Hill
 NOVEMBER 8–12, to London
 NOVEMBER 26, finished Milne-Edwards's *Zoologie*
 DECEMBER 1, Napoleon III declared Emperor of France
 DECEMBER 25, CD → Albany Hancock, has not yet examined *Alcippe*

1853

Completed sessile cirripedes: *Verruca*, *Alcippe*, *Cryptophialis*
 FEBRUARY 1–3, to London to visit brother and sisters
 FEBRUARY 10, CD → Albany Hancock; has found *Alcippe* male, hadn't dreamed it was a cirripede
 MARCH, probably found *Cryptophialus* males
 MARCH 30, CD → Albany Hancock: hard to put *Cryptophialus* and *Alcippe* in the same order
 APRIL 4–7, to London
 APRIL 6, met Huxley, at meeting of Geological Society
 APRIL 20, finished Agassiz on fossil fishes of England
 APRIL 23, CD → Huxley on notion of archetype
 APRIL 30, finished Baird on Entomostraca
 MAY 7, attended Royal Society party in London
 JUNE 1, attended meeting of Geological Society
 JULY 14–AUGUST 4, Darwin family trip to Eastbourne
 AUGUST 13–17, visit to Chobham Camp
 SEPTEMBER, read first 4 volumes of *Microscopic Journal*
 SEPTEMBER 20, read Dana's monograph on Crustacea
 SEPTEMBER 25, CD → J.D. Hooker on effect of species concepts on his barnacle researches
 NOVEMBER 30, awarded Royal Society medal, attended meeting
 DECEMBER 6, CD → Dana on homologies of cirripede limbs
 DECEMBER 10, visit to London

1854

This year was very important for morphological principles
 FEBRUARY 3–JULY 15, proofs of *Living Balanidae*
 FEBRUARY 6, finished Wallace on Amazon, Schleiden on plants
 FEBRUARY 23, Thursday, to London with Emma, Henrietta and Leonard
 FEBRUARY 25, Saturday, returned home
 FEBRUARY 29, finished first volume of Hooker's *Himalayan Journal*
 MARCH 7, finished second volume of Hooker's *Himalayan Journal*
 MARCH 7, elected Fellow of the Linnean Society of London
 MARCH 11, finished Comte on positive philosophy
 MARCH 13–17, to Hartfield because son Francis was ill
 APRIL 23, CD → Huxley, commenting on paper about morphology of mollusks paper and theoretical principles
 APRIL 24, elected to Philosophical Club of Royal Society
 MAY 1, Monday, to London with Emma
 MAY 2, attended meeting of Linnean Society
 MAY 3, Wednesday, returned home

MAY 13, Saturday, dined at the Lubbocks'
 MAY 15, finished Eaton on pigeons
 MAY 20, finished Whewell's *Plurality of Worlds*
 MAY 24, to London
 MAY 25, attended meeting of Philosophical Club
 JUNE 21–23, to London
 JUNE 22, attended meeting of Philosophical Club
 JUNE 24, J.D. Hooker → CD on highness and lowness
 JUNE 27, CD → J.D. Hooker on highness and lowness
 JUNE 29, J.D. Hooker → CD on highness and lowness
 JULY 13–15, to Hartfield
 SEPTEMBER, completed proofs of *Fossil Balanidae*
 SEPTEMBER 2, CD → Huxley; says 2nd part of *Cirripedia* out, discusses Huxley's *Vestiges* review and Owen's probable response; only cryptic assertion of evolutionary leanings
 SEPTEMBER 8, CD → Huxley on ovigerous fraena of barnacles
 SEPTEMBER 9, began sorting notes for species book
 SEPTEMBER 13, CD → Huxley on cement glands of barnacles
 SEPTEMBER 25, finished Westwood on classification of insects
 OCTOBER 9–14, trip to Leith Hill Place (Wedgwood home)
 OCTOBER 23, to London with Emma
 OCTOBER 26, Lyells and Hookers at dinner party; Hooker astonished them with trimorphic *Catasetum*
 OCTOBER 28, Saturday, Lyells departed
 NOVEMBER 2–4, to London
 NOVEMBER 2, elected to Council of Royal Society of London
 NOVEMBER 30–DECEMBER 1, to London: attended meeting of Royal Society on the 30th
 DECEMBER 1, breakfast at home of Sir Robert Inglis; present were, among others: FitzRoy, Owen, Herschel, and Robert Brown

1855

JANUARY 18, took a house in London for a month
 JANUARY 25, attended meetings of Council of the Royal Society and Philosophical Club
 JANUARY 29, party at Lyells'
 FEBRUARY 15, returned home
 FEBRUARY 20, CD → Huxley, noting absence of anus in Brachiopoda has analogue in the cirripede *Alcippe*
 MARCH 2, Wollaston → CD, responding to queries about his book on insects of Madeira
 MARCH 2, attended Linnean Society meeting, met P.H. Gosse
 MARCH 7, CD → J.D. Hooker; critique of Huxley, Wollaston; proposes explanation for apterous insects on islands
 MARCH 8, CD → Huxley on his exposition of mollusk anatomy; also barnacle cement glands and reasons for rank of Cirripedia
 MARCH 20–24, in London

MARCH 22, attended meeting of Council of Royal Society
 MARCH 30, began experiments on effects of salt on seeds
 APRIL 11, wrote letter to Editor of *Gardeners' Chronicle* requesting advice on effects of seawater on seeds (published April 14)
 APRIL 13, CD → J.D. Hooker on plant experiments
 APRIL 20, Darwins attended opening ceremony of Crystal Palace at Sydenham; socialized with Owen and his wife there
 APRIL 21, attended meeting of Council of Royal Society
 APRIL 23, attended meeting of Council of Royal Society
 APRIL 25, CD → A. Gray; first letter, had met at Kew; asks for help with plant distribution
 APRIL 30–MAY 5, to London; saw Yarrell
 MAY, *Fossil Balanidae* published (nominally 1854)
 MAY 21, completed paper on effects of seawater on seeds
 MAY 22, A. Gray → CD; first letter
 MAY 26, paper on effects of seawater on seeds published
 MAY 28, finished Lyell's *Elements of Geology*, 5th ed.
 MAY 29, finished Carpenter on comparative physiology
 JUNE, finished rereading Gaertner (begun April or earlier)
 SUMMER, experiments on hybridization carried out
 JUNE 5, CD → J.D. Hooker; describes plant competition experiments and more work on effects of salt on seeds
 JUNE 10, CD → J.D. Hooker; asks for sensitive plant
 JUNE 28, attended meeting of Council of Royal Society
 JULY 2, CD → Henslow on *Lychnis*; request for seeds, notes experiments on salting of seeds
 JULY 9–12, studied insects and nectaries of vetch
 JULY 16–19, Horners visited
 JULY 21, paper on nectaries of vetch published
 JULY 21, began experiments on vitality of seeds
 AUGUST 7–9, to London
 AUGUST 7, dinner at Erasmus Alvey Darwin's home: J.S. Henslow and J.D. Hooker among the guests
 AUGUST 28–30, attended Anerley poultry show
 AUGUST 31, CD → Tegetmeier, the first of many letters, on poultry
 SEPTEMBER, read Tegetmeier on poultry, evidently before publication
 SEPTEMBER 10–22, trip to attend British Association meeting, Glasgow, with visit to Shrewsbury on return
 OCTOBER 25, attended meeting of Council of Royal Society and probably also that of Philosophical Club
 OCTOBER 30, finished Quatrefage's *Souvenirs*
 NOVEMBER 3, paper on shell rain published
 NOVEMBER 8, attended meeting of Council of Royal Society
 NOVEMBER 13, finished paper on vitality of seeds
 NOVEMBER 17, paper on vitality of seeds published
 NOVEMBER 21, finished note on salt water and germination
 NOVEMBER 24, note on salt water and germination published
 NOVEMBER 29, attended meeting of Columbarian Society
 NOVEMBER 30, attended meeting of Council of Royal Society
 DECEMBER 20, attended meetings of Council of Royal

Society and Philosophical Club

DECEMBER 26, finished Isidore Geoffroy Saint-Hilaire's biography of Étienne Geoffroy Saint-Hilaire

DECEMBER 29, note on seedling fruit trees published

1856

Much correspondence on biogeography, research on domesticated animals, experimental plant ecology in summer

JANUARY 8, attended meeting of Philosperisteron Society

JANUARY 10, finished Baden Powell's *Unity of Worlds*

JANUARY 31, attended meeting of Council of Royal Society

MARCH 8, read 2nd ed. of Owen's lectures on invertebrates

MARCH 10–14, trip to London mainly for library work

MARCH 13, attended meeting of Council of Royal Society

MARCH 14, at British Museum to arrange for translation of Chinese materials on domesticated animals; visited Weir

MARCH 30, Treaty of Paris ended Crimean War

APRIL 13–16, Lyell visited Darwin, asked about Wallace's

paper of 1855; CD told Lyell about natural selection;

Lyell urged publication (perhaps somewhat later)

APRIL 17, attended meeting of Council of Royal Society

APRIL 22–28, J.D. Hooker and wife visited

APRIL 25–28, Wollaston visited

APRIL 26–28, Huxleys visited

APRIL 26, John Lubbock dined

MAY 2, finished Third Edition of Prichard on man

MAY 2, Woodward → CD on fossil record

MAY 5–8, to London

MAY 6, read paper on effect of salt water on seeds to Linnean Society of London

MAY 8, finished Linnaeus's *Fauna Suecica*

MAY 8, attended meeting of Council of Royal Society

MAY 14, began work on *Natural Selection* manuscript

MAY 29, to London

MAY 30, attended meeting of Council of Royal Society

JUNE 5, had finished Woodward's *Manual of the Mollusca*

JUNE 12, attended meeting of Council of Royal Society

JUNE 15, finished Watson on plant geography

JUNE 18–21, trip to London

JUNE 18, dinner at home of Philip Henry Stanhope

JUNE 19, attended meetings of Council of Royal Society and of Philosophical Club

JUNE 25, CD → Lyell on reasons for rejecting land bridges in biogeography

JULY 13, CD → J.D. Hooker; sent part of *Natural Selection* book draft dealing with high latitude plant biogeography

JULY 19, CD → J.D. Hooker on separation of the sexes in trees

JULY 20, CD → A. Gray: reveals evolutionary views

JULY 29, attended Anerly poultry show

AUGUST 14, to London

AUGUST 25, to London

SEPTEMBER 13–19, to Leith Hill (Wedgwood home)

OCTOBER, abstracted material from Koelreuter book on plant sexuality (effects of crossing)

OCTOBER 13, finished chapters 2 and 11 of *Natural Selection* (on variation under domestication and biogeography)

OCTOBER 15–19, trip to London

OCTOBER 16, attended meeting of Philosophical Club

NOVEMBER 4, CD → J.D. Hooker; he is attending to bird dissemination

NOVEMBER 6, Sarah Wedgwood died at Down House

NOVEMBER 9, J.D. Hooker → CD, commenting on manuscript on geographical distribution

NOVEMBER 13, attended meeting of Philosophical Club

NOVEMBER 23, CD → J.D. Hooker, responding to comments on *Natural Selection* manuscript

DECEMBER 16, finished chapter 3 of *Natural Selection* on possibility that all organisms cross

DECEMBER 6, Charles Waring Darwin (last child) born

DECEMBER 6, note on cross breeding of legumes published

1857

Botanical arithmetic; experiments on plant ecology

JANUARY 13–16, to London

JANUARY 15, attended meeting of Philosophical Club and lecture at Royal Society

JANUARY 26, finished chapter 4 of *Natural Selection* on variation in nature

FEBRUARY 23, Captain and Mrs. FitzRoy came to lunch

MARCH 3, finished chapter 5 of *Natural Selection* on struggle for existence

MARCH 4–7, to London

MARCH 5, attended meeting of Philosophical Club

MARCH 7, note on hybrid dianths published

No earlier than MARCH 15, CD to Asa Gray explaining his theory of separation of sexes in trees

MARCH 31, finished Chapter 6 of *Natural Selection* on natural selection (includes principle of divergence but this part may have been added in April)

End of MARCH or early APRIL, *Natural Selection* chapter 7 on laws of variation, and varieties and species compared; part sent to Huxley on July 5, returned by him on July 7

APRIL 12, Wollaston → CD, responding to letter of previous day, asking about sexual combat and lack of wings in insects

APRIL 14, probably, finished addendum on large and small genera to chapter 4 of *Natural Selection*

APRIL 22–MAY 6, at Moor Park hydropathic establishment

APRIL 27, CD → P.H. Gosse, asking about sexual combat in Crustacea

MAY 1, CD → Wallace on letter of October 10; comments on Wallace's paper of 1855 and says he has a species theory but does not expect to finish book for two years

MAY 9, CD → Asa Gray on botanical arithmetic

JUNE 13, Note on mouse-coloured breed of ponies published

JUNE 16–29, at Moor Park hydropathic establishment

JUNE 18, CD → Asa Gray, discussing extinction and notion

that crossing eliminates variation
 JUNE 27, to Selbourne (home of Gilbert White)
 JULY 3, took oath as Justice of the Peace
 JULY 5, CD → Huxley, asking about Brullé's rule
 JULY 7, Huxley → CD on Brullé's rule
 JULY 7, Asa Gray → CD on crossing and distribution
 JULY 14, CD → Lubbock, thanking him for pointing out error in botanical arithmetic
 JULY 20, CD → Asa Gray; first openly evolutionary letter
 JULY 25, note on deep wells published
 AUGUST 10, attended Crystal Palace poultry show
 AUGUST 13–14, J.S. Henslow visited
 AUGUST 22, CD → J.D. Hooker; mentions principle of divergence of character, but has not yet explained it
 SEPTEMBER and OCTOBER, correspondence with Huxley about genealogical classification, morphological principles
 SEPTEMBER 5, CD → Asa Gray, explaining natural selection
 SEPTEMBER 27, Wallace → CD, responding to earlier letter
 SEPTEMBER 29, finished chapters 7 and 8 of *Natural Selection* (on laws of variation, difficulties with transitional forms)
 OCTOBER 18, note on fertilization of beans signed
 OCTOBER 24, note on fertilization of beans published
 OCTOBER 31, J.D. Hooker visited
 NOVEMBER 5–12, at Moor Park hydropathic establishment
 NOVEMBER 29, CD → Asa Gray, clarifying evolutionary concepts
 DECEMBER 22, CD → Wallace on letter of September 27, 1855 paper by Wallace, and plans for book
 DECEMBER 29, finished chapter 9 of *Natural Selection* (on hybridism)

1858

Early in year much correspondence on cells of bees
 FEBRUARY 16–20, to London
 FEBRUARY 18, attended meeting of Philosophical Club; J.D. Hooker also was present
 FEBRUARY 19, attended party at H. Wedgwoods'; the Hookers and Buckle (considered a bore by Darwin and Hooker) also were present
 FEBRUARY 28, finished Mackintosh memoirs
 MARCH 3, read Huxley's paper on *Aphis*
 MARCH 9, finished chapter 10 of *Natural Selection* (on instinct)
 APRIL 14, section on divergence of character
 APRIL 20–MAY 14, to Moor Park hydropathic establishment
 APRIL 27, day's visit from W.D. Fox
 MAY 15, to London
 MAY 20, attended meeting of Philosophical Club, met guest speaker C. Brown-Séguard.
 JUNE 14, worked on pigeons
 JUNE 17, Huxley's Croonian Lecture against the vertebral theory of the skull delivered (Richard Owen, whose views were criticized, was in the chair)
 JUNE 18, arrival of manuscript by Wallace, CD → Lyell

JUNE 28, Charles Waring Darwin (infant son) died
 JULY 1, joint paper by Darwin and Wallace read to Linnean Society
 JULY 9, to Hartfield for holiday
 JULY 17, arrived at Isle of Wight; to Sandown July 17; to Shanklin July 27; returned home August 13
 JULY 18, Marianne Darwin Parker (sister of CD) died
 JULY 20, began to write "Abstract" that became *Origin*, continued to August 12, resumed September 16
 AUGUST 28–31, J.D. Hooker and W.H. Harvey visited
 SEPTEMBER 8, CD → Tegetmeier; "done with my pigeons"
 SEPTEMBER 14, Tegetmeier visited
 OCTOBER 6, Wallace → J.D. Hooker, expressing approval of joint publication
 OCTOBER 8, began *Origin* section on laws of variation
 OCTOBER 19, to London; long meeting with Hugh Falconer
 OCTOBER 23–NOVEMBER 13, wrote *Origin* section on difficulties of theory
 OCTOBER 25–NOVEMBER 1, at Moor Park, hydropathic establishment
 NOVEMBER 12, finished Yarrell on British birds
 NOVEMBER 13, began *Origin* section on instinct
 NOVEMBER 13, paper on agency of bees published in *The Gardeners' Chronicle*
 NOVEMBER 25, CD → Herbert Spencer on gift of *Essays*
 NOVEMBER 25–27, G.S. Henslow visited
 NOVEMBER 27, "Memorial" on Natural History Collections published (signed November 18)
 NOVEMBER 30, began *Origin* section on hybridism
 DECEMBER 11, began *Origin* section on geological succession
 DECEMBER 14–16, trip to London
 DECEMBER 16, attended meeting of Philosophical Club
 DECEMBER 17, Huxley → CD on homologies of air bladder
 DECEMBER 24, CD → J.D. Hooker on faunal invasions, competition, living fossils, and progress

1859

JANUARY 15, began *Origin* chapter on geographical distribution
 FEBRUARY 5–19, to Moor Park hydropathic establishment
 FEBRUARY 18, awarded Wollaston Medal by Geological Society
 FEBRUARY 28, began *Origin* chapter on classification
 MARCH 2, CD → J.D. Hooker; *Origin* chapter on geology and distribution finished, asks about embryology
 MARCH 15, CD → J.D. Hooker; thanks for help with chapter on geographical distribution
 MARCH 19, finished last chapter of *Origin*
 MARCH 24, CD → W.D. Fox; is revising manuscript
 APRIL 6, CD → Wallace on discovery of natural selection
 APRIL 21, J.D. Hooker visited
 MAY 10, sent first six chapters of *Origin* to printers
 MAY 18, CD → J.D. Hooker on ill health
 MAY 21–28, to Moor Park hydropathic establishment
 MAY 25, began proofs of *Origin*

JUNE 3, Huxley lecture on “persistent types”
 JUNE 14, CD → Murray, apologizes for many corrections
 JUNE 21, J.D. Hooker read paper on plant migration to
 Linnean Society, endorsing Darwin’s views
 JULY 19–26, to Moor Park hydropathic establishment
 AUGUST 20–23, to Leith Hill Place (Wedgwood home)
 SEPTEMBER 1, CD → J.D. Hooker, saying all but two chap-
 ters revised
 September 10, finished initial proofs
 OCTOBER 1, last revised proofs corrected
 OCTOBER 3–DECEMBER 7, at Ilkley hydropathic establish-
 ment
 OCTOBER 3, Lyell → CD, commenting on proofs of *Origin*
 OCTOBER 11, CD → Lyell, responding to comments
 NOVEMBER 22, *Origin* sold out at publishers’ trade sale
 NOVEMBER 23, Huxley → CD, high praise for *Origin*
 NOVEMBER 24, *Origin* published
 NOVEMBER 25, Sedgwick → CD, unkind criticisms of
Origin
 DECEMBER, got 2nd *Origin* through press
 DECEMBER 1, pseudonymous letter from FitzRoy to *Times*
 DECEMBER 7, left Ilkley for brief stay in London
 DECEMBER 9, returned to Down
 DECEMBER 13, CD → Huxley on *Variation* MS
 DECEMBER 26, Huxley reviews *Origin* in *Times*, earliest
 possible date for 2nd ed.

1860

All through this year many reviews and much controversy
 JANUARY 3, had finished Hooker on Australian flora
 JANUARY 7, 2nd edition of *Origin* published
 JANUARY 9, began work on *Variation*
 JANUARY 21, reply to Westwood in *Gardeners’ Chronicle*
 JANUARY 24–27, trip to London
 JANUARY 26, attended meeting of Philosophical Club
 FEBRUARY 10, attended Huxley’s lecture on natural and arti-
 ficial selection at Royal Institution in London
 FEBRUARY 14–16, J.S. Henslow visited
 FEBRUARY 27–28, trip to London
 MARCH, A. Gray’s review of *Origin* published in *American*
Journal of Science and Arts
 MARCH 5–6, trip to London with Henrietta and Leonard
 Darwin
 MARCH 9–12, Charles Lyell and wife visited
 MARCH 24, Sedgwick’s review of *Origin* published in *The*
Spectator
 MARCH 24, began introduction to *Variation*
 MARCH 27, elected corresponding member, Philadelphia
 Academy of Sciences
 MARCH 28, trip to London
 APRIL, Huxley review of *Origin* in *Westminster Review*
 APRIL, Owen review of *Origin* in *Edinburgh Review*
 APRIL 5, J.D. Hooker visited
 APRIL 7, Patrick Matthew claimed priority for natural selec-
 tion in *Gardeners’ Chronicle*
 APRIL 7, Thomas Henry Huxley and Mrs. Huxley visited

APRIL 14, to London
 APRIL 21, note replying to Matthew published
 APRIL 21, to London
 APRIL 23, attended meeting of Philosophical Club
 MAY, Henrietta Darwin ill with typhoid fever, had relapses
 until summer of following year
 MAY 7, CD → J.D. Hooker on heterostyly; still thought of
 it as a stage in separation of the sexes
 MAY 22, CD → Asa Gray on theological aspects
 MAY 22, first American edition of *Origin* published
 JUNE 9, note on orchids published in *Gardeners’ Chronicle*
 JUNE 10, finished second chapter of *Variation*, on pigeons
 JUNE 28, to Sudbrook Park
 JUNE 30, Oxford, Wilberforce debate with Hooker and
 Huxley at British Association meeting
 JUNE 30, note asking about moths sucking flowers pub-
 lished
 SUMMER 1860, began work on *Drosera*, worked diligently
 on it till end of September
 JULY, Wilberforce review of *Origin* in *Quarterly Review*
 JULY 7, left Sudbrook Park, visited J.D. Hooker at Kew,
 returned home
 JULY 10–AUGUST 2, trip to Hartfield and Eastbourne,
 worked on insectivorous plants
 JULY 26, Henry Holland visited
 AUGUST 11, resumed work on *Variation*
 AUGUST 21, to London, visited Hugh Falconer
 SUMMER AND FALL, experiments refuted hypothesis that
 plants sexes are becoming separated in dimorphic
Primula; began further experiments
 SEPTEMBER 22–NOVEMBER 10, trip to Eastbourne
 SEPTEMBER 28, CD → Lyell; mentions Krohn on cirripedes
 OCTOBER 29, Henry Holland visited
 NOVEMBER 22, CD → Huxley; has to prepare 3rd *Origin*
 NOVEMBER 26, CD → Asa Gray on design on installment
 plan
 DECEMBER 15, Huxley visited
 DECEMBER 24, Wallace → H.W. Bates, praising the *Origin*

1861

Worked on *Variation* Chapter 3 to end of March
 JANUARY 3, CD → T.H. Huxley on Huxley’s article on the
 brain
 JANUARY 5, note on achenia of *Pumilio* published
 JANUARY 28, took son George to London to have all his
 teeth removed
 JANUARY 29, returned
 FEBRUARY 9, note on fertilisation of orchids published
 FEBRUARY 21, trip to London where he discussed *Drosera*
 experiments at meeting of Philosophical Club
 MARCH 9, Mrs. Huxley and children arrived for two week
 visit, following death of Noel Huxley; T.H.H. joined
 them briefly on March 10 and 17
 MARCH 10, completed chapter II of *Variation*
 MARCH 17, W.B. Carpenter visited
 MARCH 20, finished chapter III of *Variation*

- MARCH 20, began chapter IV of *Variation*
 MARCH 26, CD → H.W. Bates on Amazon insect fauna paper
 APRIL, 1861, 3rd *Origin* published (with *Historical Sketch*)
 APRIL 16–20, trip to London; attended meeting of Linnean Society, visited Robert Chambers
 APRIL 21, Fort Sumter attacked: American Civil War begins
 APRIL 23, CD → Herbert Spencer on Spencer's article about population, Darwin's mode of argument
 APRIL 25, CD → J.L.A. de Quatrefages de Bréau, commenting on his *Unité de l'Espèce Humaine* and on Darwin's predecessors
 APRIL 26, CD → T. Davidson, suggesting work on fossil brachiopod evolution
 MAY 16, finished fowls
 MAY 16, R.E. Grant → CD; dedicates book to Darwin
 MAY 16, death of G.S. Henslow
 MAY 23, Henslow's funeral; Darwin was upset and unable to attend
 MAY 23, CD → J.F.W. Herschel; discusses teleology
 MAY 28, note on fertilization of *Leschenaultia* published
 MAY 30, wrote biographical sketch of Henslow
 MAY 31, finished ducks
 JUNE, examined rabbits at London zoo
 JUNE 15, note on fertilization of vincas published
 JUNE 18, note on cause of variation of flowers published
 JULY 1–AUGUST 27, to Torquay for holiday, orchid work
 JULY 11, CD → F.J. Wedgwood on philosophy
 JULY 13, CD → J.D. Hooker on homologies of orchids and review of *Origin* by W.H. Harvey
 AUGUST 2, CD → Lyell on teleology of Gray and Herschel
 SEPTEMBER 6, CD → Lyell; "Eheu" letter conceding Glen Roy on basis of manuscript by T.F. Jamieson
 SEPTEMBER 14, note on vincas published
 SEPTEMBER 14, note on fertilization of orchids published
 SEPTEMBER 21, CD → John Murray, comparing orchid book to a Bridgewater Treatise
 SEPTEMBER 24, CD → J.D. Hooker; says Murray will publish orchid book
 OCTOBER 13, T.H. Huxley and John Lubbock called
 OCTOBER 22, CD → J.D. Hooker on orchid homologies
 NOVEMBER 20–23, to London
 NOVEMBER 21, visited British Museum
 NOVEMBER 21, read paper on dimorphic *Primula* to Linnean Society
 DECEMBER 3, CD → H.W. Bates, commenting on mimetic butterfly work; says he will advise Bates on book manuscript
 DECEMBER 10–13, G.B. Sowerby Jr. at Down House to prepare illustrations
- 1862**
- JANUARY to end of MARCH, much illness in Darwin household due to influenza
 JANUARY 22, had finished Lecoq on botanical geography
 FEBRUARY 1, visited by John Lubbock
 FEBRUARY 15, had lunch at Lubbock's; J.D. Hooker and George Busk were also there
 FEBRUARY 17, attended court as Justice of the Peace
 FEBRUARY 19, to London, visited dentist
 MARCH 18, CD → J.D. Hooker on Huxley's saltation views
 MARCH 30, Lubbock and J.D. Hooker visited
 APRIL 1, to London
 APRIL 1, Wallace arrived in London
 APRIL 3, read paper on *Catasetum* to Linnean Society
 APRIL 4, Friday, returned from London
 APRIL 6, Sunday, visited by Lubbock, Busk, and Huxley
 APRIL 17, J.D. Hooker arrived with young son William
 APRIL 18, Henry Walter Bates arrived
 APRIL 21, Hooker and Bates departed
 APRIL 28, finished work on *Orchids*
 MAY 6–9, trip to London; called on H. Falconer and Lyell, perhaps also saw Wallace
 MAY 8, attended London International Exposition
 MAY 9, met with Hugh Falconer, returned home
 MAY 14, CD → J.D. Hooker; gives adaptiveness of orchid structure
 MAY 15–22, visited Wedgwoods at Leith Hill Place, their home in Surrey
 MAY 15, *Orchids* published
 MAY 31, French translation of *Origin* published
 SUMMER, much research on plant reproduction; visit from Wallace in June or July has not been dated
 JUNE 12, Leonard Darwin sent home from school with scarlet fever; his illness caused grave concern for several weeks
 JUNE 10, note on bees published in *Journal of Horticulture*
 JUNE 18, note on bees sent to *Bienen Zeitung*
 JULY 23, CD → A. Gray on *Orchids* being a "flank movement"
 JULY 28, began work on (trimorphic) *Lythrum salicaria*
 AUGUST 12, to Southampton; delayed there because Leonard Darwin had relapse of scarlet fever and Emma Darwin contracted the disease
 SEPTEMBER 1, Monday, to Bournemouth, worked on *Drosera*
 SEPTEMBER 29, to London, stayed with his brother
 SEPTEMBER 30, Monday, called on Lyell; returned home
 Fall and Winter worked on chapters VIII–XI of *Variation*
 OCTOBER 4, A. Gray → CD, recommending Max Müller's *Science of Language*
 OCTOBER 7, resumed work on *Variation* chapters 9 and 10
 OCTOBER 20, German translation of orchid book published
 OCTOBER 21, *Beagle* companions Wickham, Sullivan and Mellersh to dinner at Down House; they left the next morning; CD became very ill
 OCTOBER 31, Friday, Lubbock came to dinner
 NOVEMBER 4, CD → J.D. Hooker on Max Müller's *Science of Language*, just read
 NOVEMBER 6, CD → A. Gray, commenting on Max Müller's *Science of Language*
 NOVEMBER 8, note on peas published in *Gardeners' Chronicle*

NOVEMBER 20, CD → H.W. Bates, admiring his work on mimicry
 NOVEMBER 25, note on strawberries published
 DECEMBER 2, note on variations published
 DECEMBER 7, CD → Huxley on his *Lectures to Working Men*
 DECEMBER 11, CD → John Scott; their first letter; comments on paper
 DECEMBER 19, pt. 3 of 2nd German ed. of *Origin* published
 DECEMBER 21, paper on *Linum* finished (begun DECEMBER 11)
 DECEMBER 21, began draft of *Variation* chapter 11

1863

Mostly worked on *Variation*
 JANUARY to APRIL 1, three chapters on inheritance
 JANUARY 4, finished Falconer's paper on fossil elephants
 JANUARY 23, began chapter on inheritance for *Variation*
 FEBRUARY 4–14, trip to London, stayed with Erasmus Alvey Darwin
 FEBRUARY 5, paper on *Linum* read to Linnean Society; CD was ill and could not attend
 FEBRUARY 6, Lyell's *Antiquity of Man* published
 FEBRUARY 8, met with Huxley
 FEBRUARY 11, met with J.D. Hooker and W.H. Gower at Kew
 FEBRUARY 20, Huxley's *Man's Place in Nature* published
 FEBRUARY 22, John Lubbock dined
 FEBRUARY 26, finished Huxley's *Man's Place in Nature*
 MARCH to APRIL 1863 ill much of the time
 MARCH 6, CD → Lyell on *Antiquity of Man*
 MARCH 22, visit from J.D. Hooker
 MARCH 31, note on fertilization of orchids published
 APRIL 1, finished chapter on inheritance, began chapter on crossing and sterility
 APRIL 18, CD → H.W. Bates, praising first volume of Amazon travel book
 APRIL 18, paper on heterogeny finished
 APRIL 25, paper on heterogeny published
 APRIL 27–MAY 13, to Hartfield and (May 6) Leith Hill Place
 MAY, JUNE, wrote five chapters on crossing
 MAY 25, Bentham address to the Linnean Society
 JUNE 16 to JULY 20, two chapters on selection
 JUNE 19, CD → Bentham; says principle of divergence was discovered after 15 years (1837 + 15 = 1852)
 JUNE 25, CD → J.D. Hooker; asks for help on climbing plants
 JULY 2 and 3, observations on pollen in rain-water
 JULY 18, letter on pollen published
 AUGUST 15, note on plant in a singular place published
 SEPTEMBER, 6 months of illness began
 SEPTEMBER 2–OCTOBER 13, Malvern hydropathic establishment
 OCTOBER 14, returned home
 NOVEMBER 23, CD → J.D. Hooker on Schleicher's paper on language (not read yet)
 DECEMBER 3, paper on Pampean formation read

1864

Lyell created Baronet this year
 Health poor from JANUARY to middle of APRIL
 MARCH 3, CD → Ernst Haeckel, thanking him for *Radiolaria*
 APRIL to SEPTEMBER worked on *Lythrum* & climbing plants
 MAY 22, CD → J.D. Hooker, discussing Wallace's new paper on man
 MAY 28, finished paper on *Lythrum*, began *Climbing Plants*
 MAY 28, CD, → Wallace, on his paper on man
 MAY 29, Wallace → CD, praising Darwin's originality
 JUNE 16, paper on *Lythrum* read to Linnean Society
 JULY 9, Haeckel → CD, expressing admiration and telling of the enthusiasm for Darwinism in Germany
 JULY 17, John Lubbock visited
 JULY 24, J.D. Hooker visited
 AUGUST 10, Haeckel → CD on history of evolution
 AUGUST 18, ca., John Scott visited
 AUGUST 25–SEPTEMBER 1, visit to Sarah Wedgwood in London
 AUGUST 28, visited Lyell
 SEPTEMBER 13, finished paper on climbing plants (later revised in manuscript)
 SEPTEMBER 13, resumed work on *Variation* (on laws of variation)
 OCTOBER 15–17, Lyells visited
 OCTOBER 26, Haeckel → CD; praises Fritz Müller's *Für Darwin*
 NOVEMBER and DECEMBER, health deteriorated
 NOVEMBER 3, Council of Royal Society voted to award Copley Medal to CD
 NOVEMBER 30, awarded Copley Medal of Royal Society
 DECEMBER 5, Duke of Argyle criticized *Origin* in address to the Royal Society of Edinburgh

1865

Worked on *Variation* to end of April, ill to December
 JANUARY 8–18, corrected paper on climbing plants
 JANUARY 18, sent *Climbing Plants* to be published
 JANUARY 31, Hugh Falconer died
 FEBRUARY 2, *Climbing Plants* abstract read to Linnean Society by Frederick Currey; Bentham and Hooker in the audience
 MARCH 4–6, J.D. Hooker spent the week end at Down house
 APRIL 9, CD → A. Gray; says he is correcting proofs of *Climbing Plants*
 APRIL 9, Appomattox Court House; end of U.S. Civil War
 APRIL 14, John Lubbock came to lunch
 APRIL 22, health became worse
 APRIL 30, FitzRoy committed suicide
 MAY 27, CD → Huxley on pangenesis manuscript, soon received reply on predecessors
 AUGUST 10, CD → F. Müller; 1st letter, full of praise for *Für Darwin*, just read; remarks on Rhizocephala
 AUGUST 12, William Jackson Hooker died

NOVEMBER 8–18, CD and Emma Darwin stayed with Erasmus Alvey Darwin in London
 DECEMBER 17, John Lubbock and George Busk came to lunch
 DECEMBER 25, resumed work on *Variation*

1866

Darwin's health was better this year
 Continued work on *Variation*
 JANUARY 14, Mr. & Mrs. Cresy visited
 JANUARY 21, finished Wallace's paper on Malayan Papilionidae, wrote letter with comments the next day
 FEBRUARY 2, Catherine Darwin (sister of CD) died
 FEBRUARY 15, Thursday, Sir John Lubbock called
 MARCH 1, began 4th *Origin*; mostly finished MAY 10
 MARCH 24–26, J.D. Hooker visited
 APRIL 2, G. Henslow, Innes, Stephens and three other clergymen to dinner
 APRIL 6–13, ill with influenza
 APRIL 21, to London, stayed with his brother
 APRIL 27, attended Royal Society meeting
 APRIL 28, Society Soirée, presented to Prince of Wales
 MAY 1, returned from London
 MAY 10, resumed work on *Variation*, chapt. 13
 MAY 29–JUNE 2, trip to Leith Hill Place in Surrey
 JUNE 4, began horseback riding
 JUNE 23, Hookers and Moggeridge arrived
 JUNE 25, Monday, J.D. Hooker and Moggeridge departed
 JUNE 29, Mrs. Hooker departed
 AUGUST, the Darwins cared for the Huxley children for two weeks so that Mrs. Huxley could accompany T.H. Huxley to the Nottingham meeting of the British Association for the Advancement of Science
 AUGUST 11, notes on *Oxalis* and papilionaceous flowers published
 AUGUST 18, J.D. Hooker visited
 AUGUST 27–30, Erasmus Alvey Darwin visited at Down
 OCTOBER 2, met Herbert Spencer at Lubbock's
 OCTOBER 3, Susan Darwin (sister of CD) died
 OCTOBER 21, first visit from Ernst Haeckel
 NOVEMBER 16–19, Lyells visited for the weekend
 NOVEMBER 21, finished chapter on Pangenesis
 NOVEMBER 22–30, trip to London, stayed with his brother
 NOVEMBER 28, Erasmus Darwin gave CD his copy of Bell's *Anatomy and Philosophy of Expression*
 DECEMBER 14, CD → William Turner; asks for help with "chapter" on Man
 DECEMBER 15, 4th *Origin* published
 DECEMBER 22, resumes *Variation*, last chapter

1867

Continues work on *Variation*
 JANUARY 8, CD → Haeckel, commenting on his *Generelle Morphologie*; says it is too long for a translation
 FEBRUARY, began "chapter" on man: it became *Descent and Expression*

FEBRUARY 13–21, CD and Emma went to London and stayed with Erasmus Darwin; other family members joined them
 FEBRUARY 18, Monday, called on Bates, asked about conspicuous coloration of caterpillars
 FEBRUARY 19, ill
 FEBRUARY 23, CD → Wallace, asking for explanation of conspicuous coloration of caterpillars
 FEBRUARY 26, CD → Wallace, congratulating him on discovery of warning coloration, explaining the conspicuous coloration of caterpillars
 MARCH 1, got first proofs of *Variation*
 APRIL 6, note on *Cypripedium* published
 JUNE 17–24, stayed with Erasmus Darwin in London
 JULY 31, CD → Fritz Müller, asking about coloration of flatworms
 AUGUST 3, J.D. Hooker and son visited
 AUGUST 21, V.O. Kowalevsky visited
 AUGUST 22, CD → Lyell; says idea of pangenesis is 26-27 years old (i.e., it originated around 1841)
 SEPTEMBER 18–24, stayed with Erasmus Darwin in London
 SEPTEMBER 21–27, seriously ill with eczema
 NOVEMBER 15, last revisions of *Variation*
 NOVEMBER 26, first CD → Anton Dohrn letter, with thanks for, and comments on, Dohrn's Arthropoda paper
 NOVEMBER 28–DECEMBER 7, stayed with Erasmus Darwin in London, saw Charles Lyell, Philip Lutley Sclater
 NOVEMBER 30, Anton Dohrn → CD on cirripede evolution, with remarks on change in function, and comments on Darwin's homologies for Crustacea
 DECEMBER, began papers on illegitimate unions, *Primula*
 DECEMBER 21, J.D. Hooker visited
 DECEMBER 28–29, Saturday and Sunday, Roland Trimen visited

1868

JANUARY 30, *Variation* published
 FEBRUARY 4, began work on *Descent*
 FEBRUARY 8, Herbert Spencer → CD, explaining the difference between his homogeneous physiological units and Darwin's heterogeneous gemmules (pangenesis)
 FEBRUARY 10, *Variation* re-issued
 FEBRUARY 11, letter of inquiry on sex ratio written
 FEBRUARY 15, letter of inquiry on sex ratio published
 FEBRUARY 27, CD → Wallace on sterility
 MARCH 1, Wallace → CD on sterility
 MARCH 3, to London, stayed with Erasmus Darwin for one week, then with Elizabeth Wedgwood for three weeks
 MARCH 31, Tuesday, dined with Miss Cobbe
 APRIL 1, Wednesday, returned home
 APRIL 6, CD → Wallace on selection being of individuals
 APRIL 15, CD → Wallace on his bird's nest paper of July 1867; discussion continued at least through January 27, 1871
 APRIL 18, Saturday, Huxleys arrived for a visit
 MAY 4, Huxleys departed
 MAY 17, began work on sexual selection in birds

JULY 16, Thursday, to London on way to Isle of Wight
 JULY 17, Friday, arrived in Freshwater
 JULY 18, Saturday, called on Longfellow
 JULY 19, Sunday, Tennyson called
 AUGUST 10, Monday, saw Tennyson at Mrs. Crozier's
 AUGUST 20, Thursday, spent a night at Southampton
 AUGUST 21, Friday, returned home
 SEPTEMBER 12, entertained John Jenner Weir, the Wallaces
 and Edward Blyth at Down House
 SEPTEMBER 13, Hookers came to lunch
 OCTOBER 24, Hookers, Grays and Tyndall visited
 NOVEMBER 7-16, trip to London
 NOVEMBER 14, called on Lyell and Lewes
 DECEMBER 26, began to prepare 5th *Origin*

1869

Worked on 5th *Origin* and *Descent*

JANUARY 22, FEBRUARY 2, CD → Wallace on Fleeming
 Jenkin
 JANUARY 29, Friday, Lyells visited
 FEBRUARY 10, finished 5th *Origin* (46 days work)
 FEBRUARY 11–JUNE 10, worked on sexual selection
 FEBRUARY 16–24, trip to London; Emma returned the 26th
 MARCH 22, CD → Wallace, commenting on *Malay
 Archipelago*
 APRIL 9, Friday, fell from horse; recovered in ca. a week
 APRIL 25, Sunday, Hooker and Tyndall visited
 MAY 9, note on formation of mould by worms written
 MAY 15, note on formation of mould by worms published
 MAY 25, Tuesday, Huxleys arrived
 JUNE 4, Friday, T.H. Huxley departed
 JUNE 10–JULY 31, family trip to North Wales
 JUNE 11, London to Shrewsbury
 JUNE 12, to Caerleon
 JUNE 19, note on increase of elephant populations written
 JUNE 25–30, very ill
 JUNE 26, note on increase of elephant populations published
 JULY 17, second note on elephant populations published
 JULY 23, cover letter to editors of *Annals and Magazine of
 Natural History* for paper entitled "Notes on the
 Fertilization of Orchids" dated this day and addressed as
 from Down
 JULY 30, spent night at Stafford.
 JULY 31, returned home
 AUGUST 7, 5th *Origin* published
 AUGUST 28, Saturday, Asa Grays arrived at Down for a visit
 SEPTEMBER 30, Thursday, Kowalevsky arrived
 OCTOBER 1, Friday, Kowalevsky left
 OCTOBER 20, reply to Delpino on pangenesis published
 NOVEMBER 1–9, trip to London, stayed with Erasmus
 Darwin
 NOVEMBER 13, note on winter-flowering plants written
 NOVEMBER 18, note on winter-flowering plants published

1870

Continued work on *Descent*

JANUARY 7, Friday, Mr. Rouse arrived
 JANUARY 8, Saturday, F. Galtons arrived
 JANUARY 10, Monday, Galtons and Mr. Rouse departed
 JANUARY 22, Saturday, Francis Darwin, Newton, Gunther,
 and Swinhoe arrived
 JANUARY 23, Sunday, Hooker arrived
 JANUARY 24, Monday, all departed
 MARCH 5, Saturday, CD and Emma went to London, stayed
 with Erasmus Darwin
 MARCH 12, Saturday, returned from London
 MARCH 15, CD → E. Ray Lankester, expressing admiration
 for his book on comparative longevity; praises H.
 Spencer
 MAY 20–24, trip to Cambridge with Emma
 JUNE 12, CD → J.D. Hooker, strongly opposing design
 JUNE 24–JULY 1, trip with Emma to London
 JULY 13, infallibility of Pope proclaimed
 JULY 19, Franco-Prussian War began
 AUGUST 13–26, trip to Southampton with Emma, stayed
 with William Darwin
 SEPTEMBER 10, Saturday, Huxleys & children visited
 SEPTEMBER 26, Anton Dohrn visited
 SEPTEMBER 27, read Rolleston's British Association address
 SEPTEMBER 29, Thursday, Huxleys to tea
 OCTOBER 13, to Leith Hill Place to visit Wedgwoods
 OCTOBER 20, Thursday, home
 DECEMBER 8–14, trip to London, stayed with Erasmus
 Darwin

1871

JANUARY 15, final correction of proofs of *Descent*
 JANUARY 17, began *Expression*
 JANUARY 28, Saturday, Mr. Wilson, J.D. Hooker, Gunther,
 Swinhoe & W. Reade arrived; they departed on Monday
 FEBRUARY 23–MARCH 2, with Erasmus Darwin in London
 FEBRUARY 24, *Descent* published, reissued in March
 MARCH, 13–16, Lyells visited
 APRIL 1–5, to London to consult about photographs for
Expression, stayed with Erasmus Darwin
 APRIL 27, draft of manuscript of *Expression* finished
 APRIL 27, note on pangenesis published in *Nature*
 MAY 11–19, trip to Southampton
 JUNE 18, began 6th *Origin*
 JUNE 24–30, trip to London; stayed with Erasmus Darwin
 JULY 14, CD → Chauncey Wright, praising his review of
 Mivart's *Genesis of Species*, offering to reprint it
 By mid-JULY, he was working on response to Mivart
 JULY 28–AUGUST 24, holiday at Haredene, CD ill
 AUGUST 25, Friday, returned home
 AUGUST 31, Henrietta Darwin married R.B. Litchfield
 SEPTEMBER 9, note on fertilisation of *Leschenaultia* pub-
 lished
 SEPTEMBER 24, CD → E.B. Tylor, commenting on his book
Primitive Culture, just finished
 OCTOBER 15, Sunday, Kowalevsky visited
 OCTOBER 29, finished 6th *Origin*
 NOVEMBER and DECEMBER, proofs of *Expression*

NOVEMBER 3–10, visit to Wedgwoods at Leith Hill Place
 DECEMBER 12–22, trip to London; stayed with Erasmus Darwin

1872

JANUARY 2, elected Honorary Member, California Academy of Sciences
 JANUARY 10, finished proofs of 6th *Origin*
 FEBRUARY 3, Saturday, J.D. Hooker arrived for a visit
 FEBRUARY 13 or 16–MARCH 21, occupied a house in London
 FEBRUARY, 19, ca., 6th *Origin* published
 MARCH 6, Wednesday, lunch with Busks
 MARCH 10, Sunday, saw Lyell
 MARCH 24, Balfour visited
 APRIL 5, 1st CD → A. Weismann, discussing *Einfluss der Isolirung auf die Artbildung*, views of Moritz Wagner
 APRIL 19, Friday, Huxleys arrived
 APRIL 20, Huxleys departed
 JUNE 6, saw Tylor
 JUNE 8–20, trip to Southampton
 JULY 6, Saturday, Lyells arrived
 JULY 8, Monday, Lyells departed
 JULY 11, Memorial to Gladstone, intervening on behalf of J.D. Hooker, published in *Nature*
 AUGUST 2, Gulick and others visited
 AUGUST 13–21, trip to Leith Hill Place
 AUGUST 22, last revision of *Expression*
 AUGUST 22, resumed work on insectivorous plants, especially physiological aspects
 AUGUST 23, began work on *Drosera*
 AUGUST 28, finished Bastian on *Beginnings of Life*
 AUGUST 29, Lady Lubbock and Professor Semper called
 SEPTEMBER 4, Chauncey Wright visited and stayed at Down
 SEPTEMBER 7–11, Hookers visited
 SEPTEMBER 22, Sunday, Kowalevsky arrived
 OCTOBER 5–26, trip to Sevenoaks
 OCTOBER 13, CD → Moritz Wagner on species formation
 OCTOBER 22, worm observations at Knowle Park
 OCTOBER 22, CD → A. Gray; thinks he has found nerves in the sensitive plant *Drosera*
 NOVEMBER 26, *Expression* published
 December 7, Saturday, Lyells arrived
 DECEMBER 9, Monday, Lyells departed
 DECEMBER 12–22, trip to London, stayed with Erasmus Darwin, ill
 DECEMBER 27, Friday, F. Balfour arrived

1873

JANUARY, paper on climbing plants worked up as book
 JANUARY 11, wrote letter on inherited instinct
 JANUARY 18, letter on instinct published in *Spectator*
 FEBRUARY 3, work on *Cross-Fertilisation*
 MARCH 8, Saturday, Huxley visited
 MARCH 13, paper on “Perception in the lower animals” published

MARCH 15–APRIL 10, stay in London, in rented house
 APRIL 2, Francis Galton called
 APRIL 3, paper on “Origin of certain instincts” published
 APRIL 8, meeting about Huxley’s health problems
 APRIL 19, Saturday, J.D. Hooker arrived
 APRIL 23, CD → Huxley, informing him that 18 of his friends had contributed £2,100 to facilitate his recovery
 MAY 28, responded to Galton’s questionnaire for *English Men of Science*
 JUNE 4–12, trip to Leith Hill Place
 JUNE 14, resumed work on *Drosera*
 JULY 28, CD → J.D. Hooker on separation of sexes, new views of Bentham
 AUGUST, experiments on bloom begun
 AUGUST 5–9, visited T.H. and Euphemia Farrer at Abinger Hall
 AUGUST 10–21, trip to Southampton
 AUGUST 23, Huxley and General Stuchey visited
 AUGUST 26, suffered what was probably a minor stroke
 NOVEMBER 8–18, visit to Richard and Henrietta Litchfield in London
 NOVEMBER 10, Lyell called
 NOVEMBER 20, began 2nd *Descent*

1874

Mostly worked on *Insectivorous Plants*, 2nd *Descent*, 2nd *Reefs* (the latter two were published this year)
 JANUARY 10–17, trip to London, stayed with Erasmus Darwin
 JANUARY 12, Monday, fell down stairs
 JANUARY 16, Friday, attended a séance at Erasmus Darwin’s house, but left early. Twenty were present, including G. H. Lewes, George Eliot, T.H. Huxley and George Darwin
 FEBRUARY 20, entertained Litchfields and Frank Balfour
 MARCH 7, CD → Anton Dohrn, contributing £120 for support of the Naples Zoological Station
 APRIL 1, began *Insectivorous Plants*
 APRIL 6, note on fertilisation of Fumariaceae written
 APRIL 11, Saturday, Dr. Klein arrived
 APRIL 12, Sunday, Dr. Klein departed
 APRIL 16, note on fertilisation of Fumariaceae published
 APRIL 18, note on flowers of primrose written
 APRIL 21–29, trip to London, stayed with Henrietta and Richard Litchfield
 APRIL 23, note on flowers of primrose published
 MAY 7, second note on flowers of primrose written
 MAY 13–16, Lyells visited
 MAY 14, second note on flowers of primrose published
 Summer, worked on *Utricularia*
 JUNE 3–JULY 5, trip to Abinger Hall
 JUNE 5, CD → A. Gray on teleology
 JULY 4, quotation on *Pinguicula* published
 JULY 11, Saturday, visited by F. Balfour, J.D. Hooker, S. Forster
 JULY 23, Thursday, Francis Darwin and Amy Ruck married
 JULY 25, to Abinger Hall

JULY 28, to London
 JULY 30–AUGUST 24, to Southampton, visited William Darwin
 AUGUST 24, returned to Down
 NOVEMBER 19–23, Hookers visited
 DECEMBER 3–12, trip to London, stayed with Henrietta and Richard Litchfield
 DECEMBER 4, saw Lyell
 DECEMBER 8, CD → J. Fiske, first letter, commenting on his *Outlines of Cosmic Philosophy* and Herbert Spencer
 DECEMBER 10, met Romanes for the first time

1875

JANUARY 4, CD → Henrietta Litchfield (his daughter) on vivisection
 JANUARY 12, CD → Mivart, cutting off all communication
 FEBRUARY 1, Lubbocks called
 FEBRUARY 22, Lyell died
 MARCH 6, Saturday, Francis Maitland Balfour visited
 MARCH 31–APRIL 12, trip to London; stayed with Erasmus Darwin, then Henrietta and Richard Litchfield
 APRIL 9, CD hard at work on vivisection issues
 APRIL 17, Huxleys, Romanes and Lawson Tait visited
 APRIL 18, Romanes visited
 MAY 1, CD → August Weismann, commenting on Weismann's work on seasonal dimorphism in butterflies
 JUNE 3–JULY 5, trip to Abinger Hall
 JULY–OCTOBER 3, worked on 2nd *Variation*
 JULY 2, *Insectivorous Plants* published
 JULY 18, Sunday, Ray Lankester and Thiselton Dyer visited
 AUGUST 26, Carlyle and a Miss Aitken visited
 AUGUST 28–SEPTEMBER 11, trip to Southampton, stayed with William Darwin
 SEPTEMBER, began *Cross and Self Fertilisation*
 SEPTEMBER or NOVEMBER, *Climbing Plants* published
 SEPTEMBER 19, Sunday, Carlyle visited
 OCTOBER 10, Hooker and Sylvester called
 OCTOBER 16, Saturday, Huxleys and Tyndall visited
 OCTOBER 30, Saturday, Dr. Pye Smith visited
 NOVEMBER 2–3, to London on vivisection commission
 NOVEMBER 7, CD → F. Galton, discussing Galton's paper on "A theory of heredity"
 NOVEMBER 8, gave testimony about vivisection to Royal Commission
 DECEMBER 4, attended 80th birthday celebration for Carlyle
 DECEMBER 10–20, trip to London, stayed with Henrietta and Richard Litchfield
 DECEMBER 12, Sunday, visited Huxleys

1876

Resumed work on geology, reissued old books unchanged
 FEBRUARY 3–5, trip to London, stayed with Erasmus Darwin
 FEBRUARY 26, Friday, Huxleys arrived
 APRIL 27–MAY 3, trip to London, stayed with Erasmus Darwin

MAY 5, completed 1st draft of *Cross and Self Fertilisation*
 MAY 6–JUNE 6, trip to visit Hensleigh Wedgwood at Hopedene
 MAY 6, note on cherry blossoms written
 MAY 11, note on cherry blossoms published in *Nature*
 MAY 28, ca., began his so-called "Autobiography"
 MAY 29, CD → Romanes on Haeckel's perigenesis and memory theory
 MAY–JUNE correction of 2nd edition of *Orchids*
 JUNE 1, to Abinger
 JUNE 5, CD → Wallace, praising his book on geographical distribution
 JUNE 7–9, trip to Hollycombe
 JUNE 10, returned home
 AUGUST 3, finished "Autobiography"
 AUGUST 19, first proofs on *Cross and Self-Fertilisation*
 SEPTEMBER 11, Francis Darwin's wife died; he and infant son Bernard, born on September 7, soon moved to Down House
 SEPTEMBER 26, Tuesday, second visit from Ernst Haeckel
 OCTOBER 4–20, trip to Leith Hill Place and Southampton
 OCTOBER 16, CD → Moritz Wagner, discussing role of isolation in species formation, responds to essays
 NOVEMBER 2, sexual selection in monkeys paper published
 NOVEMBER 10, *Cross and Self-Fertilisation* published
 NOVEMBER 15, began writing on heterostyly
 DECEMBER 2, Hookers arrived
 DECEMBER 16, Saturday, Marshall arrived

1877

2nd *Orchids* published
 JANUARY, resumed experiments on bloom
 JANUARY 6, note on holly berries published
 JANUARY 6–15, trip to London, stayed with Henrietta and Richard Litchfield
 JANUARY 7, tea at Huxleys
 JANUARY 17, note with retraction on holly berries written
 JANUARY 20, note on holly berries published
 FEBRUARY 19, note on fertilisation of plants written
 FEBRUARY 24, note on fertilisation of plants published
 MARCH 11, John Lubbock visited with his guests: Huxley, Lyon Playfair, John Morley, and Prime Minister Gladstone
 APRIL 12–28, trip to London
 APRIL 22, Sunday, went to visit Huxleys
 APRIL 27, sent MS of paper on infant to editor of *Mind*
 MAY 19, Saturday, Huxleys arrived
 MAY 30, Romanes visited
 SUMMER, worked on *Different Forms of Flowers*; began research on plant movement, made observations on worms
 JUNE 6, Wednesday, left for London
 JUNE 8–JULY 3, trip to Leith Hill Place, Southampton, Stonehenge
 JUNE 22, at Beaulieu Abbey, Hampshire; did worm research
 JULY 9, *Different Forms of Flowers* published

AUGUST 15, note on contractile filaments written
 AUGUST 20–25, trip to Abinger Hall, observed excavation of Roman villa for worm research
 AUGUST 23, note on contractile filaments published
 SEPTEMBER 22, Rudolf Virchow address connecting evolution with socialism
 OCTOBER 26–29, trip to London, stayed with Erasmus Darwin
 NOVEMBER 16, went to Cambridge
 NOVEMBER 17, Saturday, awarded honorary L.L.D.
 NOVEMBER 19, returned
 NOVEMBER 21, note on Fritz Müller on flowers and orchids written
 NOVEMBER 24, F. Galton visited
 NOVEMBER 29, note on Fritz Müller on flowers and orchids published
 DECEMBER 6, completed note on growth under difficulties
 DECEMBER 29, note on growth under difficulties published

1878

All of this year on plant movements, bloom of leaves
 JANUARY 3–7, Huxleys visited
 JANUARY 17–23, trip to London, stayed with Erasmus Darwin
 JANUARY 26, Saturday, Dyers and F. Balfour arrived
 JANUARY 28, Monday, Dyers and F. Balfour departed
 FEBRUARY 9, Saturday, Hookers arrived
 FEBRUARY 12, Tuesday, Hookers departed
 FEBRUARY 28–MARCH 5, trip to London, stayed with Henrietta and Richard Litchfield
 APRIL 27–MAY 13, trip to Southampton
 MAY 18, Saturday, Romanes visited
 MAY 30, note on transplanted shells published
 JUNE 1, Saturday, Romanes visited
 JULY 20, Saturday, Hookers arrived
 AUGUST, trip to Leith Hill Place, Abinger Hall, Barlaston
 AUGUST 5, elected Corresponding Member of the French Institute, in the Botanical Section
 AUGUST 7, probable date of departure
 AUGUST 12, to Abinger Hall
 AUGUST 15, to Barlaston
 AUGUST 17, signed preface to Kerner's *Flowers and their Unbidden Guests*
 AUGUST 23, returned home
 OCTOBER 5, Saturday, F.M. Balfour arrived
 NOVEMBER, Romanes sent Darwin proofs of article on hybridism for *Encyclopaedia Britannica*
 NOVEMBER 21–26, trip to London, stayed with Henrietta and George Litchfield
 NOVEMBER 24, visited Huxleys
 NOVEMBER 25, Leslie Stephen came to lunch
 DECEMBER 8, Saturday, Huxleys and Tyndalls arrived

1879

Awarded Bressa Prize by the Turin Academy
 JANUARY 18, finished Huxley's book on Hume
 FEBRUARY 27–MARCH 5, trip to London, stayed with

Erasmus Darwin
 MARCH 27, note on rats and water-casks published
 APRIL 19, CD → Huxley, commenting on *Freedom in Science and Teaching* by Haeckel
 APRIL 26, Saturday, Galtons visited
 MAY 6–25, trip to Worthing, Southampton, Leith Hill Place, overnight in London
 MAY 26, reached home
 Early SUMMER, 6 weeks on *Life of Erasmus Darwin*, published in the autumn
 JUNE 26, departed for London
 JUNE 28–AUGUST 27, trip to Lake District and elsewhere
 AUGUST 12, lunch at Ruskins
 Late AUGUST or early SEPTEMBER, third visit from Haeckel
 SEPTEMBER 20–24, Hookers visited
 SEPTEMBER 22, Saturday, Ogles visited
 SEPTEMBER 29, Saturday, Romanes visited
 NOVEMBER, answered questionnaire by Galton for his book *Inquiries into Human Faculty* (1883)
 DECEMBER 2–12, trip to London; stayed with Henrietta and Richard Litchfield, then Erasmus Darwin
 DECEMBER 7, Sunday, visited the Huxleys
 DECEMBER 15, Down, paper on hybrid geese written
 DECEMBER 16, paper on coloration of butterflies written

1880

Work on worms in autumn
 Preface for Weismann translation written
 JANUARY 1, paper on hybrid geese published
 JANUARY 3, Horace Darwin and Ida Farrer married
 JANUARY 5, CD → Wallace on "Origin of species and genera" paper
 JANUARY 8, paper on coloration of butterflies published
 FEBRUARY 15, CD → Dohrn, offering to donate £100 of his Bressa Prize to the Zoological Station
 MARCH 4–8, trip to London, stayed with Erasmus Darwin
 APRIL 8–13, trip to Abinger Hall
 APRIL 9, note on Omori shell mounds dated this day
 APRIL 15, note on Omori shell mounds published
 Late MAY, *Movement* sent to printers
 MAY 25–JUNE 8, trip to Southampton
 JUNE 19, Saturday, Huxleys arrived
 JULY, 2nd edition *Different forms of Flowers* published
 JULY 24, Saturday, Hookers arrived
 JULY 26, Monday, Hookers departed
 AUGUST 14–18, to Cambridge, to visit his sons, then two days in London
 AUGUST 18, visited Cambridge botanic garden
 AUGUST 21, Saturday, returned home
 OCTOBER 28–NOVEMBER 2, trip to London
 NOVEMBER 5, letter to *Nature* replying to Wyville Thomson written
 NOVEMBER 6, advance sale of *Movement*, 1500 copies
 NOVEMBER 7, Sunday, Elizabeth Wedgwood died
 NOVEMBER 11, letter to *Nature* replying to Wyville Thomson published

NOVEMBER 22, *Movement* published
 DECEMBER 7, Tuesday, to London, stayed with Erasmus Darwin
 DECEMBER 11–14, to Leith Hill Place
 DECEMBER 15, Wednesday, returned home
 DECEMBER 30, note on black sheep published in *Nature*

1881

JANUARY 8, Saturday, F. Balfour and Litchfields arrived
 JANUARY 15, Saturday, George and Ethel Romanes arrived
 JANUARY 17, Monday, Romanes departed
 FEBRUARY 6, CD → C. Semper, commenting on his book *Natural Conditions of Existence*
 FEBRUARY 12, Saturday, F. Galton & Marshall visited
 FEBRUARY 22, first paper in *Nature* on F. Müller's work on movement of leaves written
 FEBRUARY 24–MARCH 3, trip to London
 MARCH 3, first paper in *Nature* on F. Müller's work on movement of leaves published
 APRIL 14, second paper on movement of leaves written
 APRIL 14, letter to Holmgren on vivisection written
 APRIL 18, letter to Holmgren printed in *Times*
 APRIL 19, response of Frances Power Cobbe in *Times*
 APRIL 21, letter to Holmgren reprinted in *Nature*
 APRIL 22, letter in *Times* replying to Frances Power Cobbe on vivisection
 APRIL 28, second paper in *Nature* on F. Müller's work on movement of leaves (based on letter of February 25, answered April 12)
 APRIL 28, young Lubbock came to tea
 MAY 5, CD → Alexander Agassiz on coral reefs
 MAY 14, Saturday, Stephen arrived
 MAY 16, Monday, Stephen departed
 JUNE 2–JULY 4, trip to Patterdale
 JULY 13, paper on inheritance written
 JULY 21, paper on inheritance published in *Nature*
 AUGUST 3–5, trip to London
 AUGUST 3, dined with Prince of Wales and others
 AUGUST 15, Ogles departed
 AUGUST 22, Monday, Erasmus Alvey Darwin taken ill
 AUGUST 26, Friday, 11 P.M., Erasmus Alvey Darwin died
 AUGUST 27, day trip to London
 SEPTEMBER 1, attended his brother's funeral at Downe
 SEPTEMBER 8–10, trip to Worthing, Sussex, to visit Anthony Rich

SEPTEMBER 10, CD → F. Müller, on plans to work up his results on leaves etc.; will send note by Müller to *Nature*
 SEPTEMBER 15, note on leaves published in *Nature*
 OCTOBER 10, *Worms* published (sent to publisher in April)
 OCTOBER 12, Wednesday, to London
 OCTOBER 13, letter on infant development published
 OCTOBER 20–27, trip to Cambridge, stayed with Horace Darwin
 OCTOBER 21, Friday, saw F. Balfour
 OCTOBER 22, Saturday, saw Michael Foster
 NOVEMBER 7, note on habits of *Molothrus* written
 NOVEMBER 17, note on habits of *Molothrus* published
 DECEMBER 3, excerpt of letter on vivisection published
 DECEMBER 13–20, trip to London
 DECEMBER 15, attack of cardiac distress
 DECEMBER 18, Sunday, called on Huxleys
 DECEMBER 19, CD → F. Müller, commenting on his paper on leaves of *Crotalaria*, read the previous night

1882

Experimentation on bloom continued
 JANUARY 8, Leslie Stephen visited at Down House
 FEBRUARY, minor corrections for 6th printing of *Worms*
 FEBRUARY 6, signed preface to H. Müller's book on flowers
 FEBRUARY 22, CD → W. Ogle on his translation of Aristotle's *De Partibus Animalium*
 MARCH 5, Sunday, visit from Max Müller
 MARCH 6, paper on chlorophyll read before Linnean Society
 MARCH 7, attack of cardiac distress
 MARCH 10, Dr. Clark came
 MARCH 16, paper on roots read before Linnean Society
 MARCH 19, Dr. Moore came
 MARCH 20, some improvement
 APRIL 6, note on dispersal of bivalves published
 APRIL 18, fatal heart attack
 APRIL 19, Darwin died
 APRIL 26, funeral at Westminster Abbey
 AUGUST 28, paper on chlorophyll published

1888

JANUARY 5, Caroline Darwin died

1896

OCTOBER 2, Emma Darwin died

Biographical Dictionary

This biographical dictionary was designed to provide information relevant to the study of Darwin's life and works. Many of the data have been taken from biographies, autobiographies and standard reference works. The commentary, however, is not all derivative of such secondary sources, but reflects many years of study of such primary sources as the writings of Darwin, Wallace, Owen, Haeckel, Spencer and Dohrn. We should mention that some of the references give conflicting information and that some dates are uncertain.

Abbreviations for works listed as References:

- BAE = *Bibliography of Australian Entomology* by Anthony Musgrave
 BDB = *Biographical Dictionary of Botanists*
 DBE = *Deutsche Biographische Enzyklopädie*
 DD = *Dictionnaire du Darwinisme* edited by Patrick Tort
 DNB = *Dictionary of National Biography*
 DSB = *Dictionary of Scientific Biography* edited by C.C. Gillispie
 EB = *Encyclopaedia Britannica* (EB 13=13th edition)
 GHG = *Geologists and the History of Geology* by W.A. Sarjeant
 NBG = *Nouvelle Biographie Générale* edited by Dr. Hoeffler
 ODNB = *Oxford Dictionary of National Biography*
 RBF = *Charles Darwin, a Companion*, by R.B. Freeman
 RD = *Dictionary of British and Irish Botanists and Horticulturalists* by Ray Desmond

A

Abercrombie, John

October 10, 1780–November 14, 1844

Aberdeen, Scotland–Edinburgh, Scotland

Scottish physician and philosopher. Darwin read his *Inquiries Concerning the Intellectual Powers and the Investigation of Truth* (1830) after the *Beagle* voyage. He was also author of *The Philosophy of Moral Feelings* (1832).

References: EB 13.

Agassiz, Alexander

December 17, 1835 – March 27, 1910

Neuchâtel, Switzerland – at sea

Swiss-American zoologist and mining engineer. The son of Louis Agassiz, he ultimately succeeded his father as Director of the Museum of Comparative Zoology at Harvard University. A shrewd businessman whose wife was from a wealthy family, he used his substantial personal fortune to advance his scientific career and enjoyed great influence on governmental and academic policy. Unlike his father, he did not oppose evolution. However, he did not support natural selection and was one of the major opponents of Darwin's coral reef theory.

References: Dupree in DSB, G.R. Agassiz 1913.

Agassiz, [Jean] Louis [Rudolphe]

May 20, 1807 – December 14, 1873

Motier-en-Vully, Switzerland – Cambridge, Massachusetts, USA

Swiss naturalist. He immigrated to the United States in 1846 and became a professor at Harvard University in 1847. Early in his career he was strongly influenced by German idealism, and later advocated successive special creation. A popular lecturer and teacher, he had many influential students. He opposed Darwin's evolutionary theories. As a geologist he was successful in establishing the notion of an ice age with extensive glaciation. However, his attempt to refute evolution by claiming that Brazil had been covered by glaciers was not successful.

References: Lurie in DSB, Lurie 1913.

Alder, Joshua

April 7, 1792 – January 21, 1867

English businessman, marine zoologist and malacologist. He collaborated with Albany Hancock on systematics of Nudibranchia, a group of some interest to Darwin.

References: Tort in DD, Bettam & Foote in DNB.

**Archiac, Étienne Jules Adolphe Desmier de Sant
Simon, Vicomte D'**

September 24, 1802 – December 24, 1868

Rheims, France – Paris, France

French cavalry officer who turned to geology after retirement and became quite eminent. His greatest work was a *Histoire des Progrès de la Géologie* (1847-1860). In the first volume he criticized Darwin's views on the formation of mould by earthworms. Darwin, in *Worms*, responded that D'Archiac was arguing from "inner consciousness" rather than observation.

References: EB13, GHG.

**Argyll, George John Douglas Campbell, 8th Duke
of**

April 30, 1823 – April 24, 1900

Scottish geologist and politician who tried to reconcile science with religion. Author of *The Reign of Law* (1866), he opposed Darwin's views on coral reefs and natural selection. Darwin cites him on anthropology and ornithology in *The Descent of Man*. He was one of the pallbearers at Darwin's funeral.

References: DHG, Tort in DD, EB 13.

Aristotle

384 BC – 322 BC

Stagira – Chalcis, Euboea

Greek philosopher. He is mentioned in the historical sketch in later editions of the *Origin*. Darwin admired a translation of his *De Partibus Animalium*.

Audubon, John James

April 26, 1785 – January 27, 1851

Les Cayes, Santo Domingo – New York, New York, USA

American ornithologist and painter. Darwin occasionally cites his works on the natural history of birds.

References: Mengel in DSB.

Azara, Félix de

May 18, 1742 – October 20, 1821

Huesca, Spain – Huesca, Spain

Spanish naturalist. His writings on South America were an important source of information for Darwin on such topics as geographical distribution and variation.

References: Guerra in DSB.

B

Babbage, Charles

December 26, 1792 – October 18, 1871

Teignmouth, Devonshire, England – London, England

English mathematician, inventor of calculating machines. Darwin, who knew him well on a social basis, discussed his character in the *Autobiography*.

References: Gridgeman in DSB.

Babington, Charles Cardale

November 23, 1808 – July 22, 1895

Ludlow, England – Cambridge, England

Botanist, author of the *Manual of British Botany* (1843). A professor at Cambridge, succeeding Henslow in 1863, he founded the Ray Club as a successor to Henslow's evenings. He was not enthusiastic about evolution.

References: Desmond in DSB, Babington 1897.

Baden-Powell, see Powell, Baden

Baer, Karl Ernst von

February 28, 1792 – November 28, 1876

Piep, Estonia – Dorpat, Estonia

Embryologist, professor at Königsberg, later worked at the Academy of Sciences of Saint Petersburg. He was one of the most influential scientists of his day, his reputation resting upon his discovery of the mammalian egg and his comparative embryological work, which gave four basic types of animals much like those of Cuvier. The law that he enunciated has been treated as an alternative to embryological recapitulation, but it was strictly formal and not historical. Although he was favorably impressed by Darwin's accomplishment, he remained an idealist and insisted that evolution must have a teleological basis.

References: Di Gregorio in DSB.

Bain, Alexander

June 11, 1818 – September 18, 1903

Aberdeen, Scotland – Aberdeen, Scotland

Scottish philosopher and psychologist, author of *The Senses and the Intellect* (1855) and *The Emotions and the Will* (1859), abridged as *Mental and Moral Science* (1868), all very influential works. Bain's psychology was in the associationist tradition and tended to emphasize experience and de-emphasize instinct, especially in morals. Darwin was more of

a “nativist” in keeping with his view that the mind is a product of evolution. Both he and Darwin had a strongly physiological approach to psychology. Darwin frequently cites Bain in *The Descent of Man* and *The Expression of the Emotions*.

References: Tort in DD, Hattiangadi in DSB.

Baird, Spencer Fullerton

February 3, 1883 – August 18, 1887

Reading, Pennsylvania, USA – Woods Hole, Massachusetts, USA

American systematic zoologist, became assistant to Joseph Henry at Smithsonian Institution 1850, Secretary 1878. Darwin cites his work on bird migration.

References: Allard in DSB, Rivinus & Youssef 1992.

Balfour, Francis Maitland

November 10, 1851 – July 19 or 20, 1882

Edinburgh, Scotland – near Courmayeur, Switzerland
English comparative embryologist and comparative anatomist. A student of Michael Foster, he was very talented and became a professor of animal morphology at Cambridge in 1882. He died in a climbing accident at the age of thirty.

References: Churchill in DSB.

Barrande, Joachim

August 11, 1799 – October 5, 1883

Sangués, Haute-Loire, France – Frohsdorf, Austria
French paleontologist and stratigrapher, worked much of the time in Prague. The author of *Système Silurien* and other important paleontological works, he was one of Darwin's more vehement opponents with respect to evolution. Darwin cites him as one of the leading references on the fossil record.

References: Hansen in DSB.

Bastian, Henry Charlton

April 26, 1837 – November 17, 1915

Truro, Cornwall, England – Chesham Bois, England
British physician and biologist, an authority on nematode worms. He was a major advocate of spontaneous generation, and debated the topic with Huxley. He also severely and rather intemperately criticized Darwin's theory of pangenesis.

References: Clarke in DSB.

Bate, Charles Spence

March 16, 1819 – July 29, 1889

Near Truro, Cornwall, England – South Brent,

Devon, England

British dental surgeon and carcinologist. Darwin often corresponded with him and cited his works.

References: Foote in ODNB.

Bates, Frederick

November 18, 1829 – October 6, 1903

Leicester, England – Chiswick, England

English entomologist, a younger brother of Henry Walter Bates.

References: Poulton 1904, BAE.

Bates, Henry Walter

February 8, 1825 – February 16, 1892

Leicester, England – London, England

English naturalist and entomologist. Bates accompanied Wallace to South America. Darwin helped arrange for the publication of Bates's classic book on natural history, *The Naturalist on the River Amazons*. His work on geographical variation and “Batesian” mimicry was very important in establishing the theory of natural selection.

References: McKinney in DSB.

Beaumont, Élie: see Élie de Beaumont, J.

Bechstein, Johann Matthäus

July 11, 1757 – February 23, 1822

Waltershausen, Thuringia, Germany – Dreissigacker, Germany

German zoologist. Darwin made use of his *Gemeinnützige Naturgeschichte Deutschlands*. Darwin cites him in *Variation*.

References: Jahn's *Geschichte der Biologie*, NBG.

Beechey, Frederick William

February 17, 1796 – November 29, 1856

London, England – London, England

English sailor, naturalist and explorer. Darwin cites his work in the coral reef book.

References: EB 13.

Belcher, Edward (Sir)

1799 – March 18, 1877

Halifax, Nova Scotia – London, England

English navigator and explorer. Darwin cites his publications in his book on coral reefs.

References: EB.

Bell, Charles (Sir)

November, 1774 – April 28, 1842

Edinburgh, Scotland – Worcester, England

Scottish anatomist and surgeon. His publications on

the hand and on facial expression were important for Darwin's psychological work.

References: Tort in DD, Amacher in DSB.

Bell, Thomas

October 11, 1792 – March 13, 1880

Poole, Dorsetshire, England – Selbourne, Hampshire, England

English dental surgeon and zoologist and Professor of Zoology in King's College, London. An expert on reptiles, he monographed the reptiles of the voyage of the *Beagle*. He was in the chair at the meeting on July 1, 1858 where the preliminary statement on evolution by natural selection by Darwin and Wallace was read, but he was strongly opposed to Darwinism.

References: RBF.

Belt, Thomas

1832 – September 21, 1878

Newcastle-on-Tyne, England – Denver, Colorado, USA

English geologist, author of a celebrated travel book, *The Naturalist in Nicaragua*. He provided Darwin with information about seed distribution.

References: RD.

Beneden, Edouard van

March 5, 1846 – April 28, 1910

Louvain, Belgium – Liège, Belgium

Belgian zoologist, cytologist and comparative anatomist, son of Pierre-Joseph van Beneden.

References: Florkin in DSB.

Beneden, Pierre-Joseph van

December 19, 1809 – January 8, 1894

Mechlin, Belgium – Louvain, Belgium

Belgian zoologist, professor at the University of Louvain. He was the author of a classic book on symbiosis.

References: Florkin in DSB.

Bennett, John Joseph

January 8, 1801 – February 29, 1876

Tottenham, Middlesex, England – Maresfield, Sussex, England

English botanist, on the staff of the British Museum 1852-1870. He was Secretary of the Linnean Society from 1838-1852.

References: BDB, RD.

Bentham, George

September 22, 1800 – September 10, 1884

Stoke, Devonshire, England – London, England

English systematic botanist, author of the *Handbook to the British Flora*, and President of the Linnaean Society from 1862 to 1874. He was a nephew of the philosopher Jeremy Bentham. He was an important source of data for Darwin on plant variation and diversity. He was one of the first of Darwin's colleagues to endorse evolution. He collaborated with Joseph Hooker on the *Genera Plantarum*.

References: Taylor in DSB.

Berkeley, Miles Joseph (The Reverend)

April 1, 1803 – July 3, 1889

Biggin, Northamptonshire, England – Harbrough, England

English clergyman and systematic botanist, an outstanding expert on fungi. A close associate of Darwin's teacher J.S. Henslow. He described some of Darwin's fungi from the *Beagle* voyage. Later he did some research that extended Darwin's experimental work on the effects of seawater on the seeds of plants.

References: BDB, Tort in DD.

Bingley, William

1774 – March 11, 1823

Doncaster, England – London, England

English naturalist and popular writer, author of *Animal Biography* (1802) and *Practical Introduction to Botany* (1817).

References: Courtney in DNB.

Bischoff, Theodor Ludwig Wilhelm

October 28, 1807 – December 5, 1882

Hanover, Germany – Munich, Germany

German embryologist and physiologist. His dualistic philosophy inhibited him from accepting evolution, and he objected to natural selection on the grounds that it provided no explanation for the union of body and soul. Darwin cites his work in *The Descent of Man* in connection with the resemblance of human development to that of other primates.

References: Tort in DD, Rothschild in DSB.

Blackwall, John

January 20, 1790 – May 11, 1881

Manchester, England – Llanrwst, Wales

English zoologist, an expert in spiders.

References: Bettany in DNB.

Blainville, Henri Marie Ducrotay de

September 12, 1777 – May 1, 1850

Arques, Normandy, France – Paris, France

French paleontologist and zoologist. He was closely associated with Georges Cuvier, and succeeded him at the Muséum National d'Histoire Naturelle in Paris. He was an advocate of the great chain of being (*scala naturae*), and not an evolutionist.

References: Laurent and Tort in DD, Coleman in DSB.

Blomefield, L.; see **Jenyns, L.**

Blumenbach, Johann Friedrich

May 11, 1752 – January 22, 1840

Gotha, Germany – Göttingen, Germany

German vertebrate anatomist and physiologist. He is sometimes considered a proto-evolutionist. His work on generation was of considerable interest to Darwin. His work on man and other primates was important for Darwin's physical anthropology.

References: Tort in DD, Baron in DSB.

Blyth, Edward

December 23, 1810 – December 27, 1873

London, England – London, England

English zoologist, lived in India 1841-1862. He was a prolific writer who shared many interests with Darwin, especially in species and variation. They corresponded extensively and Darwin often cited his publications. Although it has been suggested that Darwin derived some important ideas from Blyth without giving due credit, there is no real evidence that such was the case.

References: McKinney in DSB.

Boerhaave, Herman

December 31, 1668 – September 23, 1738

Verhout, near Leiden, Netherlands – Leiden, Netherlands

Dutch physician, professor of medicine and chemistry at Leiden. A very influential teacher, he is mentioned in Darwin's essay on the life of Erasmus Darwin.

References: Lindeboom in DSB.

Bonaparte, Charles Lucien

May 24, 1803 – July 29, 1857

Paris, France – Paris, France

French zoologist. He was the son of Napoleon's younger brother Lucien Bonaparte.

References: Tort in DD, Petit in DSB.

Bonnet, Charles

March 13, 1720 – May 20, 1793

Geneva, Switzerland – Geneva, Switzerland

Swiss philosopher and biologist. His embryological theory was very influential in his day and subsequently, especially with respect to the great chain of being or *scala naturae*. His work on parthenogenesis and regeneration were particularly important. Darwin was very much interested in such matters.

References: Tort in DD, Pilet in DSB.

Bonney, Thomas George

July 27, 1833 – December 10, 1923

Rugeley, England – Cambridge, England

English geologist.

References: Bulman in DSB, EB13.

Bory de Saint-Vincent, Jean Baptiste Georges Marie

July 6, 1778 – December 22, 1846

Agen, France – Paris, France

French naturalist, a follower of Buffon and Lamarck.

He directed an expedition to Morea in 1829. He edited the *Dictionnaire Classique d'Histoire Naturelle*, which was an important reference work for Darwin while on the *Beagle*. Darwin mentions him in the *Historical Sketch* in later editions of the *Origin*.

References: George in DSB, NBG.

Bowerbank, James Scott

July 14, 1797 – March 8, 1877

London, England – London, England

English businessman and paleontologist, founder of the Palaeontographical Society. He lent Darwin cirripedes from Gault. He was also an authority on sponges, and provided Darwin with specimens of sponge-dwelling barnacles from his collection.

References: DHG, EB13.

Braun, Alexander Carl Heinrich

May 10, 1805 – March 29, 1877

Regensburg, Germany – Berlin, Germany

German botanist, professor in Berlin from 1851. His investigations on phyllotaxis were highly influential in plant morphology. An advocate of *Naturphilosophie* and a teleologist, he was strongly opposed to natural selection.

Geison in DSB.

Bree, Charles Robert

1811 – 1886

English physician. An anti-evolutionist, he frequently criticized Darwin's views in print.

References: Tort in DD.

Brehm, Alfred Edmund

February 2, 1829 – November 11, 1884

Renthendorf, Germany – Renthendorf, Germany

German zoologist, director of the Hamburg zoo and the Berlin aquarium. Darwin frequently referred to his popular zoological reference work *Thierleben*, especially in *The Descent of Man*.

References: Tort and Rupp-Eisenreich in DD.

Brehm, Christian Ludwig

January 1, 1787 – June 23, 1864

Schönau vor dem Walde bei Gotha, Germany – Renthendorf, Thüringen, Germany

German clergyman and naturalist, father of Alfred Edmund Brehm

References: *Lexikon der bedeutenden Naturwissenschaftler*.

Bridgewater, Francis Henry Egerton, 8th Earl of

November 11, 1756 – February 12, 1829

Probably London, England – Paris, France

English naturalist and antiquarian. He bequeathed £8,000 under the aegis of the Royal Society of London for publication of books "On the Power, Wisdom and Goodness of God, as Manifested in the Creation." Darwin responded to many of these "Bridgewater Treatises" in his writings.

References: ODNB, NBG.

Bridgman, Laura Dewey

December 21, 1829 – May 24, 1889

Hanover, New Hampshire, USA – Boston, Massachusetts, USA

American blind deaf-mute, deprived of her eyesight and hearing at the age of two by an attack of scarlet fever. Thus she was not, as Darwin believed, congenitally blind and deaf. Thanks to the efforts of Dr. S.G. Howe, head of the Perkins Institute for the Blind in Boston she was educated and with remarkably good results. Darwin used material on her in considering whether facial expressions are innate or acquired.

References: EB 13.

Brocchi, Giambattista

February 18, 1772 – September 23, 1826

Bassano, Italy – Khartoum, Sudan

Italian mining engineer, geologist and invertebrate paleontologist. Author of *Conchiologia Fossile Subappennina* (1814), he did extensive field research in the Italian peninsula and influenced Darwin both directly and indirectly through Lyell. Although not an evolutionist he was interested in extinction and changes in the fossil record through time.

References: Pancaldi, 1983, Preto in Vaccari 1998, Gregory in DSB.

Broderip, William John

November 21, 1789 – February 27, 1859

Bristol, England – London, England

English lawyer, zoologist and paleontologist

References: Boase and Pease-Watkin in ODNB.

Bromfield, William Arnold (Dr.)

July 4, 1801 – October 9, 1851

Boldre, Hants, England – Damascus, Syria

English physician and botanist. Darwin cited his work in *Flowers*.

References: RD.

Brongniart, Adolphe Théodore

January 14, 1801 – February 18, 1876

Paris, France – Paris, France

French paleobotanist, son of Alexandre Brongniart, and professor of botany at the *Musée d'Histoire Naturelle*. An important botanical comparative anatomist, he believed in progressive changes in the fossil record, but was not an evolutionist.

References: Laurent in DD, Leroy in DSB.

Brongniart, Alexandre

February 5, 1770 – October 7, 1847

Paris, France – Paris, France

French geologist and paleontologist. A collaborator with Cuvier, he was also one of the pioneers of stratigraphy.

References: Laurent in DD, Rudwick in DSB.

Bronn, Heinrich Georg

March 3, 1800 – July 5, 1862

Ziegelhausen near Heidelberg, Germany – Heidelberg, Germany

German zoologist, professor at Heidelberg. He produced the first German translations of the *Origin of Species* and of *Orchids*. He had an idealistic approach and was sort of a proto-evolutionist.

References: Tort in DD, Hansen in DSB.

Brougham, Henry Peter, 1st Baron Brougham & Vaugh

September 19, 1778 – May 7, 1868

Edinburgh, Scotland – Cannes, France

British lawyer and politician. Darwin was interested in his *Discourse on Natural Theology* (1835).

References: Hunt in DNB, Lobban in ODNB.

Brown, Robert

December 21, 1773 – June 10, 1858

Montrose, Scotland – London, England

Eminent British botanist, Keeper of the Botanical collections of the British Museum. He made major contributions to systematics and cytology. He first appreciated the ubiquity of the nucleus in cells, and discovered the so-called “Brownian movement” in 1827. He provided Darwin, with whom he often visited socially, with important information on the reproduction of flowering plants and other matters. It was Brown who first recommended the work of Sprengel to Darwin.

References: Stearn in DSB.

Brown, Robert

March 23, 1842 – October 26, 1895

Campster, Caithness, England – Streatham, Surrey, England

English botanist and plant collector. It is important not to confuse him with the older botanist of the same name.

References: RD, Tort in DD.

Brown-Séguard, Charles Édouard.

April 8, 1817 – April 1, 1894

Port-Louis, Mauritius – Sceaux, France

French physiologist. His experimental work seemed to Darwin to provide evidence for the inheritance of acquired characters.

References: Tort in DD, Grmek in DSB.

Browne, James Crichton (Sir)

November 29, 1840 – January 31, 1938

Edinburgh, Scotland – Dumfries, Scotland

Scottish physician, head of the West Riding Lunatic Asylum. He later changed his name to Crichton-Browne. He was of great assistance to Darwin in his work on emotional expression.

References: RBF, J. D. Rolleston in DNB.

Brullé, Gaspard Auguste

April 7, 1809 – January 21, 1873

French zoologist, professor at Dijon. Darwin was much interested in what he called “Brullé’s rule.”

References: BAE, RBF.

Buch, Leopold von

April 25, 1774 – March 4, 1853

Stolpe, Germany – Berlin, Germany

German geologist. His views on volcanoes were of great importance for Darwin’s work on South America. Darwin mentions him in the *Historical Sketch* in later editions of the *Origin*.

References: Tort in DD, Nieuwenkamp in DSB.

Buckland, William (the Reverend)

March 12, 1784 – August 14, 1856

Axminster, England – Islip, England

English geologist and paleontologist. He was a catastrophist and his views were strongly influenced by theological considerations, being author of a “Bridgewater Treatise” in support of natural theology.

References: Cannon in DSB, EB 13.

Buckle, Henry Thomas

November 24, 1821 – May 20, 1862

Lee, Kent, England – Damascus, Syria

English historian and social philosopher, author of *History of Civilization in England*. Darwin, who knew him socially, makes some interesting comments about him in his autobiography, but did not think very highly of his generalizations.

References: Tort in DD, Heyck in ODNB, EB13.

Buckman, James (Professor)

November 20, 1814 – November 23, 1884

Cheltenham, England – Bradford Abbas, England

English botanist and paleontologist, Professor at the Royal Agricultural College in Cirencester 1848-1863. He sent Darwin specimens of fossil barnacles which he had named. Darwin cites his botanical work, including the *Variation*. He was a strong supporter of Darwin beginning with a report to the British Association meeting of 1860.

References: GHG, RD, Torrens in ODNB.

Büchner, Ludwig

March 29, 1824 – April 1, 1899

Darmstadt, Germany – Darmstadt, Germany

German physician and philosopher. A materialist, he was author of *Kraft und Stoff* (1855). He was a strong supporter of evolution.

References: EB13.

Buffon, Georges-Louis Leclerc (Chevalier de, Comte de)

September 7, 1707 – April 16, 1788

Montbard, Burgundy, France – Montbard, Burgundy, France

French natural scientist. Although Buffon made contributions to the physical sciences and mathematics early in his career, he soon switched to natural history. His multi-volume *Histoire Naturelle* was very popular. It contained a great deal of speculation about the nature of species and other topics of theoretical and philosophical interest. Buffon maintained that both the earth and its biota have changed through time, but was not an evolutionist in the modern sense. Darwin mentions him in the *Historical Sketch* in later editions of the *Origin*.

References: Tort in DD, Roger in DSB 1989.

Burdach, Karl Friedrich

June 12, 1776 – July 16, 1847

Leipzig, Germany – Königsberg, Germany

German anatomist and physiologist, director of the anatomical institute at Königsberg. He maintained that lower forms of life have given rise to higher ones. Mentioned by Darwin in the *Historical Sketch* in later editions of the *Origin*, he was an advocate of *Naturphilosophie*.

References: Kay in DSB, Breidbach 2005.

Burdon-Sanderson, John Scott

December 21, 1828 – November 23, 1905

Jesmond, near Newcastle-on-Tyne, England – Oxford, England

English physician and physiologist, professor at University College, London and later at Oxford. He provided Darwin with information useful to his studies on insectivorous plants, including some experimental work on digestion described in that book. Like Darwin, he advocated vivisection.

References: Geison in DSB.

Burmeister, (Karl) Hermann (Konrad)

January 15, 1807 – May 2, 1892

Stralsund, Prussia – Buenos-Aires, Argentina

German zoologist, professor at Halle from 1834 until forced to leave as a result of the unrest during 1848 to 1850. He was director of the National Museum of Buenos Aires from November 1, 1861. He was author of *Geschichte der Schöpfung* (Leipzig, 1856) and many publications on fossil and living arthropods. Darwin refers favorably to his early

work on cirripedes.

References: Tort in DD.

Burnett, James, Lord Monboddo

October or November, 1714 – May 26, 1799

Monboddo, Kincardineshire, Scotland – Edinburgh, Scotland

Scottish judge. He was author of a book in six volumes *Of the Origin and Progress of Language* (1773-1792).

References: Hammett in ODNB.

Busk, George

August 12, 1807 – August 10, 1886

St. Petersburg, Russia – London, England

English zoologist, trained as a physician.

References: Thomas in DSB.

Butler, Arthur Gardiner

June 27, 1844 – May 28, 1915

England – Beckenham, Kent, England

English entomologist, an expert on Lepidoptera. He worked at the British Museum from 1865-1901.

Darwin mentions Butler showing him specimens in one of his papers in *Nature*, 21:237 (1880).

References: BAE.

Butler, Samuel (Dr.)

January 30, 1774 – December 4, 1839

Kenilworth, England – Shrewsbury, England

English schoolmaster and bishop of Lichfield. He was

Head Master of Shrewsbury School 1798-1839, which Darwin attended as a child. Darwin's experience there may help to explain why he detested conventional education.

References: RBF, EB13.

Butler, Samuel

December 4, 1835 – June 18, 1902

Langar Rectory, Nottinghamshire, England – London, England

Novelist, now best known for his autobiographical *The Way of All Flesh*. He vehemently attacked Darwin in his *Evolution, Old and New* (1879) and later works. He was the grandson of Dr. Samuel Butler and the son of Thomas Butler.

References: EB13.

Butler, Thomas (Canon)

1806 – 1886

English clergyman and amateur botanist. He was the model for Theobald Pontifex in Samuel Butler the

younger's novel *The Way of All Flesh*. He attended Samuel Butler the elder's school together with Darwin, but because of their different ages they were mere acquaintances at the time. Later they were both students at Cambridge and Darwin stimulated Butler's life-long interest in botany.

References: Allen 1979.

C

Caldcleugh, Alexander

? – 1858

Businessman and author of some travel works on South America. Darwin spent some time with him there. Although Darwin did not think highly of his books, he was most grateful for Caldcleugh's hospitality. He also published a paper on South American geology to which Darwin refers.

References: Tort in DD, RBF.

Candolle, Alphonse de

October 17, 1806 – April 4, 1893

Paris, France – Geneva, Switzerland

Botanist, son of Augustin-Pyramus de Candolle, with whom he should not be confused. He succeeded his father as Professor of Botany at Geneva in 1835. He did outstanding work on plant classification, ecology, and biogeography. His *Géographie Botanique Raisonné* is the most heavily-annotated item in Darwin's personal library.

References: Pilet in DSB.

Candolle, Augustin-Pyramus de

February 4, 1778 – September 9, 1841

Republic of Geneva – Geneva, Switzerland

Botanist, father of Alphonse de Candolle, with whom he should not be confused. Although primarily a systematist, he had broad interests, and Darwin paid much attention to his works, especially those that dealt with biogeography and teratology.

References: Pilet in DSB.

Canestrini, Giovanni

December 26, 1835 – February 14, 1900

Revò, in Val di Non – Padua, Italy

Italian zoologist (born in what was then part of the Austro-Hungarian Empire). He took his doctorate in Vienna and ultimately became professor of Zoology at Padua. His scientific publications largely dealt with the systematics of fish and arthropods. In addition, he made important contributions to anthropology. He was Darwin's

strongest supporter in Italy and an important popularizer. With Leonardo Salimbeni he produced the first Italian translation of *The Origin of Species* (1864). He also translated some of Darwin's later books. Darwin cites his work on human anatomy and some other topics in *The Descent of Man*.

References: Landucci in DD; Pancaldi 1983, Battaglia, Danielli & Minelli 1998.

Carlyle, Thomas

December 4, 1795 – February 5, 1881

Ecclefechan, Dumfriesshire, Scotland – London, England

Historian and essayist. Because they were friends of his brother, Erasmus Alvey Darwin, Charles Darwin knew him and Mrs. Carlyle socially.

References: Tort in DD.

Carpenter, Philip Herbert

1852 – October 21, 1892

London, England – Eton, England

English zoologist, fourth son of William Benjamin Carpenter. A schoolmaster at Eton, he worked on echinoderms, especially crinoids.

Carpenter, William Benjamin

October 29, 1813 – November 19, 1885

Exeter, England – London, England

English physiologist, Professor at the University of London. He was author of some influential text books, notably his *Comparative Physiology*. With Darwin and others he signed a "memorial" on natural history museums in 1858. When *The Origin of Species* was published Carpenter published a supportive review.

References: Tort in DD, Thomas in DSB, Bettany in DNB.

Carrière, Élie Abel

1818 – 1896

Mayen Multien, Seine et Marne, France – Paris, France

French horticulturalist. He worked at the natural history museum in Paris, and was "chef" of the *Revue Horticole*. Darwin cites his work in relation to variation and artificial selection.

References: Tort in DD.

Carus, Carl Gustav

January 3, 1789 – July 28, 1869

Leipzig – Dresden, Germany

German philosophical physician, scientist and painter, an advocate of *Naturphilosophie*.

References: *Lexikon der bedeutenden Naturwissenschaftler*.

Carus, Julius Victor

August 23, 1823 – March 10, 1903

Leipzig, Germany – Leipzig, Germany

German zoologist, professor at Leipzig, also author of an important book on the history of biology. From the fourth English edition, he prepared a new German translation of the *Origin of Species*, the one by Bronn not having been satisfactory. He also translated several of Darwin's other books.

References: Tort in DD, Robinson in DSB.

Chambers, Robert

July 10, 1802 – March 17, 1871

Peebles, Scotland – St. Andrews, Scotland

Scottish writer and publisher. His anonymously published popular book *Vestiges of the Natural History of Creation* presented Lamarckian and quarian notions about evolution. The book tended to discredit evolutionary thinking among professional scientists and may have contributed to Darwin's hesitancy to publish. Darwin mentions him in the *Historical Sketch* in later editions of the *Origin*.

References: Williams in DSB.

Chamisso, Adelbert von

ca. January 27, 1781 – August 21, 1838

Château de Boncourt, Champagne, France – Berlin, Germany

French-born naturalist who spent much of his life in Prussia. Chamisso was also a famous poet and humorist. He circumnavigated the globe with the Russian Kotzebue and made important observations on geology and zoology.

References: Rudwick in DSB, Lahnstein 1984.

Champion, George Charles

April 29, 1851 – August 6, 1927

London, England – Horsell, England

English entomologist. He described some of Darwin's Coleoptera of the *Beagle* voyage.

Cheeseman, Thomas Frederick

1846 – October 15, 1923

Hull, Yorkshire, England – Auckland, New Zealand

English Botanist. He immigrated to New Zealand in 1854, where he became Curator of the Auckland

Museum. He corresponded extensively with Darwin about orchids.

References: Garber 1994.

Claparède, [Jean Louis René Antoine] Édouard

April 24, 1832 – May 31, 1871

Geneva, Switzerland – Siena, Italy

Swiss invertebrate zoologist. An early and strong supporter of Darwinism, he published a favorable review of the *Origin of Species* in 1861. He also persuaded Clemence Royer to restrain herself somewhat when she translated the *Origin of Species* into French. Darwin cites his histological work in *Worms*.

References: Tort in DD, Saussure 1873.

Clarke, Thomas Belt

1798 – 1878

English geologist. Darwin met him before he immigrated to Australia in 1839. They had important correspondence on geological topics.

References: Garber 1994.

Claus, Carl

January 2, 1835 – January 18, 1899

Kassel, Hessen, Germany – Vienna, Austria

Invertebrate zoologist, Professor at Vienna. He was a strong supporter of Darwin's views, and dedicated a work on the phylogeny of crustaceans to him.

References: Tort in DD.

Cobbe, Frances Power (Miss)

December 4, 1822 – April 5, 1904

Newbridge, near Dublin, Ireland – Hengwyr, near Dolgelly, Wales

British political activist and writer, feminist and antivivisectionist, author of *The Theory of Intuitive morals* (1855). She disagreed with Darwin on vivisection and the ethical implications of Darwinism. Darwin responded to her criticisms in a footnote in the second edition of *The Descent of Man*.

References: Phyllis J. Scherle in P. & J. Schleuter, eds., *British Women Writers* (1998), New Brunswick: Rutgers University Press.

Cobbold, Thomas Spencer

1828 – March 20, 1886

Ipswich, England – London, England

English physician and parasitologist. He described the parasitic worms from Darwin's *Beagle* collections.

References: RBF, Pagel's *Biographisches Lexicon*

herforragender Ärzte des neunzehnten Jahrhunderts, George Thomas Bettany in DNB.

Coldstream, John

March 19, 1806 – December 7, 1863

Leith, Scotland – Irthing House, near Carlisle, Scotland

Scottish physician and invertebrate zoologist.

Coldstream was a friend of Darwin at Edinburgh who shared his interests in marine animals and other aspects of natural history. He was also the author of an important encyclopedia article on cirripedes.

References: ODNB.

Colling, Charles

1751 – 1836

Ketton, near Darlington, England

English cattle breeder. Darwin refers to him in *The Variation of Animals and Plants under Domestication*.

References: Tort in DD.

Collins, Mr.

Animal breeder mentioned in *The Origin of Species*. Perhaps Charles Colling (*q.v.*).

References: Ogawa, 2001.

Comte, Auguste

January 19, 1798 – September 5, 1857

Montpellier, France – Paris, France

French philosopher, the founder of positivism.

Darwin was interested in his philosophical views.

References: Laudan in DSB.

Conrad, Timothy Abbot

June 21, 1803 – August 8, 1877

Near Trenton, New Jersey – Trenton, New Jersey

American malacologist and paleontologist, one of the first to correlate American strata with those of Europe. He provided Darwin with some specimens of barnacles. He opposed evolution.

References: GHG, Moore in DSB.

Conybeare, William Daniel (Reverend)

June 7, 1787 – August 12, 1857

London, England – Ichenstoke, England

English geologist.

References: EB Torrens in ODNB.

Cope, Edward Drinker

July 28, 1840 – April 12, 1897

Philadelphia, Pennsylvania, USA – Philadelphia,

Pennsylvania, USA

American paleontologist. He was an important Neolamarckian.

References: Tort in DD, Osborn 1931, Maline in DSB.

Corfield, Richard Henry

1804 – 1897

Friend of Darwin at Shrewsbury School. He lived in Valparaiso, and Darwin stayed with him there in 1834 and 1835.

References: RBF.

Covington, Syms

1816? – February 17, 1861

England – Australia

Darwin's servant from 1833 to 1839. He emigrated to Australia in 1839 and corresponded with Darwin from time to time. He sent specimens of cirripedes from there.

References: RBF.

Cresy, Edward

May 7, 1792 – November 12, 1858

Dartford, Kent, England – South Darenth, Kent, England

English architect. A neighbor of Darwin at Down, he had a son of the same name.

References: Goodwin in DNB.

Cresy, Edward

1823 – October 13, 1870

English architect and amateur botanist.

References: Tort in DD.

Crocker, Charles William

1832 – February 19, 1868

Chichester, Sussex, England – Torquay, Devon, England

English botanist.

References: Tort in DD, RD.

Crofts, Ellen Wordsworth

1856 – 1903

Second wife of Francis Darwin (married 1883); lecturer at Newnham College, Cambridge.

References: RBF.

Crüger, Hermann

February 11, 1818 – February 28, 1864

Hamburg, Germany – San Fernando, Trinidad

German pharmacist who settled in Trinidad in 1841.

He was government botanist director of the botan-

ical garden from 1857 to 1864. He was a major source of information for Darwin on various aspects of floral biology.

References: Tort in DD, RD.

Cuming, Hugh

February 14, 1791 – August 10, 1865

West Alvington, Kingsbridge, Devonshire, England – London, England

English naturalist and collector of shells and plants. He made extensive voyages in the Pacific. Darwin used his collections in preparing his barnacle monograph. He shipped orchids from Manila to England.

References: RD.

Cumming, Joseph George (The Reverend)

February 15, 1812 – September 21, 1868

Matlock, Derbyshire, England – London, England

English clergyman, geologist and historian, professor at Birmingham. Author of *The Isle of Man* (1848).

Darwin refers to his early geological work in his paper on boulders.

References: GHG.

Currey, Frederick

August 19, 1819 – September 8, 1881

Norwood, Surrey, England – Blackheath, London, England

English mycologist.

References: RD.

Cuvier, Frédéric

June 8, 1773 – July 24 1838

Montbéliard, Württemberg – Strassbourg, France

French naturalist, younger brother of Georges Cuvier.

Darwin took a great interest in his work on the behavior and intelligence of animals.

References: Tort in DD.

Cuvier, Georges

August 23, 1769 – May 13, 1832.

Montbéliard, Württemberg – Paris, France

French zoologist and educator. He was leading comparative anatomist of the early nineteenth century, and founder of modern vertebrate paleontology.

He was opposed to evolution, especially the version of Lamarck. He advocated catastrophism and opposed E. Geoffroy Saint-Hilaire's notion of the unity of type. Their debate about that and related matters attracted a great deal of attention. Darwin often refers to his writings on the principles of

comparative anatomy.

References: Bourdier in DSB.

D

Dallas, William Sweetland

January 31, 1824 – May 28, 1890

London, England – London, England

English entomologist. He translated Müller's *Für Darwin* into English, and wrote the glossary that was added to the sixth edition of *The Origin of Species*.

References: Tort in DD.

Dana, James Dwight

February 12, 1813 – April 14, 1895

Utica, New York – New Haven, Connecticut

American mineralogist, geologist, and zoologist, professor at Yale. A student of Louis Agassiz and an idealistic morphologist, he accepted evolution only reluctantly. Dana was important to Darwin because of his work on coral reefs, on systematic theory, and on the systematics, comparative anatomy and biogeography of crustaceans. They corresponded extensively.

References: Stanton in DSB, Gilman 1899

Darwin, Anne Elizabeth ("Annie")

March 2, 1841 – April 23, 1851

London, England – Malvern, England

Daughter of Charles Darwin. He was very fond of her, and her death at the age of ten, an event that was very painful to him, was instrumental in causing him to rethink his position on religion and ethics.

References: RBF.

Darwin, Bernard Richard Meirion

September 7, 1876 – October 18, 1961

Downe, England – St. Leonards, Sussex, England

Son of Francis Darwin and grandson of Charles Darwin. His mother having died of puerpal fever in 1876, he subsequently lived with his father and grandparents at Down.

References: RBF, Ryde in ODNB.

Darwin, Caroline

September 14, 1800 – January 5, 1888

Shrewsbury, England – Surrey, England

Older sister of Charles Darwin. She married Josiah Wedgwood III in 1837.

References: RBF.

Darwin, Catherine (Mrs. Charles Langton)

May 10, 1810 – February 2, 1866
 Shrewsbury, England – Shrewsbury, England
 Younger sister of Charles Darwin.

Darwin, Charles [Robert]

February 9, 1809 – April 19 1882
 Shrewsbury, England – Downe, Kent, England
 English naturalist, the father of modern evolutionary biology and author of its central document, *On the Origin of Species by means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life*.

Darwin, Charles Waring

December 5, 1856 – June 28, 1858
 Downe, Kent, England – Downe, Kent, England
 Tenth and last child of Charles Darwin. He died of scarlet fever around the time that Wallace's manuscript on natural selection arrived. The child never learned to walk or talk, but accounts of his being seriously retarded would seem to have been somewhat exaggerated.

References: RBF.

Darwin, Elizabeth (“Bessy”)

July 8, 1847 – 1928
 Sixth child of Charles Darwin. She never married.
 References: RBF.

Darwin, Emma

See Wedgwood, Emma

Darwin, Erasmus (Dr.)

December 12, 1731 – April 18, 1802
 Elston, near Newark, England – the Priory, near Derby, England
 Paternal grandfather of Charles Darwin. A sort of polymath, he was a physician, philosophical poet, popular writer, and natural scientist. He is well known for having invented a quasi-evolutionary theory quite similar to that of Lamarck. For that reason he is mentioned in the *Historical Sketch* in later editions of the *Origin*. His writings may have influenced Charles Darwin's thinking on a variety of subjects, including psychology and developmental genetics. Charles Darwin's biography of Erasmus Darwin was published after having been censored by Henrietta Darwin.

References: EB13.

Darwin, Erasmus Alvey

December 29, 1804 – August 26, 1881
 Shrewsbury, England – London, England
 Older brother of Charles Darwin. He took a medical degree but never practiced. Instead he chose to live most of his life in London, where he had a rich social and intellectual life. Erasmus and Charles shared quarters in Edinburgh while both of them were in medical school there. Charles often visited Erasmus in London and seems to have derived a great deal of valuable information about a wide range of topics, including philosophy and economics, from him and his friends.

References: Tort in DD.

Darwin, Francis (Professor, Sir)

August 16, 1848 – September 19, 1925
 Down House, England – Cambridge, England
 Son of Charles Darwin. An important botanist and plant physiologist, he became professor at Cambridge. He qualified as a physician but did not practice. He assisted his father in his plant physiological researches, especially in later years, and was a sort of junior author of *The Power of Movement in Plants*. His observations and experiments are also incorporated in some of Darwin's other publications. He was author of *The Elements of Botany*, *The Physiology of Plants*, *Life and Letters of Charles Darwin* and *More Letters of Charles Darwin* as well as many scientific papers. He married three times: to Amy Ruck 1874-1876 (two children); to Ellen Crofts 1883-1903 (three children); to Florence Fisher, 1913-1920.

References: RBF, George in DSB, Junker in ODNB, Seward and Blackman, 1932.

Darwin, Frances Crofts

1886 – March 30, 1960
 Daughter of Francis Darwin and Ellen Wordworth Crofts Darwin, and granddaughter of Charles Darwin. She became the wife of Professor F. M. Cornford of Cambridge, and was the mother of the poet Francis Cornford.

References: RBF.

Darwin, George Howard (Professor, Sir)

July 9, 1845 – December 7, 1912
 Down House, Kent, England – Cambridge, England
 Fifth child of Charles and Emma Darwin. An astronomer, he was Plumian Professor, Cambridge from 1883 to 1912, and was knighted in 1905. He

often assisted his father with mathematical problems. His observations on the fertilization of orchids are recorded in Darwin's publications. References: Kopal in DSB, Kushner in ODNB.

Darwin, Henrietta Emma

September 25, 1843 – 1930
Down House, Kent, England – London, England
Daughter of Charles Darwin, became Mrs. Richard Litchfield in 1871. She assisted Darwin in many ways, especially with his publications. As Mrs. Litchfield, she was author of *Emma Darwin: a Century of Family Letters*.

Darwin, Horace (Sir)

May 13, 1851 – September 22, 1925
Downe, England – Cambridge, England
Ninth child of Charles and Emma Darwin. He assisted his father in some experiments, and devised instruments for plant physiology used by Charles and Francis Darwin and otherwise assisted him in research. He married Emma (Ida) Cecilia Farrer. They had three children. References: RBF, Glazebrook in ODNB.

Darwin, Leonard (Major)

January 15, 1850 – March 26, 1943
Downe, England – West Hoathly, Sussex, England
Eighth child of Charles and Emma Darwin, he was commissioned in the Royal Engineers in 1870. Later he became involved in politics and served as President of the Eugenics Society. References: RBF, Edwards in ODNB.

Darwin, Marianne (Mrs. Henry Parker)

April 7, 1798 – July 18, 1858
Older Sister of Charles Darwin. References: RBF.

Darwin, Mary Eleanor

September 23, 1842 – October 16, 1842
Downe, England – Downe, England
Third child of Charles Darwin. References: RBF.

Darwin, Robert Waring (the elder)

1724 – 1816
Brother of Erasmus Darwin and great-uncle of Charles Darwin. He was the author of a book entitled *Principia Botanica; or, a Concise and Easy Introduction to the Sexual Botany of Linnaeus*.

Darwin, Robert Waring

May 30, 1766 – November 13, 1848
Litchfield, England – Shrewsbury, England
A wealthy physician, the son of Erasmus Darwin and father of Charles Darwin. He studied medicine at Edinburgh from 1784 to 1787, and took his M.D. at Leiden 1785. Although he was a Fellow of the Royal Society of London he was author of only one scientific paper and it was probably written with the help of his father. Charles Darwin did not think that he had much talent for science. References: Tort in DD.

Darwin, Susan

October 3, 1803 – October 3, 1866
Shrewsbury, England – Shrewsbury, England
Older sister of Charles Darwin. References: RBF.

Darwin, William Erasmus

December 27, 1839 – September 1, 1914
London, England – ?
First child of Charles and Emma Darwin. Observations on his behavior when very young were the basis of his father's classic paper in *Mind* (1877). With his father's assistance he became a partner in the Southampton and Hampshire Bank in 1861. Afterward his parents often visited him. Observations that he made on plants in his spare time were incorporated in Charles Darwin's publications. References: RBF.

Davidson Thomas

May 17, 1817 – October 14, 1885
Edinburgh, Scotland – London, England
Scottish paleontologist, an expert on fossil brachiopods. References: GHG.

de Bary, [Heinrich] Anton

January 26, 1831 – January 19, 1888
Frankfurt am Main – Strassbourg, France
German mycologist, professor of Botany at Strassburg beginning in 1872. The father of modern mycology, he took his doctorate at Berlin in 1849. He introduced the word "symbiosis" in 1879. References: Robinson in DSB.

de Candolle, Alphonse; see Candolle, Alphonse de

de Candolle, Augustin Pyramus; see Candolle, Augustin-Pyramus de

De Filippi, Filippo

April 20, 1814 – February 9, 1867

Milan, Italy – Hong Kong

Italian zoologist, professor of zoology and comparative anatomy at Turin. An early supporter of Darwin, his lecture entitled *L'Uomo e le Scimmie* was a milestone in attracting attention to evolution.

References: Landucci in DSB.

De la Beche, Henry Thomas (Sir)

February 10, 1796 – April 13, 1855

London, England – London, England

English geologist. Darwin refers to his work in the paper on boulders.

References: GHG.

Deshayes, Gerard Paul

May 24, 1797 – June 9, 1875

Nancy, France – Boran-sur-Oise, France

French paleontologist and malacologist.

References: Tobien in DSB.

De Vries, Hugo

February 16, 1848 – May 21, 1935

Haarlem, Netherlands – Lunteren, Netherlands

Dutch plant physiologist, professor at Amsterdam. He visited Darwin in the summer of 1877. Darwin cites him on numerous topics in plant physiology. Sympathetic with Darwin's work on pangenesis, he later became the main rediscoverer of Mendel's work on genetics.

References: van der Pas in DSB.

Dick, Sir Lauder; see Lauder, Thomas Dick

Delpino, Federico

December 12, 1833 – May 14, 1905

Chiavari, Italy – Naples, Italy

Italian botanist. He did extensive research on plant fertilization as a consequence of Darwin's contribution, and was an important, but friendly, critic of pangenesis.

References: Landucci in DD, *Enciclopedia Italiana*.

Dieffenbach, Ernst

January 27, 1811 – October 1, 1855

Giessen, Germany – Giessen, Germany

German physician, naturalist and geologist, translator

of the *Journal of Researches*. He provided Darwin with information about New Zealand.

References: GHG, Landucci in DD, DNB, Garber 1994.

Dohrn, [Felix] Anton

December 29, 1840 – September 26, 1909

Stettin, then part of Germany, now in Poland – Munich, Germany

German zoologist, a student of Ernst Haeckel. Inspired by Darwin's work, he founded the great Zoological Station at Naples with Darwin's enthusiastic encouragement. He made important contributions to systematics and evolutionary biology, most notably his principle of the succession of functions. He knew Darwin personally and they corresponded extensively.

References: Oppenheimer in DSB, Heuss 1991.

Donders, Francisco Cornelius (Professor)

May 27, 1818 – Marcy 24, 1889

Tilburg, Netherlands – Utrecht, Netherlands

Dutch ophthalmologist, professor at Utrecht. At Darwin's instigation he carried out experiments that are discussed in *The Expression of the Emotions*. He also advised Darwin on various other physiological matters including the sensitivity of plants.

References: Ter Laage in DSB.

Doubleday, Edward

October 9, 1810 – December 14, 1849

Epping, England – London, England

English entomologist, a specialist on Lepidoptera.

References: BAE.

Doubleday, Henry

July 1, 1809 – June 29, 1875

London, England – London, England

English entomologist, a specialist on Lepidoptera.

There are several references to his work on butterflies in *The Descent of Man*. He is also cited in *Flowers*.

References: RD.

Douglas, John William

1814–1905

English entomologist, an expert on Hemiptera.

Darwin cites him in respect to sexual selection.

References: DD.

Drummond, James

Baptized January 8, 1787 – March 26 or 27, 1863
 Inverarity, Scotland – Hawthornden, Western Australia
 Scottish botanist and plant collector who settled in Western Australia in 1829. He was superintendent of the government gardens until 1834.
 References: Risher in DNB, Garber, 1994.

Duchenne, Guillaume Benjamin Amand (Dr.)

September 17, 1806 – September 15, 1875
 Boulogne-sur-Mer, France – Paris, France
 French physician and physiologist. Darwin cites his work in *The Expression of the Emotions*.
 References: EB13

Duméril, Constant [André-Marie-Constant]

January 1, 1774 – August 14, 1860
 Amiens, France – Paris, France
 French vertebrate zoologist; father of Auguste Henri - André Duméril
 References: Adler 1989.

Duméril, Auguste [Auguste-Henri-André]

November 30, 1812 – November 12, 1870
 Paris, France – Paris, France
 French vertebrate zoologist, son of André Marie Constant. Duméril.
 References: Adler 1989.

Dumont d'Urville, Jules Sébastien César

May 23, 1790 – May 8, 1842
 Condé-sur-Noireau, France – near Meudon, France
 French navigator and explorer.
 References: EB13.

Dutrochet, René Joachim Henri (Marquis de Néons)

November 14, 1776 – February 4, 1847
 Néon, France – Paris, France
 French physician, zoologist and botanist, sometimes considered the founder of the cell theory. Darwin frequently refers to his publications in *Climbing Plants*.
 References: Kruta in DSB.

Dzierzon, Johann (Pfarer)

January 16, 1811 – December 26, 1906
 Lokowitz, Upper Silesia (now Poland) – Lokowitz, Poland
 German apiculturist, originally a clergyman. He discovered parthenogenesis in bees. Darwin cited his work frequently.

E**Edwards, Henry**

August 27, 1830 – June 9, 1891
 Herefordshire, England – New York, New York, USA
 English-born American systematic entomologist who was an actor by profession. An expert on Lepidoptera, he was a Fellow of the California Academy of Sciences and active in California until 1877, when he moved to New York.
 References: RBF, Essig 1931.

Edwards, Frederick Erasmus

1799 – 1875
 English paleontologist. Darwin used his specimens for the monograph on fossil Lepididae
 References: GHG.

Egerton, Philip de Malpas (Baronet)

November 13, 1806 – April 5 1881
 Cheshire, England – London, England
 English paleontologist, an expert on fossil fishes.
 References: Bettany in DNB.

Ehrenberg, Christian Gottfried (Professor)

April 19, 1795 – June 27, 1876
 Delitsch, near Leipzig, Germany – Berlin, Germany
 German microscopist and zoologist, professor at Berlin. He examined Darwin's specimens of dust and other materials from the *Beagle* expedition.
 References: Tort in DD, Jahn in DSB.

Élie de Beaumont, Jean-Baptiste-Armand-Louis-Léonce

September 25, 1798 – September 21, 1874
 Canon, Calvados, France – Canon, Calvados, France
 French geologist and mining engineer, important to Darwin for his work on glaciers, volcanoes, and mountain-building. Beaumont maintained that mountain-building occurs as the result of the earth contracting as it cools, whereas Darwin attributed it to the injection of molten rock.
 References: Birembaut in DSB, GHG.

Eliot, George – Pseudonym of Mary Ann Evans, later Mrs. J.W. Cross

November 22, 1819 – December 22, 1880
 Warwickshire, England – Chelsea, England
 English novelist and literary intellectual. She was part of the group of people associated with Erasmus Darwin in London and knew many distinguished persons. However, her cohabitation with George

Henry Lewes made her socially unacceptable to many.

References: EB13.

Eyton, Thomas Campbell

September 10, 1809 – October 25, 1880

Wellington, Shropshire, England – Wellington, Shropshire, England

English ornithologist, an expert on ducks. A friend of Darwin at Cambridge, they remained friends and corresponded, although Eyton did not support Darwin's evolutionary theory. He wrote the anatomical section on birds in the *Zoology* of the *Beagle* voyage. Darwin cites him as an authority on hybridization.

References: Tort in DD, Fisher in ODNB.

F

Fabre, Jean-Henri

December 22, 1823 – October 11, 1915

Saint-Léons, Aveyron, France – Sérignan, Vaucluse, France

French entomologist and author of popular works on science. Darwin cites his works on insect behavior.

References: Tort in DD, Théodoridès in DSB.

Fabricius, Johann Christian

January 7, 1745 – March 3, 1808

Tornberg, Schleswig, Denmark – Kiel, Germany

Danish systematic entomologist, a pupil of Linnaeus.

References: NBG, Landin in DSB.

Falconer, Hugh

February 29, 1808 – January 31, 1865

Forres, Scotland – London, England

British botanist and vertebrate paleontologist. His untimely death caused Darwin considerable distress.

References: DHG, Challinor in DSB, EB13.

Farrer, Thomas Henry

June 24, 1819 – October 11, 1899

London, England – Abinger Hall, Dorking, England

English lawyer and civil servant, author of works on political economy. He was made a Baronet in 1883 and First Baron in 1893. He married Katherine Euphemia Wedgwood, daughter of Hensleigh and Fanny Wedgwood. Their daughter Ida (1854-1946) became the wife of Darwin's son Horace in 1880. The Darwins often visited them. Darwin mentions Farrer's research on the fertilization of plants, including orchids. Farrer excavated Roman

ruins on his property and these are discussed in Darwin's book on *Worms*.

References: EB13.

Fawcett, Henry

August 25, 1833 – November 6, 1884

Salisbury, England – Cambridge, England

English politician, political economist and philosopher, author of a *Manual of Political Economy*. He was accidentally blinded in 1858. He was a supporter of Darwin.

References: RBF, EB13.

Férussac, André (Baron de)

1786 – 1836

Chartron, France – Paris, France

French malacologist. Darwin cites an important article by him on cirripedes.

References: Tort in DD.

Filippi, Filippo de

1814 – 1867

Milan, Italy – Hong Kong

Italian zoologist

References: Landucci in DD.

Fiske, John

March 30, 1842 – July 4, 1902

Hartford, Connecticut, USA – Gloucester, Massachusetts, USA

American writer on historical, philosophical and scientific topics. Author of *Outlines of Cosmic Philosophy*, *Excursions of an Evolutionist* and other books he played an important role in making the work of Darwin and Spencer known in America.

References: EB13.

Fitch, Robert

October 21, 1802 – April 4, 1895

Pharmacist and geologist. He loaned Darwin specimens of fossil barnacles. These included a collection from Chalk of Norwich where he resided.

References: GHG, Newman 1993.

Fitton, William Henry (Dr.)

January 24, 1780 – May 13, 1861

Dublin, Ireland – London, England

Irish physician and geologist, an important stratigrapher.

References: GHG, Eyles in DSB, Torrens & Browne in ODNB.

Fitzgerald, Robert David

November 30, 1830 – August 12, 1892

Tralee, County Kerry, Ireland – Sydney, New South Wales, Australia

Irish naturalist who moved to Australia around 1856.

He was an authority on Australian orchids and author of a magisterial survey of them, *Australian Orchids* (1875-1894). He provided Darwin with much useful information.

References: RD, Garber 1994, Butcher 1999.

Fitz-Roy, Robert (Captain, Vice-Admiral)

July 5, 1805 – April 30, 1865

Suffolk, England – London, England

English naval officer. He commanded the *Beagle* while Darwin was on board as his guest. Although a difficult person he was a superb sailor and had the respect and loyalty of his men. He published an account of the voyage, in addition to some papers on geography. He was very rigid and orthodox in his beliefs and publicly denounced Darwin's evolutionary theory. During the voyage he suffered from bouts of depression. Ultimately he committed suicide.

References: GHG, Basala in DSB.

Fleming, John

January 10, 1785 – November 18, 1857

Kirkroads, near Bathgate, Linlithgowshire, Scotland – Edinburgh, Scotland

Scottish geologist and zoologist. Darwin read his *Philosophy of Zoology* and other works.

References: Page in DSB.

Flourens, Marie-Jean-Pierre

April 13, 1794 – December 8, 1867

Maureilhan, near Béziers, France – Montgeron, near Paris, France

French physiologist, Perpetual Secretary of the Académie des Sciences de Paris. He published a scathing denunciation of the *Origin of Species* in 1864. Darwin cites his work on animal intelligence.

References: Kruta in DSB.

Flower, John Wickham

August 11, 1807 – April 11, 1873

London, England – London, England

English geologist. Darwin used his specimens for research on fossil barnacles.

References: GHG, Newman 1993.

Flower, William Henry (Sir)

November 30, 1831 – July 1, 1899

Stratford-on-Avon, England – London, England

English zoologist. Curator of the Hunterian Museum of the Royal College of Surgeons 1861-1884, Professor of comparative anatomy 1870-1884. He supported Huxley in an important controversy with Owen about the human brain.

References: Williams in DSB.

Forbes, Edward (Professor)

February 12, 1815 – November 18, 1854

Isle of Man, England – Edinburgh, Scotland

(Pronounced “four bees.”) British marine biologist, invertebrate zoologist, and geologist. He described some of Darwin's South American fossil shells. His work on biogeography was of great interest to Darwin. His untimely death was much regretted by his colleagues.

References: Egerton in DSB, EB13, Mills 1984.

Forchhammer, Johann Georg (Professor)

July 26, 1794 – December 14, 1865

Husum, Denmark – Copenhagen, Denmark

Danish geologist, professor at Copenhagen. He helped Darwin to obtain specimens of barnacles.

References: Goldberg in DSB.

Forsskål, Per [Peter]

January 11, 1732 – July 11, 1763

Helsinki, now Finland – Yemen

Scandinavian systematic botanist.

References: Eriksson in DSB.

Forster, Johann Reinhold

October 11, 1729 – December 9, 1798

Dirschau, Poland – Halle, Germany

German naturalist and geographer. His explorations in the Pacific were important background to Darwin's geological and biological work.

References: Hoare in DSB.

Forster, Johann Georg Adam

November 27, 1754 – January 12, 1794

Gdansk, now in Poland – Paris, France

German naturalist and explorer. The son of Johann Reinhold Forster, he often accompanied him on voyages.

References: Hoare in DSB.

Foster, Michael

March 8, 1836 – January 28, 1907

Huntington, England – London, England
 English physiologist, professor at Cambridge, and as such the leader of an important school. Huxley and he worked together to reform biological education.
 References: Geison in DSB, Geison 1978.

Fothergill, John

March 8, 1712 – December 26, 1780
 Wensleydale, Yorkshire, England – London, England
 English physician and botanist. Darwin read his *Philosophy of Natural History*.
 References: Moore in DNB, RD.

Fox, Henry Stephen

September 22, 1791 – October 13, 1846
 Chatham, Kent, England – Washington, D.C., USA
 English diplomat, Minister Plenipotentiary at Rio de Janeiro.
 References: Arbuthnot in DNB, Wright in ODNB.

Fox, William Darwin

1805 – 1880
 Second cousin of Charles Darwin, and his closest friend at Cambridge University. He became Vicar of Delamere, Cheshire. Fox introduced Darwin to the study of beetles, and they kept up a lifetime correspondence.
 References: RBF.

Frankland, Edward (Professor)

January 18, 1825 – August 9, 1899
 Churchtown, England – Golaa, Gudbrands-dalen, Norway
 English chemist, professor at the Royal Institution. He was a friend and collaborator of Tyndall. He did the analytical work described in *Insectivorous Plants* and also provided CD with reagents for the experiments. He was knighted in 1897, partly in recognition of his work on the London water supply.
 References: RBF, EB13.

Freke, Henry (Dr.)

Died 1888
 Irish eccentric physician and evolutionist, mentioned in the *Historical Sketch*.
 References: RBF, DD.

G

Gärtner, Karl Friedrich von

May 1, 1772 – September 1, 1850

Göppingen, Germany – Calw, Württemberg, Germany
 German botanist. An important student of plant hybridization, Darwin made considerable use of his publications.
 References: Tort in DD, Hoppe in DSB.

Galton, Francis

February 16, 1822 – January 17, 1911
 Birmingham, England – Haslemere, Surrey, England
 A cousin of Charles Darwin, he is noted for having been remarkably intellectually precocious. A gifted mathematician, he made important contributions to statistics, and helped Darwin by applying statistics to his data. He also studied psychology, and had Darwin fill out a questionnaire as part of a study on talent. His transfusion experiments on rabbits, designed to test Darwin's hypothesis of pangenesis, gave negative results. He became a leader in the eugenics movement.
 References: Gridgeman in DSB.

Gaudry, Albert Jean

September 15, 1827 – November 27, 1908
 Saint-Germain-en-Laye, France – Paris, France
 French paleontologist. Gaudry was one of the founders of evolutionary paleontology. However, he believed that species are transformed under divine supervision, leading progressively to man.
 References: Laurent in DD, Bourdier in DSB.

Gegenbaur, Carl (Professor)

August 21, 1826 – June 14, 1903
 Würzburg, Germany – Heidelberg, Germany
 German zoologist, professor at Jena, then at Heidelberg. He was very influential in establishing an evolutionary approach to morphology, especially that of vertebrates.
 References: di Gregorio in DD, Coleman in DSB.

Geikie, Archibald

December 28, 1835 – November 10, 1924
 Edinburgh, Scotland – near Haslemere, Surrey, England
 Scottish geologist, professor at Edinburgh beginning in 1871, knighted in 1891. He should not be confused with his younger brother James. Darwin cites his work in *Worms*.
 References: EB13.

Geikie, James

August 23, 1839 – March 1, 1913

Edinburgh, Scotland – Edinburgh, Scotland
 Scottish geologist, professor at Edinburgh beginning in 1882. He should not be confused with his older brother Archibald. Darwin cites his book *Prehistoric Europe* (1881) in *Worms*.

References: EB13.

Geoffroy Saint-Hilaire, Étienne-François

April 15, 1772 – June 19, 1844

Étampes, France – Paris, France

French zoologist. His work on comparative anatomy, with its notions of unity of type and the principle of connections, was highly influential. He was one of the founders of the modern science of teratology (abnormal development). In the 1830s he engaged in a very important debate with Georges Cuvier. As a result, Geoffroy's ideas, which included the possibility of evolution, were supported by only a small minority of biologists. He is mentioned in the *Historical Sketch* in later editions of the *Origin*.

References: le Guyader in DD, Bourdier in DSB, le Guyader 1998, 2004.

Geoffroy Saint-Hilaire, Isidore

December 1805 – November 10, 1861

Paris, France – Paris, France

French zoologist, son of Étienne Geoffroy Saint-Hilaire, whom he succeeded as professor at the Muséum d'Histoire Naturelle in 1841. Like his father he was interested in teratology, and his book on that topic profoundly influenced Darwin. Also of importance were his writings on geographical distribution and domesticated animals. Something of an evolutionist, he is mentioned in the *Historical Sketch* in later editions of the *Origin*.

References: Laurent in DD, Bourdier in DSB.

Gerstäcker, [Karl Eduard] Adolf

August 30, 1828 – June 20, 1895

Berlin, Germany – Greifswald, Germany

German zoologist, professor at Greifswald. He was the author of a very scholarly review on arthropods in the *Handbuch der Zoologie* (1863). Skeptical statements with respect to the dwarf males of cirripeds by an unidentified German zoologist have been attributed to him, but this seems most unlikely. There is no trace of that notion in the aforementioned work.

References: DBE.

Gibbon, Edward

April 27, 1737 (old style) – January 16, 1794

Putney, Surrey, England – London, England

English historian, author of *The Decline and Fall of the Roman Empire*.

References: Womersly in DNB, Bury in EB13.

Gibbs, George

July 17, 1815 – April 9, 1873

Near Astoria, New York, USA – New Haven, Connecticut, USA

Ethnologist at the Smithsonian. He was an informant about emotional expression

References: RBF, *Dictionary of American Biography*.

Gilbert, Joseph Henry (Dr., Sir)

August 1, 1817 – December 23, 1901

Hull, Yorkshire, England – Rothamsted, Herts., England

English agricultural chemist, an expert on fertilization and plant nutrition. He advised Darwin on plant nutrition.

References: RD.

Gladstone, William Ewart

December 29, 1809 – May 19, 1898

Liverpool, England – Hawarden, Wales

British statesman of Scottish descent, four times Prime Minister. He visited Down with Huxley in 1876. He arranged for Wallace's Civil List pension.

References: RBF, EB13.

Gmelin, Johann Georg

August 10, 1709 – May 20, 1755

Tübingen, Germany – Tübingen, Germany

German botanist and geographer who worked in Russia. He studied mutations in plants.

References: Kruta in DSB.

Gmelin, Samuel Gottlieb

July 4, 1744 – July 27, 1774

Tübingen, Germany – Achmetkent, Caucasus, Russia
 German botanist and explorer, nephew of Johann Georg Gmelin.

References: Kruta in DSB.

Godwin, William

March 3, 1756 – April 7, 1836

Wisbeach, Cambridgeshire, England – London, England

English political writer, educated as a clergyman. His

book *Of Population* (1820) was of some interest to Darwin.

References: EB13.

Goethe, Johann Wolfgang von

August 28, 1749 – March 22, 1832

Frankfurt am Main, Germany – Weimar, Germany

Germany's greatest poet, the author of *Faust*. A civil servant, he had broad scientific interests. He was particularly influential in the study of plant and animal morphology..

References: EB13

Gosse, Philip Henry

April 6, 1810 – August 23, 1888

Worcester, England – Devon, England

English naturalist, and author of popular scientific works, and more technical publications. He was important for Darwin's work on orchid fertilization. His anti-evolutionary book *Omphalos* was much ridiculed. His son, Edmund Gosse, portrays him in his autobiographical novel *Father and Son*.

References: EB13.

Gould, Augustus Addison

April 23, 1805 – September 15, 1866

New Ipswich, New Hampshire, USA – Boston, Massachusetts, USA

American physician and malacologist.

References: Gifford in DSB.

Gould, John

September 14, 1804 – February 3, 1881

Lyme Regis, England – London, England

English ornithologist. Gould studied Darwin's *Beagle* collections, giving important evolutionary implications, and also described the birds of the voyage.

References: Simpkins in DSB.

Gower, William Hugh

November 6, 1835 – July 30, 1894

Unknown – Tooting, London, England

English gardener, a foreman at Kew Gardens until 1865. He was an expert on orchids.

References: RD

Grant, Robert Edmund

November 11, 1793 – August 23, 1874

Edinburgh, Scotland – London, England

British zoologist, M.D. Edinburgh 1814. Grant was an important influence on Darwin during his Edinburgh period. Later he became a professor of

zoology and comparative anatomy in London. A major Lamarckian, he published important works on sponges and other marine invertebrates. Evidently he published some of Darwin's earliest work without due acknowledgment. Darwin had little if anything to do with him later in life, though Grant did dedicate a book to him. Darwin mentions him in the *Historical Sketch* in later editions of the *Origin*.

References: RBF.

Gray, Asa (Professor)

November 18, 1810 – January 30, 1888

Sauquoit, New York, USA – Cambridge, Massachusetts, USA

American botanist, professor at Harvard. After they had met in England, Darwin enlisted Gray's assistance, and explained his evolutionary views to him. Gray was a major supplier of botanical information, especially in relation to biogeography, and they corresponded extensively. Gray supported evolution, opposing his colleague Louis Agassiz. However, he remained a devout theist, and tried to reconcile Darwin's theories with Christian theology. Darwin rebutted Gray's arguments in favor of design in the last chapter of the *Variation*. Darwin dedicated his book *The Different Forms of Flowers on Plants of the Same Species* to him.

References: Dupree in DSB.

Gray, George Robert

July 8, 1808 – May 6 1872

Chelsea, England – London, England

English zoologist, the younger brother of J.E. Gray.

He wrote much of the text for John Gould's work on the birds of the *Beagle* voyage.

References: RBF.

Gray, John Edward

London, England – Walsall, Staffordshire, England

February 12, 1800 – March 7, 1875

English zoologist, trained as a physician, a specialist on sponges. He worked in the British Museum beginning in 1824 and became Keeper of Zoology in 1840. He encouraged Darwin to monograph the Cirripedia.

References: Newman 1993.

Günther, Albrecht [Albert Carl Ludwig]

October 3, 1830 – February 1, 1914

Esslingen, Württemberg, Germany – Kew, England

German (naturalized British) systematic ichthyolo-

gist, a student of Johannes Müller in Berlin. He worked at the British Museum in London beginning in 1862, and provided Darwin with much information on fishes.

References: Tort in DD.

Gulick, John Thomas

March 13, 1832 – April 14, 1923

Waimea, Kauai, Hawaii – Honolulu, Hawaii

American missionary and naturalist. A major evolutionary biologist, he did classic work on the evolution of land snails in Hawaii. He visited Darwin at Down in 1872.

References: Garber, 1994, *Dictionary of American Biography* ed. Dumas Malone.

Gully, James Manby (Dr.)

March 13, 1808 – March 27, 1883

Kingston, Jamaica – ?

Physician, a hydrotherapist of whom Darwin was a patient. Darwin spent much time getting treatment at his establishment at Malvern.

References: RBF, Bose in DNB.

H

Haast, John Francis Julius von (Sir)

May 1, 1824 – August 15, 1887

Bonn, Germany – Wellington, New Zealand

German geologist and paleontologist who settled in New Zealand and became a professor at Canterbury. He provided Darwin with information for his book on *Worms*.

References: Anderson in DNB.

Haeckel, Ernst [Heinrich Phillip August] (Professor)

February 16, 1834 – August 9, 1918

Potsdam, Germany – Jena, Germany

German zoologist. Although trained as a physician he never practiced, and became a professor at Jena. An early convert to Darwinism, he soon developed his own version, and was a prolific writer of both scientific and popular works that were very influential. He was also a very successful teacher, with many eminent students. Although largely remembered for the aphorism stating that “ontogeny recapitulates phylogeny” the idea was by no means original with him but was largely derivative of the work of Fritz Müller, who in turn was profoundly influenced by Darwin. Haeckel was very controversial, and often offended people as a result of his

criticisms of his colleagues and his opposition to established religion. Darwin expressed admiration for Haeckel’s work, and seems to have enjoyed Haeckel’s visits to his home at Down.

Haldeman, Samuel Steman (Professor)

August 12, 1812 – September 10, 1880

Locust Grove, Pennsylvania, USA – Chickies, Pennsylvania, USA

American natural historian, geologist and philologist, professor at the University of Pennsylvania. Darwin refers to his support of evolution in the *Historical Sketch* in later editions of the *Origin*.

References: Harvey in *Dictionary of American Biography*.

Haller, Albrecht von

October 16, 1708 – December 12, 1777

Bern, Switzerland – Bern, Switzerland

Swiss physiologist. Darwin cites his work.

References: Hintsche in DSB, *Lexikon der bedeutenden Naturwissenschaftler*.

Hancock, Albany

December 26, 1806 – October 24, 1873

Newcastle upon Tyne, England – Newcastle upon Tyne, England

English invertebrate zoologist, collaborator with Joshua Alder. His main contributions were to the anatomy of brachiopods, mollusks and tunicates. He described the burrowing barnacle *Alcippe* (= *Trypetesa*) and corresponded extensively with Darwin about this and related animals. Darwin gave his *Beagle* voyage mollusk collections to him, but nothing seems to have come of that.

References: Newman 1993, Tort in DD, Boulger and Rees in ODNB.

Harvey, William Henry

February 5, 1811 – May 15, 1866

Summerville, Limerick, Ireland – Torquay, Devon, England

Irish systematic botanist, professor at University College, Dublin. Together with Darwin and others he signed a “memorial” on natural history museums in 1858.

References: Mitchell in DSB, RD.

Henslow, George (Reverend)

March 23, 1835 – December 30, 1925

Cambridge, England – Bournemouth, Hants, England
English botanist, popular writer, and educator. He was

Lecturer on Botany at St. Bartholomew's Hospital, London from 1886 to 1890. The son of John Stevens Henslow, he was, like his father, a clergyman. He wrote some commentary on Darwin's work that Darwin did not consider very accurate. His book entitled *The Theory of Evolution of Living Things and the Application of the Principles of Evolution to Religion Considered as Illustrative of the Wisdom and Beneficence of the Almighty*, published in 1873, was awarded the Actonian Prize for natural theology in 1872. The book attempted to reconcile evolution with theology.

References: RBD.

Henslow, John Stevens (Professor)

February 6, 1796 – May 16, 1861

Rochester, Kent, England – Hitcham, Suffolk, England

English clergyman and botanist. Professor of Botany at Cambridge University from 1825, he was Darwin's most important teacher there. He arranged for Darwin to go on the *Beagle* voyage and took responsibility for the specimens that were sent home. He also described some of the plants from the voyage, and provided Darwin with information about plants. Together with Darwin and others he signed a "memorial" on natural history museums in 1858. Darwin wrote a biographical memoir of him.

References: Mathew in DSB.

Herbert, John Maurice

1808 – 1882

English judge. A friend of Darwin beginning as a student at Cambridge, he gave him a microscope in May, 1831.

References: RBF.

Herbert, William (Dr.)

January 12, 1778 – May 28, 1847

Highclere, Hampshire, England – London, England

English naturalist and clergyman, Dean of Manchester. He was an early student of plant hybridization. He advised Darwin on that topic and Darwin refers to him frequently in his publications. On the basis of his hybridization experiments Herbert denied that there is a clear distinction between species and variety. Darwin mentions him in the *Historical Sketch* in later editions of the *Origin*.

References: Guimond in DSB.

Herschel, John (Sir)

March 7, 1792 – May 11, 1871

Slough, England – Hawkhurst, Kent, England

English astronomer and philosopher of science.

During his Cambridge period Darwin read, and was much influenced by, his book *A Preliminary Discourse on the Study of Natural Philosophy*. Darwin visited him at the Cape of Good Hope. It was Herschel who characterized natural selection as "the law of higgledy-piggledy."

References: Evans in DSB.

Hildebrand, Friedrich (Professor)

April 6, 1835 – December 30, 1915

Köslin, Pomerania, Germany – Freiburg im Breisgau, Germany

German botanist, Professor at Freiburg. Darwin and he corresponded about floral biology.

References: Jahn, *Geschichte der Biologie*.

Hoek, Paulus Peronius Cato

1851 – 1914

Dutch invertebrate systematic zoologist, monographer of *Challenger* Expedition Cirripedia and Pycnogonida. He did major work on reproduction, anatomy, systematics and phylogenetics of Cirripedia.

References: Newman 1993.

Hofmann, Augustus Wilhelm von

April 8, 1818 – May 5, 1892

Giessen, Germany – Berlin, Germany

German chemist, Director of the Royal College of Chemistry in London from 1864, later professor at Berlin. He helped Darwin with experiments on insectivorous plants.

References: RBF, *Lexikon der Naturwissenschaftler*.

Hofmeister, Wilhelm

May 18, 1824 – January 12, 1877

Leipzig, Germany – Lindenau, near Leipzig, Germany

German botanist, professor at Heidelberg beginning in 1863, and at Tübingen from 1872. Major publications by him were important in modernizing botany. His work on plant movements relates to that of Darwin on climbing plants.

References: Proskauer in DSB.

Holland, Henry (Dr., Sir)

October 27, 1788 – October 27, 1873

Knutsford, Cheshire, England – London, England

English physician, physician in ordinary to Prince Albert and Queen Victoria. He was Darwin's cousin. Darwin read his publications on medicine, such as *Medical Notes and Reflections* (1839) and often received information about medicine and physiology from him.

References: Berry in DNB, EB13.

Holmgren, Frithiof

October 22, 1831 – August 14, 1897

West Ny, Sweden – Uppsala, Sweden

Swedish physiologist, professor at Uppsala. His most important scientific work was on color vision. He played a major role in the arguments about vivisection in which Darwin participated.

References: RBF, Granit in DSB.

Hooker, Joseph Dalton (Sir)

June 30, 1817 – December 10, 1911

Halesworth, England – Sunningdale, England

English botanist, son of Sir William Hooker, whom he succeeded as Director of the Royal Botanical Gardens, Kew. Darwin and Hooker became close friends, and there is a vast correspondence between them. Darwin explained his evolutionary ideas to Hooker and they discussed them at great length. Hooker also supplied Darwin with a great deal of botanical information. He was one of the earliest supporters of Darwin's evolutionary theories, and one of the most effective.

References: Desmond in DSB, L. Huxley 1918.

Hooker, William Jackson (Sir)

July 6, 1785 – August 12, 1865

Norwich, England – Kew, England

English systematic botanist and first Director of the Royal Botanical Gardens, Kew. He was the father of Joseph Dalton Hooker.

References: Allen in DSB.

Hope, [Frederick] William (Reverend)

January 3, 1797 – April 15, 1862

London, England – London, England

English entomologist, President of the Entomological Society of London in 1835 and 1846, and author of *The Coleopterist's Manual* (1837). Darwin knew him while still an undergraduate at Cambridge. He described some of the Coleoptera of the voyage of the *Beagle*.

References: BAE.

Hope, Thomas Charles

July 21, 1766 – June 13, 1844

Edinburgh, Scotland – Edinburgh, Scotland

Scottish chemist, professor of that subject at Edinburgh. He was a very popular teacher, and Darwin enjoyed his lectures.

References: Scott in DSB.

Horner, Leonard

January 17, 1785 – March 5, 1864

Edinburgh, Scotland – London, England

Scottish geologist. He was the father in law of Charles Lyell and the father of Leonora Horner (b. 1818), a family friend of the Darwins. In his 1861 address to the Geological Society he warmly recommended *The Origin of Species*.

References: Rudwick in DSB.

Howe, Samuel Gridley (Dr.)

November 10, 1801 – January 9, 1876

Boston, Massachusetts, USA – Boston, Massachusetts, USA

American physician and philanthropist. Director of the Perkins Institution for the blind, he educated the blind deaf-mute Laura Bridgman, in whom Darwin took considerable interest in relation to his work on facial expression.

References: EB 13.

Huber, François

July 2, 1750 – December 22, 1831

Geneva, Switzerland – Lusanne, Switzerland

Swiss entomologist, noteworthy for having done experimental work even though blind. Darwin cites the 1814 edition of his *Nouvelles Observations sur les Abeilles* (1792).

References: Guvot de Fère in NBG.

Huber, Pierre

1777 – 1840

Geneva, Switzerland – Yverdon, Switzerland

Swiss naturalist, the son of François Huber. Darwin cites his views on instinct.

References: Tort in DD.

Humboldt, Alexander von

September 14, 1769 – May 6, 1859

Berlin, Germany – Berlin, Germany

German geographer and explorer, who should not be confused with his older brother Wilhelm. His travel writings made a profound impression upon the

young Darwin, especially in his publications on South America. Darwin cites Humboldt's works frequently. Humboldt expressed great admiration for Darwin's *Journal*.

References: Gayet in DD, Biermann in DSB.

Hume, David

April 26, 1711 (old style) – August 25, 1776

Edinburgh, Scotland – Edinburgh, Scotland

Scottish philosopher. Darwin read his *Dialogues on Natural Religion*, a work that seriously challenged natural theology, in 1839. In *The Descent of Man* Darwin quotes his *Enquiry Concerning the Principles of Morals*.

References: EB13, Passmore in DSB.

Hunter, John

February 13, 1728 – October 16, 1793

Long Calderwood, Lanarkshire, Scotland – London, England

Scottish anatomist and physician. His collections formed the nucleus of the Hunterian Museum in London. Some of his works were edited and published posthumously by Richard Owen. Darwin cites him as an authority on anatomy and reproduction.

References: Dobson in DSB.

Hutton, Frederick Wollaston

November 16, 1836 – October 29, 1905

Gate Burton, Lincolnshire, England – New Zealand

British biologist and geologist. Hutton published one of the first reviews of *The Origin of Species* and it was a favorable one. In 1865 he emigrated to New Zealand, where he occupied influential positions and became the leading proponent of Darwinism there.

References: Stenhouse 1999.

Hutton, James

June 3, 1726 – March 26, 1797

Edinburgh, Scotland – Edinburgh, Scotland

Scottish geologist. As author of *Theory of the Earth*, he was a major figure in the development of uniformitarianism.

References: Eyles in DSB.

Huxley, Thomas Henry

May 4, 1825 – June 29, 1895

Ealing, Middlesex, England – Hodslea, Sussex, England

English zoologist. Although known as “Darwin's

Bulldog” and widely considered the main popularizer of Darwinism in England, Huxley had his own agenda and was slow to embrace Darwin's evolutionary ideas, including natural selection. Together with Darwin and others he signed a “memorial” on natural history museums in 1858.

References: Williams in DSB, L. Huxley 1908, Di Gregorio 1984.

Hyatt, Alpheus

April 5, 1838 – January 15, 1902

Washington, D.C. – Cambridge, Massachusetts

American paleontologist. He was a major Lamarckian. Darwin and he corresponded.

References: Tort in DD, Gould in DSB.

I

Ihering, Hermann von

October 9, 1850 – February 24, 1930

Kiel, Germany – Büdingen, Hessen, Germany

German malacologist and zoogeographer. He lived and worked in Brazil from 1880 to 1920.

References: DBE.

Innes, John Brodie

1817 – 1894

English clergyman, at Downe, 1846-1862.

References: Stecher 1961.

J

Jaeger, Gustav

June 23, 1832 – May 13, 1917

Bürg/ Kocher, Germany – Stuttgart, Germany

German ichthyologist. Jaeger was a strong supporter of Darwin and defended him against the attacks of Wigand.

References: Rupp-Eisenreich and Tort in DD, DBE, EB13.

Jameson, Robert

July 11, 1774 – April 19, 1854

Leith, Scotland – Edinburgh, Scotland

Scottish geologist and professor of natural history at Edinburgh. Darwin attended his course and found the lectures so “incredibly dull” that he resolved never to study geology. Fortunately, the effect was only temporary.

References: Tort in DD, Eyles in DSB.

Jeffreys, John Gwyn

January 18, 1809 – January 24, 1885

Swansea, Wales – London, England
 British malacologist. Author of *British Conchology*, he did important deep-sea research on the vessels *Lightning* and *Porcupine*, showing that life exists at greater depths than had been supposed.
 References: Heppel in DSB.

Jenkin, [Henry Charles] Fleeming

March 23, 1833 – June 12, 1885
 Kent, England – Edinburgh, Scotland
 British engineer. (His name rhymed with lemming.) Darwin took Jenkin's criticisms of his theory quite seriously, and consequently made some important changes.
 References: Chipman in DSB.

Jenyns, Leonard, later Blomefield (the Reverend)

May 25, 1800 – September 1, 1893
 Bath, Somerset, England – Bath, Somerset, England
 Anglican priest and naturalist, Vicar of Swaffham, Bulbeck, Cambridgeshire. He changed his surname on inheritance. He described the fishes of the *Beagle* voyage, and wrote a number of other significant publications on natural history. The brother in law of John Stevens Henslow, he wrote a *Memoir of John Stevens Henslow*, which contains reminiscences by Darwin. There are many letters between Jenyns and Darwin.
 References: RBF.

K

Kant, Immanuel

April 22, 1724 – February 12, 1804
 Königsberg, East Prussia – Königsberg, East Prussia
 German philosopher. In *The Descent of Man* Darwin quotes him on duty and mentions his views on the number of human races or species.
 References: Ellington in DSB.

Kelvin, William Thomson, Baron

June 26, 1824 – December 7, 1907
 Belfast, Ireland – Netherhall, near Largs, Scotland
 British physicist, professor and ultimately Chancellor at the University of Glasgow. His most important scientific work dealt with thermodynamics (the Kelvin scale is named after him) and electricity. With respect to Darwin, however, he is noteworthy for having calculated the age of the earth and concluded that it is much younger than Darwin and other geologists had believed. The premises for

Kelvin's proposal were false, but this was not discovered until the effects of radioactive decay were understood. Darwin rejected Kelvin's chronology.
 References: Buchwald in DSB, Burchfield 1975.

Kerner, Anton Joseph, Ritter von Marilaun

November 12, 1831 – June 21, 1898
 Mautern, Austria – Vienna, Austria
 Austrian botanist, professor at the University of Innsbruck, and an important pioneer in the study of plant ecology. Darwin wrote a preface to the English translation of his book, *Flowers and their Unbidden Guests*.
 References: Tort in DD.

Keyserling, Alexander Andreevich

August 15, 1815 – May 8, 1891
 Courland, Latvia – Raikül estate, Estonia
 Also known under his Russian name, Alexandr Andreevich Keyserling, he did important work on the geology and paleobotany of the Urals. Darwin praised his protoevolutionary speculations in the *Historical Sketch* in later editions of the *Origin*.
 References: Tikhomirov in DSB.

King, Philip Gidley

1817 – 1904
 English naval officer. Son of Phillip Parker King. A mate on the *Beagle* while Darwin was on board, he settled in Australia.
 References: Garber 1994.

King, Philip Parker (Rear Admiral)

December 13, 1793 – February 1856
 Norfolk Island – Sydney, Australia
 English naval officer and amateur naturalist. He commanded the *Adventure* while it accompanied the *Beagle* during its first voyage (1826-1830). Darwin visited him in Sydney and cited his work in his geological writings.
 References: Garber 1994, Laughton in DNB.

Kingsley, Charles (The Reverend)

June 12, 1819 – January 23, 1875
 Dartmoor, Devon, England – Eversley, Hampshire, England
 English clergyman, appointed chaplain to Queen Victoria in 1859. He was also a poet and novelist, and from 1860 to 1869, he was professor of modern history at Cambridge University. Deeply interested in natural history, his children's books *Water Babies* (1863) and *Madam How and Lady Why*

(1869), were important in bringing evolutionary ideas and modern scientific thought to a broader audience. A somewhat liberal thinker in both religion and politics, he was a friend and supporter of both Darwin and Huxley.

References: EB13.

Kirby, William (The Reverend)

September 19, 1759 – July 4, 1850

Witnesham, Barnham, Suffolk, England – Barnam, near Ipswich, England

English entomologist and clergyman. A natural theologian, he was the author of one of the *Bridgewater Treatises* on that topic. Darwin made considerable use of the *Introduction to Entomology*, which Kirby coauthored with William Spence.

References: Tort in DD, Essig 1931.

Knight, Thomas Andrew

August 12, 1759 – May 11, 1838

Wormesley, near Ludlow, Herefordshire, England – London, England

English horticulturist, one of the founders of the Horticultural Society of London and its president from 1811 to 1838. Darwin gave him credit for the Knight-Darwin Law, which states that “Nature abhors perpetual self-fertilization.”

References: Tort in DD, Simpkins in DSB.

Kölliker, Rudolf von

July 6, 1817 – November 2, 1905

Zürich, Switzerland – Würzburg, Germany

Swiss zoologist, later professor in Germany. He was influential as the teacher of Gegenbaur, Haeckel and other important scientists. He was critical of natural selection, advocating a kind of saltationism.

References: Hintzsche in DSB.

Kölreuter, Joseph Gottlieb

April 27, 1733 – November 12, 1806

Sulz am Neckar, Germany – Karlsruhe, Germany

German botanist. He was at St. Petersburg from 1755 to 1761, then until 1763 at Calw. Afterward he became director of the botanical garden at Karlsruhe. Darwin thought quite highly of his work on plant hybridization.

References: Tort in DD, Olby in DSB.

Kowalevsky, Alexander Onufrievich

November 19, 1840 – November 22, 1901

Vitebsk region in what is now Latvia – St. Petersburg, Russia

Russian embryologist, the brother of Wladimir O. Kowalevsky. His embryological researches, especially his discovery of a notochord in tunicates, indicating a link between vertebrates and invertebrates, were recognized as important contributions to evolutionary biology by Darwin and others.

References: Adams in DSB.

Kowalevsky, Wladimir Onufrievich

August 14, 1842 – April 28, 1883

Vitebsk region of what is now Latvia – Moscow, Russia

Russian vertebrate paleontologist, the brother of Alexander O. Kowalevsky. His work on the evolution of the horse was a major contribution to evolutionary studies. He made several visits to Darwin's home and arranged for translations of his works into Russian.

References: Blacher in DSB.

Krause, Ernst Ludwig

November 22, 1839 – August 28, 1903

Zielenzug, Germany – Eberswalde, Germany

German apothecary and writer, also known by the pseudonym Carus Sterne. He was editor of the Darwinist periodical *Kosmos* from 1877 to 1882, and author of several books in that genre. He was the author of a biography of Erasmus Darwin that was translated into English and published together with a biographical piece on him by Charles Darwin. Samuel Butler was offended by this publication. Krause also published German translations of Darwin's shorter works, including the previously unpublished paper on humble bees (1875).

References: Uschmann in DSB.

Krauss, (Christian) Ferdinand (Friedrich von)

July 9, 1812 – September 15, 1890

Stuttgart, Germany – Stuttgart, Germany

German naturalist and plant collector.

References: BDB.

Krefft, Johann Ludwig Louis Gerhard von

February 17, 1830 – February 18, 1880

Brunswick, North Germany – Sydney, Australia

German botanist, Curator of the Australian Museum from 1864-74. He was one of Darwin's informants about plant reproduction.

References: Garber, 1994, BAE.

Krohn, August David

1803 – February 26, 1891

St. Petersburg, Russia – Bonn, Germany

Russian physician and invertebrate zoologist. He lived in Bonn, Germany much of the time between his extensive trips to the Mediterranean and Atlantic, where he did important research on the anatomy and embryology of marine animals. He politely corrected Darwin's work on the female reproductive system of barnacles.

References: RBF, Tort in DD.

L**Lamarck, Jean-Baptiste [Pierre Antoine de Monet], chevalier de**

August 1, 1744 – December 18, 1829

Bazantin, Picardy, France – Paris, France

French naturalist. Lamarck is generally considered the most important pre-Darwinian evolutionist. Darwin himself, however, did not think at all highly of Lamarck's views on that topic, and considered him a bad scientist. Darwin mentions him in the Historical Sketch in later editions of the *Origin*.

References: Laurent in DD, Burlingame in DSB.

Lankester, Edwin

April 23, 1814 – October 30, 1874

Melton, near Woodbridge, Suffolk – London, England

English physician, Professor of Natural History, New College London, editor of *The Quarterly Journal of Microscopical Science*. He was involved with the publication of Darwin's barnacle monograph through his connection with the Ray Society.

References: Lester and Bowler 1995.

Lankester, E[dwin] Ray

May 15, 1847 – August 15, 1929

London, England – London, England

English zoologist, professor at London and Oxford, and Director of the British Museum (Natural History). The son of Edwin Lankester, he succeeded his father as editor of *The Quarterly Journal of Microscopical Science* and made it a major outlet for publications in evolutionary anatomy and embryology. He was introduced to Darwin while still quite young and became one of the most influential evolutionists of his time, thanks to his teaching, his popular writings, and his articles in reference works.

References: de Beer in DSB, EB13, Lester and Bowler 1995.

Latreille, Pierre-André

November 29, 1762 – February 6, 1833

Brives-la-Gaillarde, France – Paris, France

French zoologist, successor to Lamarck at the Paris museum of natural history. He was a specialist on insects, crustaceans and other arthropods, but also worked on other groups of animals.

References: Burkhardt in DSB.

Lauder, Thomas Dick (Sir), 7th Baronet

1784 – May 29, 1848

Edinburgh, Scotland – Edinburgh, Scotland?

Scottish naturalist and author. Darwin cites Lauder's work in his paper on the Parallel Roads of Glen Roy and Lochaber, but refers to him as Sir Lauder Dick. The paper in the *Transactions of the Royal Society of Edinburgh* (1818; 9:1–164, pls. 1–7) uses the name Thomas Lauder Dick. It was published before he succeeded to the baronetcy in 1820.

References: EB13, GHG.

Lavater, Johann Kaspar

November 15, 1741 – January 2, 1801

Zurich, Switzerland – Zurich, Switzerland

Swiss clergyman. His well-known book on physiognomy is cited in Darwin's *Expression of the Emotions*.

References: Tort in DD, EB13.

Lawrence, William (Sir)

July 16, 1783 – July 5, 1867

Cirencester, Gloucestershire, England – London, England

English surgeon. He has erroneously been treated as an early evolutionist, though his views on the scriptural interpretation of man were considered heretical.

References: Jaycna in ODNB.

Laxton, Thomas

Around 1830 – August 6, 1893

Tinwell, Rutland – Bedford, England

English nurseryman. He did some breeding experiments for Darwin.

References: RD.

Lecoq, Henri

April 18, 1802 – August 5, 1871

Avesnes, France – Clermont-Ferrand, France
 French botanist, director of the gardens at Clermont-Ferrand. Darwin mentions him in the *Historical Sketch* in later editions of the *Origin*.

References: BDB.

Leggett, William Henry

February 24, 1816 – April 11, 1882

New York, New York, USA – New York, New York, USA

American botanist, helped Darwin with botany.

References: RBF, BDB.

Leidy, Joseph (Professor)

September 9, 1823 – April 30, 1891

Philadelphia, Pennsylvania, USA – Philadelphia, Pennsylvania, USA

American physician and naturalist, founder of vertebrate paleontology in America. His work is cited in Darwin's barnacle monograph. They were introduced to each other by Richard Owen during Leidy's visit to Europe in 1848.

References: Warren 1998.

Leighton, William Alport (The Reverend)

May 7, 1805 – February 25, 1889

Shrewsbury, Shropshire, England – Shrewsbury, Shropshire, England

English clergyman and botanist, an expert on lichens.

In *Flowers* he is cited on cowslips and other topics.

References: RD.

Lessona, Michele

September 20, 1823 – July 20, 1894

Venaria Reale (Torino), Italy – Torino, Italy

Italian zoologist, professor at Torino. He translated four of Darwin's books into Italian, and wrote a book about him.

References: RBF, *Enciclopedia Italiana di Scienze, Lettere ed Arti*.

Leuckart, Rudolf

October 7, 1822 – February 6, 1898

Helmstedt, Germany – Leipzig, Germany

German zoologist, professor at Giessen and later at Leipzig. He was particularly distinguished for his work on parasitology.

References: Tort in DD, Schadewaldt in DSB.

Lewes, George Henry

April 18, 1817 – November 28, 1878

London, England – Witley, near Godalming, Surrey, England

English philosopher and literary intellectual. He and the novelist George Eliot were friends of Erasmus Alvey Darwin.

References: EB13.

Liebig, Justus von (Baron, Professor)

May 12, 1803 – April 10, 1873

Darmstadt, Germany – Munich, Germany

German chemist, professor at Giessen, Munich, and, beginning in 1863, Berlin. Among ecologists he is known for "Liebig's law of the minimum." Darwin read and cited the English translation of his book on agricultural chemistry.

References: Tort in DD, Holmes in DSB.

Lindley, John

February 5, 1799 – November 1, 1865

Catton, Near Norwich, England – Turnham Green, Middlesex, England

English botanist, an expert on horticulture. D. Phil., München, 1832. From 1828 to 1860 he was professor of Botany at London University. Beginning in 1841 he was editor of *The Gardeners' Chronicle*, a newspaper that published many of Darwin's notes and queries. He was also author of several books on general and applied botany that Darwin used and cited. Together with Darwin and others he signed a "memorial" on natural history museums in 1858.

References: EB13, Stearn in DSB, Stearn 1999.

Linnaeus, Carolus (Carl von Linné)

May 23, 1707 (new style) – January 10, 1778

Södra Råshult, Sweden – Uppsala, Sweden

Swedish naturalist, professor of botany at Uppsala, and founder of the modern method of taxonomic nomenclature. Darwin read and annotated many of his works and thought very highly of him.

References: Lindroth in DSB.

Litchfield, Richard Buckley

1831 – 1903

Son-in-law of Charles Darwin. He married Henrietta Emma Darwin in 1871.

Locke, John

August 29, 1632 – October 28, 1704

Wrighton, near Buellton, Sommersetshire, England – Otes, Essex, England

English philosopher. Darwin apparently read one of

his books, *An Essay Concerning Human Understanding*, as an undergraduate. On August 16, 1838 Darwin wrote in a notebook: "Origin of man now proved.—Metaphysic must flourish.—He who understands baboon would do more toward metaphysics than Locke."

References: Cranston in DSB.

Lombroso, Cesare

November 6, 1835 – October 19, 1909

Verona, Italy – Turin, Italy

Italian criminologist, professor at Turin.

References: Villa in DD, EB.

Longfellow, Henry Wadsworth

February 27, 1807 – March 24, 1882

Portland, Maine, USA – Cambridge, Massachusetts, USA

American poet. Darwin and he met in 1868.

References: RBF, Davidson in EB13.

Loudon, John Claudius

April 8, 1783 – December 1843

Cambuslang, Lanarkshire, England – Bayswater, London, England

English agronomist, author of books on gardening and editor of periodicals. Darwin frequently refers to his publications with respect to botanical topics such as variation.

References: Tort in DD, RD.

Lovén, Sven

January 6, 1809 – September 3, 1895

Stockholm, Sweden – Stockholm, Sweden

Swedish zoologist and marine biologist.

References: Nyholm in DSB.

Lubbock, John (Sir, Lord Avebury)

April 30, 1834 – May 28, 1913

London, England – Kingsgate Castle, Kent, England

English banker. The son of the elder John Lubbock, he frequently visited Darwin at his home, and was encouraged by him to become a scientist. The author of scientific papers largely on arthropods and of popular books, he was one of Darwin's major supporters.

References: Somkin in DSB.

Lubbock, John William (Sir)

March 26, 1803 – June 20, 1865

London, England – Farnborough, England

English banker. He built a house about one mile from

Darwin's at Downe.

References: RBF.

Lütken, Christian Frederik

October 4, 1827 – February 6, 1901

Danish carcinologist.

References: Wolff in Truesdale (1993)

Lyell, Charles (Sir)

November 14, 1797 – February 22, 1875

Kinnordy, Scotland – London, England

Leading uniformitarian geologist, trained as a lawyer.

He had a major influence on Darwin's work, especially through reading of his textbook during the voyage of the *Beagle*. He was influential in getting Darwin accepted by the London scientific establishment. With J.D. Hooker he arranged for the reading of the joint publication on natural selection by Darwin and Wallace in 1858. Lyell was rather reluctant to endorse evolution but did so after considerable hesitation.

References: Wilson in DSB, Laurent in DD.

M

McCormick, Robert

1800 – 1890

Senior Surgeon on the *Beagle* and its official naturalist, he felt aggrieved and left the vessel in 1832.

References: RBF.

Macculloch, John

October 6, 1773 – August 20, 1835

Guernsey, Channel Islands – Poltair, Cornwall, England

British chemist, physician and geologist. His important works include a book on *The Western Isles of Scotland* and a geological map of that country that was published posthumously. Darwin discusses his contributions in his writings on volcanic islands and glacial phenomena.

References: DHG, Eyles in DSB.

Mackintosh, James (Sir)

October 24, 1765 – May 30, 1832

Aldourie, near Inverness, Scotland – London, England

Scottish political philosopher and publicist. Darwin characterized him as the best converser on grave subjects whom he had ever met. Darwin read Mackintosh's *Dissertation on the Progress of Ethical Philosophy* (1831) after returning from the

voyage. He quotes him on the moral sense in *The Descent of Man*.

References: EB13.

Macleay, Alexander

June 24, 1767 – July 19, 1848

Ross, Scotland – Sydney, Australia

British administrator, politician and naturalist. He was elected Fellow of the Linnean Society of London in 1794, and FRS in 1809. He moved to Australia in 1825, and was influential in supporting natural history research there.

References: Fletcher 1893, *The Australian Encyclopaedia*.

Macleay, George (Sir)

1809 – June 24, 1891

Third son of Alexander Macleay, and younger brother of William Sharpe Macleay. He contributed specimens to the museum in Sydney.

References: Fletcher 1893, *The Australian Encyclopaedia*.

Macleay, William John (Sir)

June 13, 1820 – December 7, 1891

Wick, County Caithness – Sydney, Australia

Scottish naturalist and politician. He accompanied his cousin, William Sharpe Macleay to Australia in 1839. He was a benefactor of biology in Australia.

References: Fletcher 1893, *The Australian Encyclopaedia*.

Macleay, William Sharpe

July 21, 1792 – January 26, 1865

London, England – Sydney, Australia

English zoologist and diplomat, second son of Alexander Macleay. He retired in Australia in 1839 where he was locally quite influential. Darwin spent a lot of time studying his works from the point of view of the principles of classification. He was a major advocate of the “quinarian” approach to systematics, which was numerical in rationale and attempted to arrange all organisms in groups of five circles. He was, of course, a creationist and continued to oppose evolution throughout his life.

References: Tort in DD, Fletcher 1893.

Magendie, François

October 6, 1783 – October 7, 1855

Bordeaux, France – Sannois, France

French physiologist. Darwin mentions his cruel

experiments in a letter on vivisection to the *Times*.

References: Grmek in DSB

Malthus, [Thomas] Robert (The Reverend)

February 13, 1766 – December 23, 1834

Near Guilford Surry, England – Bath, England

English economist, the first professor of that subject.

As noted above, he went by his middle name. Malthus's *Essay on the Principle of Population* was seminal in Darwin's discovery of natural selection.

References: Simpkins in DSB, Petersen 1979.

Mandeville, Bernard

Baptized November 20, 1670 – January 21, 1733

Rotterdam, Holland – Hackney, England

Dutch physician who later moved to London and spent the rest of his life there. An important social and economic theorist, he was the author of *The Fable of the Bees: or, Private Vices, Publick Benefits*, first published in 1724. Darwin is known to have read it.

References: Mandeville 1732.

Mantell, Gideon

February 3, 1790 – November 10, 1852

Lewes, Sussex, England – London, England

English surgeon and geologist, a pioneer in the study of dinosaurs.

References: EB13, Dean 1999.

Marsh, Othniel Charles

October 29, 1831 – March 18, 1899

Lockport, New York, USA – New Haven, Connecticut, USA

American vertebrate paleontologist, professor at Yale.

References: Shor in DSB, Schuchert & Le Vene 1940.

Martin Saint-Ange, Gaspard Joseph

1803 – 1888

Nice, France – Paris, France

French zoologist. His was one of the few important works on cirripedes before that of Darwin.

References: Tort in DD.

Martineau, Harriet

June 12, 1802 – June 27, 1876

Norwich, England – Near Ambleside, Westmorland, England

English writer. She published short stories and novels and wrote extensively on religious, philosophical, economic and political matters. She was an

acquaintance of Darwin and friend of his brother.
References: EB13.

Marx, Karl

May 5, 1818 – March 14, 1883
Trier, Prussian Rhineland – London, England
German political philosopher. That he wanted to dedicate his book *Das Kapital* to Darwin is a myth.
References: Cohen in DSB.

Masters, Maxwell, Tylden

April 15, 1833 – May 30, 1907
Canterbury, Kent, England – Ealing, Middlesex, England
English physician and botanist. Darwin cites his *Vegetable Teratology* (1869) in *Flowers*.
References: RD.

Matthew, Patrick

October 20, 1790 – June 8, 1874
Near Scone, Perth, Scotland – Gourdie Hill, Perthshire, Scotland
Scottish writer on agricultural topics. His *Naval Timber and Arboriculture* (1832) to some extent anticipated the principle of natural selection, justifying Darwin's mention of it in the *Historical Sketch* in later editions of the *Origin*.
References: Tort in DD, RD.

Mayo, Herbert

April 3, 1796 – May 15, 1852
London, England – Bad Weilbach, Germany
English surgeon, neurophysiologist and anatomist.
After the return from his voyage, Darwin read Mayo's *The Philosophy of Living* (1837, 1838).
References: LeFanu in DSB.

Mendel, Johann Gregor

July 22, 1822 – January 6, 1884
Heinzendorf, Austro-Hungarian Empire – Brno, Austro-Hungarian Empire
Moravian natural scientist, posthumously declared the founder of modern genetics. Although he is often characterized as a “monk” his responsibilities were mainly those of a teacher and administrator. Darwin evidently heard of Mendel's work, but did not read it.
References: Vickery in DSB.

Meldola, Raphael

July 19, 1849 – November 16, 1915
Islington, England – London, England

English entomologist, an important contributor to the study of mimicry. He translated Weismann's *Studies in the Theory of Descent*, for which Darwin wrote a brief preface (1852).
References: RBF.

Mill, John Stuart

May 20, 1806 – May 8, 1873
London, England – Avignon, France
English philosopher and political economist. His epistemology became part of the debates about evolution.
References: EB13.

Miller, Hugh

October 10, 1802 – December 23, 1856
Cromarty, Scotland – Portobello, Scotland
Scottish stonemason, geologist and popular writer, author of *The Old Red Sandstone* (1841) and *Footprints of the Creator* (1849). He opposed the “development hypothesis” as put forth by Robert Chambers.
References: Rudwick in DSB, EB13.

Milne, David (later David Milne Home)

January 22, 1805 – September 19, 1890
Inveresk, Scotland – Milne-Graden, near Coldstream, Berwickshire, England
Scottish lawyer and geologist. He was an important critic of Darwin's work on the parallel roads of Glen Roy.
References: Tort in DD, Roy in ODNB.

Milne Edwards, Alphonse

October 13, 1835 – April 21, 1900
Paris, France – Paris, France
French zoologist and paleontologist, son of Henri Milne-Edwards.
References: Tort in DD, GHG.

Milne Edwards, Henri

October 23, 1800 – July 29, 1885
Bruges, (now Belgium) – Paris, France
French zoologist of English ancestry. He became a very influential professor at Paris. Milne-Edwards was the author of many important works, including a monograph on the Crustacea that was a major source for Darwin. Darwin dedicated a volume of his cirripede monograph to him.
References: Anthony in DSB, Tort in DD.

Mivart, St. George Jackson

November 30, 1827 – April 1, 1900

London, England – London, England

English comparative anatomist, he accepted evolution but opposed Darwin's views. A convert to Roman Catholicism he alienated himself from both the scientific community and the church, and was excommunicated. By rebutting Mivart's arguments Darwin was able to show the strength of his theory.

References: Gruber in DSB.

Moggridge, John Traherne

March 8, 1842 – December 24, 1874

Woodfield, England – Mentone, France

English entomologist and botanist, author of *Contributions to the Flora of Mentone*. He extended Darwin's work on orchids, and sent him specimens and information, which Darwin incorporated in later publications.

References: RD, BDB.

Mohl, Hugo von

April 8, 1805 – April 1, 1872

Stuttgart, Germany – Tübingen, Germany

German botanist, professor at Tübingen. Darwin cites his publications in works on floral biology and climbing plants.

References: DD, BDB.

Monboddo, Lord; See Burnett, James**Moquin-Tandon, Alfred**

May 7, 1804 – April 15, 1863

Montpellier, France – Paris, France

French naturalist. A pupil of A. P. de Candolle, he received his Dr. Sci. at Montpellier in 1826. Director of the botanic garden of Toulouse 1834-1853, he was subsequently professor of botany at the Faculté de Médecine, Paris. His work on plant teratology and variation was of considerable interest to Darwin.

References: Tort in DD.

Morley, John (Viscount)

December 24, 1838 – September 23, 1923

Blackburn, England - London, England

English liberal statesman and author, editor of the *Fortnightly Review* from 1867 to 1883. A philosophical writer, he reviewed *Descent*. Together with Gladstone and others he visited Darwin at

Down House.

References: EB 13.

Morris, John

February 19, 1810 – January 7, 1886

Homerton, London, England – St. John's Wood, London, England

English paleontologist, professor of geology, University College, London 1855-1877. He described Darwin's fossil brachiopods from the Falkland Islands.

References: RD, GHG.

Morse, Edward Sylvester (Professor)

June 18, 1838 – December 20, 1925

Portland, Maine, USA – Salem, Massachusetts, USA

American zoologist, curator at the Peabody Museum at Yale and from 1877 to 1880 professor at Tokyo. He was an expert on brachiopods and interested in their evolutionary relationships. When Morse's pamphlet on the Omori shell mounds was unfavorably reviewed in 1880, he sent it to Darwin, who forwarded it to *Nature* with a brief introduction.

References: Shor in DSB.

Müller, [Friedrich] Max

December 6, 1823 – October 28, 1900

Dessau, Germany – Oxford, England

German, later naturalized English, philologist. He was on the faculty of Oxford University. He was opposed to, and ridiculed, much of the evolutionary thinking about language at the time.

References: Tort in DD, Fynes in DNB.

Müller, Fritz [Johann Friedrich Theodor]

March 31, 1822 – May 27, 1897

Windischolzhhausen, Thuringia, Germany – Blumenau, Brazil

German naturalist. He became a political refugee in Brazil in 1852. One of Darwin's most important supporters, Müller is best remembered for his discovery of Müllerian mimicry. He was most unusual among Darwin's contemporaries in having an excellent understanding of natural selection. His book *Für Darwin* extended Darwin's ideas on the relationship between ontogeny and phylogeny, and was the first application of the theory of recapitulation to evolutionary biology. Much of his early systematic and evolutionary work was based upon Crustacea, including barnacles. Darwin arranged for Müller's book to be translated into English and

wrote a preface to the translation; he also arranged for the publication of many of Müller's papers in *Nature*.

References: McKinney in DSB, Breidbach & Ghiselin 2008, West 2003.

Müller, [Heinrich Ludwig] Hermann

September 23, 1829 – August 25, 1883

Mühlberg, Thuringia, Germany – Prad, Germany

German botanist, younger brother of Fritz Müller. He received his doctorate at Berlin, and subsequently was a high school teacher at Lippstadt; hence he is sometimes referred to as "Hermann Müller von Lippstadt." His work on plant fertilization was of great importance to Darwin, who wrote a preface to the translation of one of his books.

References: RBF.

Müller, Johannes [Peter]

July 14, 1801 – April 28, 1858

Colblenz, Germany – Berlin, Germany

German physiologist, professor at Berlin. Darwin made considerable use of the English translation of his text book.

References: Steudel in DSB.

Müller, Otto Frederick

March 2, 1730 – December 26, 1784

Copenhagen, Denmark – Copenhagen, Denmark

Danish microscopist and naturalist, professor of botany at the University of Copenhagen. Of interest in respect to Darwin because of his work on systematics of Crustacea.

References: BDB.

Murchison, Roderick Impey (Sir)

February 19, 1792 – October 22, 1871

Tarradale, Scotland – London, England

Scottish geologist, a leading stratigrapher. Darwin refers to his work in a paper on boulders.

References: Rudwick in DSB.

Murray, John III

April 16, 1808 – April 2, 1892

London, England – London, England

Darwin's publisher for his later works.

References: EB 13, DNB.

Murray, John (Sir)

March 3, 1841 – March 16 1914

Coburg, Ontario, Canada – Kirkliston, Scotland

British oceanographer, a scientist on the *Challenger*

expedition and editor of its *Reports*. He challenged Darwin's ideas on coral reefs.

References: Burstyn in DSB.

N

Nägeli, Carl Wilhelm von

March 27, 1817 – May 10, 1891

Kilchberg, near Zürich, Switzerland – München, Germany

German botanist, a professor at Freiburg im Breisgau and then München. Not considering natural selection very important, he tried to develop his own mechanico-physiological theory. He also worked on hybridization, and is of some interest in having read Mendel's publications but not considered them very important.

References: Olby in DSB.

Naudin, Charles

August 14, 1815 – March 19, 1899

Autun, France – Antibes, France

French botanist who worked at the natural history museum in Paris. He was an important student of plant hybridization. Darwin mentions him in the *Historical Sketch* in later editions of the *Origin*.

References: Tort in DD, Coleman in DSB.

Neumayr, Melchior

October 24, 1845 – January 29, 1890

Munich, Germany – Vienna, Austria

German paleontologist, and professor at Vienna beginning in 1873. His work on mollusks was important in showing gradual transformation of species in the fossil record. He was a strong supporter of Darwin.

References: Tobien in DSB, GHG.

Newman, Edward

May 13, 1801 – June 12, 1876.

Hampstead, England – Peckham, England

English businessman and amateur entomologist, an expert on Coleoptera. He described some of Darwin's *Beagle* specimens.

References: BAE.

Newport, George

July 4, 1803 – April 7, 1854

Canterbury, England – London, England

English surgeon, entomologist and embryologist.

References: Clarke in DSB.

Newton, Alfred

June 11, 1829 – June 7, 1907

Geneva, Switzerland – Cambridge, England

English ornithologist, professor of zoology and comparative anatomy at Cambridge University from 1866-1907. He was an important informant on birds, especially with respect to sexual selection.

References: Tort in DD, EB13.

Nilsson, Sven

1787 – 1883

Landskrona, Sweden – Lund, Sweden

Swedish naturalist, director of the zoological museum in Stockholm. He provided Darwin with information about growth of reindeer antlers for *Descent*.

References: RBF.

O**Ogle, William**

1827 – May 16, 1905

Oxford, England – London, England

English physician, physiologist and botanist, lecturer at St. George's Hospital. Ogle provided material for *Variation*. He translated Kerner's *Flowers and their Unbidden Guests*, for which Darwin wrote an introduction. Darwin was much interested in Ogle's translation of Aristotle's *De Partibus Animalium*.

References: RD.

Oken, Lorenz

August 1, 1779 – August 11, 1851

Bohlsbach bei Offenburg, Baden, Germany – Zurich, Switzerland

German zoologist. Oken was one of the leaders of the mystical movement called *Naturphilosophie* and was first to publish the vertebral theory of the skull. There is no evidence of his writings having had any direct or significant influence on Darwin's work, but he had a profound influence upon Richard Owen and other idealistic morphologists. Oken is perhaps best known in the English-speaking world for the translation of his *Lehrbuch der Naturphilosophie* which Darwin read, or at least looked into, but did not annotate. In the *Historical Sketch* in the sixth edition of the *Origin*, Darwin erroneously states that Oken was an evolutionist. Actually Oken believed in spontaneous generation.

References: Klein in DSB, Ghiselin 2005.

Oliver, Daniel (Professor)

February 3, 1830 – December 21, 1916

Newcastle, Northumberland, England – Kew, Surrey, England

English botanist, on the staff of the Royal Botanic Garden at Kew. Professor of botany at University College London, 1861-88. He was one of Darwin's major informants about floral biology and also advised him about plant taxonomy.

References: RD.

Omalius D'Halloy, Jean Baptiste Julien D'

February 16, 1783 – January 15, 1875

Liège, [now] Belgium – Brussels, Belgium

Belgian geologist. Influenced by Lamarck and Geoffroy Saint Hilaire, he was one of the supporters of evolutionary ideas before Darwin, but did not accept natural selection as a major cause of change. Darwin mentions him in the *Historical Sketch* in later editions of the *Origin*.

References: Torrey in DSB.

Orbigny, Alcide d'

September 6, 1802 – June 30, 1857

Couéron, near Nantes, France – Pierrefitte, near Paris, France

French paleontologist. He travelled extensively in South America from 1831-1836, contemporaneously with Darwin, although they did not meet. An extreme catastrophist, he believed that the succession of fossils reflected a series of extinctions and special creations. D'Orbigny identified fossil shells from Darwin's collections made in South America.

References: Laurent in DD, Tobien in DSB.

Owen, Richard (Professor, Sir)

July 20, 1804 – December 18, 1892

Lancaster, England – London, England

English anatomist. Sometimes called the "English Cuvier," he was Hunterian Professor at the Royal College of Surgeons, and later head of the British Museum (Natural History). Owen described the fossil mammals of the *Beagle* voyage and provided Darwin with a great deal of advice. Their relationship deteriorated beginning at the time of the publication of *The Origin of Species*, Owen becoming one of Darwin's main opponents, and Darwin came to detest him. He was involved in frequent controversies with Thomas Henry Huxley, and is said to have coached Bishop

Wilberforce in preparation for their celebrated debate at Oxford. Darwin discusses him at some length in versions of the *Historical Sketch* in later editions of the *Origin*.

References: Williams in DSB, Owen 1894, Rupke 1994.

P

Packard, Alpheus Spring

February 19, 1839 – February 14, 1905

Brunswick, Maine, USA – Providence, Rhode Island, USA

American entomologist, who also worked on a variety of other scientific topics including Crustacea. A student of Louis Agassiz, he was a neolamarckian, and published a book about Lamarck.

References: Tort in DD, Norland in DSB.

Paget, James (Sir)

January 11, 1814 – December 30, 1899

Yarmouth, England – London, England

English surgeon and pathologist. He was an important informant for Darwin's work on emotional expression.

References: EB13.

Paley, William

July, 1743 – May 25, 1805

Peterborough, England – Lincoln, England

English clergyman, a tutor at Christ's College from 1771 to 1774. As a student Darwin (who occupied the same rooms that Paley had) greatly admired his writings on natural theology. Later he remarked that Paley's logic was sound but his premises were questionable.

References: Thiry in DD, Rodney in DSB.

Pallas, Peter Simon

October 3, 1741 – September 20, 1811

Berlin, Germany – Berlin, Germany

German naturalist who worked mainly in St. Petersburg, Russia. His writings were important for Darwin's work on variation and domestication.

References: Tort in DD, Esakov in DSB.

Pander, Christian Heinrich

July 12, 1794 – September 22, 1865

Riga, Latvia, Russia – Saint Petersburg, Russia

Latvian embryologist, anatomist and paleontologist of German descent. Darwin knew of his proto-evolutionary speculations through secondary sources

and mentioned him in the *Historical Sketch* in later editions of the *Origin*.

References: RBF, Bullough in DSB.

Pfeffer, Wilhelm Friedrich Philipp

March 9, 1845 – January 31, 1920

Grebenstein, Germany – Leipzig, Germany

German botanist, professor at Basel, Tübingen and Leipzig. He was an important supporter of Darwin's views on plant movement.

References: Robinson in DSB.

Philippi, Rudolph Amandus

September 14, 1808 – July 23, 1904

Charlottenburg, near Berlin, Germany – Santiago, Chile

German naturalist, a teacher at Cassel until forced to leave for political reasons. After immigrating to Chile in 1851 he became professor of botany and zoology and head of the National Museum. He provided Darwin with specimens of fossil barnacles. In *The Origin of Species*, Darwin cites his prize-winning monograph on the paleontology of Sicily.

References: McLellan 1927.

Phillips, John (Professor)

December 25, 1800 – April 24, 1874

Marden, Wiltshire, England – Oxford, England

English geologist, ultimately professor at Oxford.

Darwin refers to his work in his paper on boulders.

References: Edmonds in DNB.

Pictet de la Rive, François Jules

September 27, 1809 – May 15, 1872

Geneva, Switzerland – Geneva, Switzerland

Swiss zoologist and paleontologist.

References: RBF.

Planchon, Jules-Émile

March 21, 1823 – April 1, 1888

Ganges, France – Montpellier, France

French botanist, professor at Montpellier. Darwin refers to his work in publications on heterostyly.

References: BDB.

Playfair, John

March 10, 1748 – July 20, 1819

Benvie, Scotland – Edinburgh, Scotland

Scottish geologist. A major proponent of uniformitarianism in geology, he was author of *Illustrations of the Huttonian Theory of the Earth*.

References: Challenor in DSB.

Playfair, Lyon (Baron)

May 21, 1818 – May 29, 1898
 Chuar, Bengal, India – London, England
 English chemist.
 References: Farrar in DSB.

Poiret, Jean Louis Marie

1755 – April 7, 1834
 Saint Quentin, France – Paris, France
 French clergyman and botanist. Darwin mentions him in the *Historical Sketch* in later editions of the *Origin*.
 References: Levot in NBG.

Poli, Giuseppe Saverio

October 28, 1746 – April 7, 1825
 Molfetta, Italy – Naples, Italy
 Italian physicist and natural historian, professor at Naples. His book on the Testacea of the Kingdom of the Two Sicilies was an important source for Darwin's barnacle work.
 References: Castellani in DSB.

Powell, Baden (Reverend)

August 22, 1796 – June 11, 1860
 Stamford Hill, England – London, England
 English mathematician and physicist, professor at Oxford. He was the father of Lord Baden Powell, founder of the scouting movement. In the *Historical Sketch* in later editions of the *Origin* Darwin cites his essay on the *Unity of Worlds* in support of the idea that the origin of new species is a natural phenomenon.
 References: RBF, Fox in DSB.

Preyer, William

July 4, 1847 – July 15, 1897
 England – Wiesbaden, Germany
 English-born physiologist who immigrated to Germany in 1857. He wrote some early biographical pieces on Darwin. Author of *Die Seele des Kindes* (1882), he was an important developmental psychologist.
 References: Colp 1983.

Price, John

June 3, 1803 – October 14, 1887
 Pwll-y-Crochen, Colwyn Bay, Denbighshire, England – Chester, Cheshire, England
 English botanist. He sent Darwin specimens of the insectivorous plant *Utricularia*.
 References: RBF, RD.

Prichard, James Cowles

February 11, 1786 – December 22, 1848
 Ross-on-Wye, Herefordshire, England – London, England
 English ethnologist. His work on human races and variability was of considerable interest to Darwin, who studied his *Researches into the Physical History of Man*.
 References: Stocking 1973, introductory essay to reprint of *Researches into the Physical History of Man* (Prichard 1813).

Pritchard, Charles (Rev.)

February 29, 1808 – May 28, 1893
 Albergury, Shropshire, England – Oxford, England
 English astronomer and educator, appointed Savilian Professor of Astronomy at Oxford in 1870. He was the founder and Headmaster of Clapham Grammar School (1834–1862), which Darwin's sons, with the exception of William, attended.
 References: RBF; Meadows in DSB.

Q**Quatrefages de Bréau, Jean-Louis-Armand de**

February 10, 1810 – January 12, 1892
 Berthezème, France – Paris, France
 French invertebrate zoologist and anthropologist. He was basically a follower of Milne Edwards. He was opposed to evolution and maintained that human beings form a distinct kingdom.
 References: Tort in DD, Limoges in DSB.

Quekett, John Thomas

August 11, 1815 – August 20, 1861
 Langport, Somerset, England – Pangbourne, Berkshire, England
 English microscopist, Professor of Histology at the Royal College of Surgeons from 1852. He was an expert on fossil plants.
 References: RD.

Quetelet, Adolphe

February 22, 1796 – February 17, 1874
 Ghent, Belgium – Brussels, Belgium
 Belgian mathematician. He championed statistical research and made important contributions to the study of human populations.
 References: Tort in DD, Freudenthal in DSB, EBB.

R

Rafinesque, Constantine Samuel

October 22, 1783 – September 18, 1840

Galata, near Constantinople, Turkey – Philadelphia, Pennsylvania, USA

French-American naturalist and archaeologist.

Darwin mentions him in the *Historical Sketch* in later editions of the *Origin*.

References: Ewan in DSB.

Ralfs, John

September 13, 1807 – July 14, 1890

English surgeon and botanist, author of *British Phanerogamous Plants and Ferns* (1839) and *British Desmidae* (1848). He sent Darwin specimens of *Pinguicula* and *Utricularia* for research on insectivorous plants.

References: RBF, RD.

Ramsay, Andrew Crombie (Professor, Sir)

January 31, 1814 – December 9, 1891

Glasgow, Scotland – Beaumaris, Wales

British geologist, important to Darwin for theories on glaciation and origins of continents and oceans.

References: Tort in DD, Beckinsale in DSB, EBB.

Rengger, Johann Rudolph

1795 – 1832

Baden, Switzerland – Baden, Switzerland

Swiss zoologist. Darwin occasionally cites his work on South American mammals.

References: Tort in DD.

Reynolds, Joshua (Sir)

July 16, 1723 – February 23, 1792

Plympton Earl, Devonshire, England – London, England

English painter, eminent for his portraits. He was President of the Royal Academy. Darwin was interested in his writings on aesthetics and also referred to his views on facial expression.

References: Tort in DD, EB 13.

Riley, Charles Valentine

September 18, 1843 – September 14, 1895

Chelsea, England – Washington, D.C., USA

English-born entomologist who moved to the United States at age 17. He was State Entomologist of Missouri and later Entomologist to the Bureau of Agriculture.

References: RBF, Howard in *Dictionary of American Biography*.

Rivers, Thomas

December 27, 1798 – October 17, 1877

Sawbridgeworth, Herts, England – Sawbridgeworth, Herts, England

English nurseryman, author of popular works on horticulture. His son, T. Francis Rivers (1831-1899) succeeded him in the family business. Darwin mentions him in a paper of 1855.

References: RD, RF.

Roget, Peter Mark

January 18, 1779 – September 12, 1869

London, England – West Malvern, Worcestershire, England

English physician and philologist, best remembered for his *Thesaurus*. He was important for Darwin because of his Bridgewater Treatise of 1833-1834, entitled *Animal and Vegetable Physiology Considered with Reference to Natural Theology*, which was adaptationist but not evolutionary.

References: Murray in ODNB.

Rolleston, George

July 30, 1829 – June 16, 1881

Maltby, Yorkshire, England – Oxford, England

English anatomist, professor at Oxford. He supported Huxley in the dispute with Owen over man's place in nature.

References: Geison in DSB.

Romanes, George John

May 2, 1848 – May 23, 1894

Kingston, Ontario, Canada – Oxford, England

English zoologist and comparative psychologist. He was a close associate of Darwin and his work on the behavior and nervous organization of animals was strongly influenced by Darwin's work on plants. Darwin turned much of his material on behavior over to Romanes, who published a posthumous *Essay on Instinct* as an appendix to one of his books. Romanes published extensively on evolutionary theory. His major publications include *Animal Intelligence* and *Darwin and After Darwin*.

References: Tort in DD, *Life and Letters*, Lesch in DSB.

Rosas, Juan Manuel (General)

March 30, 1793 – March 14, 1877

Buenos Aires, Argentina – Swaythling, near Southampton, England

Argentine cattleman and dictator from 1835 to 1852.

He helped Darwin with his travel arrangements. In 1852 he became a refugee in England and was met by Darwin at Southampton.

References: RBF.

Royer, Clémence

April 28, 1830 – 1902

Nantes, Brittany, France – Neuilly-sur-Seine, France

French feminist, social philosopher, and popularizer of scientific ideas. A Lamarckian and social Darwinist, she produced the first French translation (1862) of *The Origin of Species*. Darwin was displeased with this translation, partly because her introduction and footnotes were critical of the work, and partly because of her clumsy efforts to improve upon the original.

References: Blanckaert in DD, Harvey 1997.

Ruck, Amy Richenda

1850 – 1876

Daughter of Lawrence Ruck, first wife of Francis Darwin, daughter-in-law of Charles Darwin. She died at the birth of Bernard Richard Meirion Darwin.

References: RBF.

Ruskin, John

February 8, 1819 – January 20, 1900

London, England – Brantwood, England

English art critic and writer. Darwin visited him while vacationing in the Lake District.

References: Frederick Harrison in EB13.

Rütimeyer, Karl Ludwig

February 26, 1825 – November 25, 1895

Biglen, Bern Canton, Switzerland – Basel, Switzerland

Swiss paleontologist, professor at Basel. His work on fossil mammals supported evolution, but he rejected natural selection.

References: Nelson in DSB.

S

Sabine, Edward (Sir)

October 14, 1788 – June 26, 1883

Dublin, Ireland – Richmond, Surrey, England

Irish geophysicist and explorer. He was somewhat manipulative, and his machinations with respect to

the award of the Copley Medal to Darwin created a minor scandal.

References: Rheingold in DSB.

Sachs, Julius von (Professor)

October 2, 1832 – May 29, 1897

Breslau, Germany – Würzburg, Germany

German botanist, studied in Prague, professor of botany at Freiburg 1867-1868, subsequently professor of botany at Würzburg. He was an important critic of Darwin's work on plant physiology. Darwin's research in that area has survived the criticism very well. Sachs also criticized various other aspects of Darwin's work.

References: Tort in DD, Bopp in DSB.

Saint-Hilaire, Auguste de

October 4, 1779 – September 30, 1853

Orléans, France – Loiret, France

French botanist, professor at Paris. He collected extensively in Brazil. Darwin studied his botanical text book and mentioned his views on morphology in the *Origin*.

References: Guerra in DSB.

Sanderson See **Burdon-Sanderson**

Saporta, Louis Charles Joseph Gaston, Marquis de

July 28, 1823 – January 26, 1896

St. Zacharie, France – St. Zacharie, France

French paleobiologist. He and Darwin corresponded about botanical matters.

References: Stockmans in DSB.

Say, Thomas

June 27, 1787 – October 10, 1834

Philadelphia, Pennsylvania, USA – New Harmony, Indiana, USA

American naturalist, considered the father of American Entomology and author of books on entomology and conchology. His travels led to important contributions to the study of the American fauna.

References: Shor in DSB.

Schaffhausen, Hermann Joseph

1816 – 1893

Koblenz, Germany – Bonn, Germany

German physician and anthropologist. Darwin mentions him in the *Historical Sketch* in later editions

of the *Origin*.

References: RBF, I. Jahn *Geschichte der Biologie*.

Schleiden, [Jacob] Matthias

April 5, 1804 – June 23, 1881

Hamburg, Germany – Frankfurt am Main, Germany
German botanist, professor at Jena, afterward at Dorpat. He was one of the founders of the cell theory. Darwin read and made use of his works on plants.

References: Klein in DSB.

Sclater, Philip Lutley

November 4, 1829 – June 27, 1913

Tangier Park, Hampshire, England – Odiham, Hampshire, England

English ornithologist and Secretary of the Zoological Society of London. In 1858 he published an important paper on the biogeography of birds. He was an important source of information for Darwin, who often visited him. Darwin thanks him for reading the chapters on birds and mammals in the manuscript of *The Descent of Man*.

References: Austin in DSB.

Schleicher, August

February 19, 1821 – December 6, 1868

Meiningen, Germany – Jena, Germany

German philologist, professor at Jena. A colleague of Ernst Haeckel, he was stimulated by him to write a short book entitled *Die Darwinsche Theorie und die Sprachwissenschaft* (1863), which compared the evolution of species to that of languages. It was later translated into English.

References: EB13.

Scott, John

1836 – June 10, 1880

Denholm, Scotland – Garvald, East Lothian, Scotland
Scottish gardener and botanist, trained at Edinburgh.

While still at Edinburgh he did important experimental work on floral biology. Darwin recognized his talent and encouraged him. He immigrated to India, where he became Curator of the Botanic Garden, Calcutta, and from there sent Darwin such publications as his *Manual of Opium Husbandry*. He was also an important source of information about emotional expression and other matters.

References: Tort in DD, RD.

Scrope, George

March 10, 1797 – January 19, 1876

London, England – Fairlawn, Surrey, England

English geologist. He was an important authority on volcanoes.

References: Page in DSB, GHG.

Sedgwick, Adam (Professor, Reverend)

March 22, 1785 – January 27, 1873

Dent, Yorkshire – Cambridge, England

Geologist, Professor of Geology at Cambridge University. He taught Darwin a lot of geology, especially during a field trip to Scotland in 1831. He was strongly opposed to evolution.

References: Rudwick in DSB.

Semper, Carl Gottfried

July 6, 1832 – May 29, 1893

Altona, Germany – Würzburg, Germany

German invertebrate zoologist. After taking his degree he made an extensive expedition to Palau and the Philippines, where he made important collections of invertebrates. Later he became a professor at Würzburg, and he and his students made significant contributions to comparative anatomy. He was highly critical of Darwin's coral reef theory.

References: Rupp-Eisenreich in DD, Mayr in DSB.

Sharpe, Daniel

April 6, 1806 – May 31, 1856

London, England – London, England

English geologist. His work on cleavage and foliation was important for Darwin. He described Darwin's brachiopods from the Falkland Islands.

References: EB13.

Siebold, Carl Theodor Ernst von

February 16, 1804 – April 7, 1885

Würzburg, Germany – Munich, Germany

German zoologist, professor at Freiburg, Breslau and Munich. His work on parthenogenesis was of great interest to Darwin.

References: Geus in DSB.

Sismondi, Jean Charles Leonard de

May 9, 1773 – June 25, 1842

Geneva, Switzerland – Geneva, Switzerland

Swiss political economist and historian. He married Emma Wedgwood Darwin's mother's sister Jessie. Darwin evidently read his *Principes d'Économie Politique*.

References: EB13.

Smellie, William

February 5, 1697 – March 5, 1763

Lanarkshire, Scotland – Lanark, Scotland

Scottish male midwife and naturalist. Darwin read the 1790 edition of his *Philosophy of Natural History*.

He did not think highly of it, but annotated it for information on the reproduction of mammals and birds.

References: ODNB.

Smith, Adam

June 5, 1723 – July 17, 1790

Kirkcaldy, Scotland – Edinburgh, Scotland

Scottish economist and philosopher, author of *The Wealth of Nations*, which Darwin may have read.

His book *The Theory of Moral Sentiments* was fundamental to Darwin's ideas about the evolution of society discussed in *The Descent of Man*.

References: EB13.

Smith, Frederick

December 30, 1805 – February 16, 1879

London, England – London, England

English entomologist who worked in the zoology department at the British Museum. He identified Hymenoptera for Darwin's orchid research.

References: BAE.

Smith, James Edward (Sir)

December 2, 1759 – March 17, 1828

Norwich, Norfolk, England – Norwich, England

English physician and botanist, founder of the Linnean Society. Darwin cites his publications in *Flowers*.

References: RD.

Sowerby, George Brettingham

May 12, 1788 – July 26, 1854

London, England – London, England

English conchologist, author of *The Genera of Recent and Fossil Shells* (1820–1825). He identified shells discussed in Darwin's book on South America.

References: Newman 1993, Woodward in DNB.

Sowerby, George Brettingham, Jr.

March 25, 1812 – July 26, 1884

London, England – London, England

English conchologist and illustrator. The son of George Brettingham Sowerby, he was author of the *Conchological Manual*. He illustrated much of

Darwin's work on barnacles, namely *Living Lepadidae*, *Living Balanidae*, and *Fossil Balanidae* and also the book on *Orchids*.

References: Newman 1993, Woodward in DNB, Cleavelly in ODNB.

Sowerby, James

March 21, 1757 – October 25, 1822

London, England – London, England

English natural history artist. He founded the *Mineral Conchology of Great Britain*, to which Darwin refers.

References: EB13, Woodward in DNB, Cleavelly in ODNB.

Sowerby, James de Carle

June 5, 1787 – August 26, 1871

London, England – London, England

English botanist and paleontologist, the brother of George Brettingham Sowerby. He illustrated Darwin's monograph on *Fossil Lepadidae*.

References: RD; Woodward in DNB, Cleavelly in ODNB.

Spallanzani, Lazzaro

January 10, 1729 – February 12, 1799

Scandiano, Modena, Italy – Pavia, Italy

Italian philosopher and biologist, professor at Modena and later at Pavia. He was a major figure in the controversy over spontaneous generation. Darwin read his work on reproduction.

References: EB 13.

Spencer, Herbert

April 27, 1820 – December 8, 1903

Derby, England – Brighton, England

English social philosopher. Although he is known for having advocated a kind of evolutionism in publications that appeared prior to 1859, he did so as a philosopher rather than a natural scientist. He presented a vast evolutionary scheme in a multi-volumed *Synthetic Philosophy*. During his life time his works were widely read and very influential. Although Darwin did not say so in public, he did not think very highly of Spencer's contribution or what he called his "deductive" approach. (See the unexpurgated version of Darwin's *Autobiography*.) Darwin mentions him in the *Historical Sketch* in later editions of the *Origin*.

References: Peel in DSB.

Sprengel, Christian Konrad

September 22, 1750 – April 7, 1816

Brandenburg, Germany – Berlin, Germany

German botanist. Sprengel's book with the quaint title *Das Entdeckte Geheimniss der Natur im Bau und in der Befruchtung der Blumen (The Mystery of Nature Revealed in the Structure and in the Fertilization of Flowers)* was a very important source for Darwin's work on pollination biology. It is largely thanks to Darwin's praise for the book that Sprengel gets credit for his pioneering research.

References: King in DSB.

Stainton, Henry Tibbats

August 13, 1822 – December 2, 1892

London, England – Mountsfield, Lewisham, England

English businessman, an amateur entomologist.

References: RBF, BAE.

Stebbing, Thomas Roscoe Rede (Reverend)

February 6, 1835 – July 8, 1925

London, England – Tunbridge Wells, England

Anglican clergyman and marine biologist, an expert on Crustacea. He was a supporter of evolutionary ideas, which he believed could be reconciled with religion.

References: RBF, Mills in DSB.

Steenstrup, [Japetus] Johannes [Smith]

March 8, 1813 – June 20, 1897

Vang, Denmark – Copenhagen, Denmark

Danish zoologist and paleontologist. He provided Darwin with a great deal of help with fossil cirripedes. His ideas on hermaphroditism and other aspects of reproduction were also of considerable interest to Darwin.

References: Newman 1993, Müller in DSB.

Stephen, Leslie

November 28, 1832 – February 22, 1904

Kensington Gore, England – London, England

English biographer and literary critic. He took a considerable interest in evolution, especially its relationship to ethics. He advised Darwin not to reply to Samuel Butler.

References: EB13.

Stephens, James Francis

September 16, 1792 – December 22, 1852

Shoreham, Sussex, England – Kennington, England

London entomologist who worked at the British

Museum. He was the author of *Illustrations of British Entomology*.

References: RBF, Woodward in DNB.

Stimpson, William

February 14, 1832 – May 26, 1872

Roxbury, Massachusetts, USA – Ilchester, Maryland, USA

American marine biologist.

References: Johnson in DSB.

Strickland, Hugh Edwin

March 2, 1811 – September 14, 1853

Righton, Yorkshire, England – run over by a train near Retford, England

English geologist and zoologist. He was the head of British Association Committee on nomenclature, of which Darwin was a member. Their correspondence on nomenclature and related topics is quite interesting.

References: GHG.

Studer, Bernhard

August 21, 1794 – May 2, 1887

Büren, Switzerland – Bern, Switzerland

Swiss geologist, professor at Bern.

References: Tobien in DSB.

Sullivan, Bartholomew James (Captain)

November 18, 1810 – January 1, 1890

Tregew, England – Bournemouth, England

English naval officer. A Second Lieutenant on the *Beagle* during Darwin's voyage, he was knighted in 1869 and promoted to Admiral in 1877. Darwin made considerable use of Sullivan's geological observations and collections. He and another shipmate, John Wickham, visited Darwin at Down on October 21, 1861.

References: RBF; Laughyon in DNB.

Swainson, William

October 8, 1789 – December 7, 1855

Newington Butts, London, England – Wellington, New Zealand

English naturalist, whose views on biogeography and classification were of considerable interest to Darwin, in spite of his holding their author in contempt. Swainson was a follower of William Sharpe MacLeay and advocated "Quinarianism," a numerological approach to systematics. He wrote a series of popular books that seem not to have had

much influence upon the scientific community. In 1840 he ceased to write on systematics and retired to New Zealand.

References: McMillan in DSB.

Swinhoe, Robert

September 1, 1836 – October 28, 1877

Calcutta, India – London, England

English amateur botanist, author of a floral list from Formosa. He was consul at Taiwan in 1865 and at Ning-po from 1873 to 1876. He sent Darwin specimens of domesticated animals and other material.

References: RD, Garber, 1994.

T

Taine, Hippolyte Adolphe

April 21, 1828 – March 5, 1893

Vouziers, France – Paris, France

French literary historian, philosopher and psychologist, author of *On Intelligence*. He was strongly influenced by evolutionists, including Darwin. His paper in *Mind* stimulated Darwin to publish his own observations on the behavioral development of his oldest son, William.

References: EB13.

Tait, Robert Lawson

1845 – June 13, 1899

Edinburgh, Scotland – Birmingham, England

English physician, surgeon and gynecologist. Darwin cites his remarks on natural selection in civilized nations.

References: RBF, Pagel in ODNB.

Tait, William Chester

June, 1844 – April 7, 1928

Oporto, Portugal – Oporto, Portugal

Botanist, whose family was in the wine-export business. He provided *Drosophyllum* for Darwin's work on insectivorous plants.

References: RD, RBF.

Tegetmeier, William Bernhard

November 4, 1816 – November 19, 1912

Coinbrook England – Hampstead, England

English ornithologist and pigeon-fancier, a successful author, trained as a surgeon. He and Darwin had extensive correspondence, and he supplied Darwin with specimens used in the study of variation. He also helped Darwin with his work on bee cells.

References: RBF, Secord in DNB.

Tennant, James (Professor)

February 8, 1808 – February 28, 1881

Upton, near Southwell, Nottinghamshire, England – London, England

English mineralogist, professor of geology at King's College. Darwin thanks him for use of fossil barnacle specimens.

References: EB13.

Tennyson, Alfred (Lord)

August 6, 1809 – October 6, 1892

Somersby, Lincolnshire, England – Aldworth, Sussex, England

English poet, appointed Poet Laureate on November 19, 1850. Darwin quotes his *Idylls of the King* in *The Descent of Man*.

References: EB13.

Thiselton-Dyer, William Turner (Sir)

July 28, 1843 – December 23, 1928

Westminster, London, England – Witcombe, England

English Botanist.

References: RD.

Thompson, D'Arcy Wentworth

May 2, 1860 – June 21, 1948

Edinburgh, Scotland – St. Andrews, Scotland

Scottish biologist, classical scholar and mathematician. He translated Hermann Müller's *Befruchtung der Blumen durch Insekten*, a work to which Darwin wrote a preface.

References: RBF, Thompson in DSB.

Thompson, John Vaughan

November 19, 1779 – January 21, 1847

Berwick-upon-Tweed, England – Sydney, New South Wales, Australia

English surgeon and zoologist. His observations on the development of cirripedes established that these animals are crustaceans, not mollusks.

References: Wheeler in DSB.

Thompson, William

November 2, 1805 – February 17, 1852

Belfast, Ireland – London, England

Irish naturalist, an expert on algae. He sent Darwin information about living barnacles.

References: RD.

Thomson, [Charles] Wyville (Sir)

November 19, 1830 – March 10, 1882

Bonnyside, Linlithgow, Scotland – Bonnyside, Scotland

Scottish marine biologist, professor at Edinburgh from 1870. He made valuable contributions to the study of the deep-sea fauna, and was scientific director of the *Challenger* Expedition. Darwin responded in print to some of his criticisms.

References: Thomas in DSB.

Thomson, William (Lord Kelvin): See **Kelvin**

Thwaites, George Henry Kendrick

July 9, 1811 – September 11, 1882

Bristol, England – Kandy, Ceylon

English botanist, director of Peradeniya Ceylon botanic garden. An important correspondent, he sent Darwin materials for work on flowers.

References: RBF, RD.

Tournefort, Joseph Pitton de

June 3, 1656 – November 28, 1708

Aix-en-Provence, France – Paris, France

French systematic botanist.

References: Leroy in DSB.

Treviranus, Ludolph Christian (Prof.)

September 18, 1779 – May 6, 1864

Bremen, Germany – Bonn, Germany

German botanist, not to be confused with his older brother, Gottfried Reinhold. He confirmed some of Darwin's findings on orchids.

References: Smit in DSB.

Trimen, Henry

October 26, 1843 – October 16 1896

Paddington, London, England – Peradenia, Ceylon

English botanist, brother of Roland Trimen. He worked at the British Museum from 1869 to 1879 and subsequently became the director of the botanical garden at Peradenia, Ceylon.

References: RD.

Trimen, Roland

October 29, 1840 – July 25, 1916

London, England – Epsom, Surrey, England

English entomologist, brother of Henry Trimen. He provided Darwin with information about orchid fertilization and related topics from the Cape of Good Hope.

References: DD.

Turner, William (Sir)

January 7, 1832 – February 15, 1916

Lankaster, England – Edinburgh, Scotland

English anatomist. An important informant for Darwin about anatomical matters, including rudimentary organs, for the *Descent*.

References: RBF.

Tylor, Edward Burnett (Sir)

October 2, 1832 – January 2, 1917

London, England – Wellington, Somerset, England

English anthropologist. His *Researches on the Early History of Mankind* (1865, ed. 2 1870) is a classic.

In his *Primitive Culture* (1871) he gave an important definition of the term 'culture' that is still widely quoted. Darwin's copies of both books are lightly annotated. In the *Variation* Darwin cites an essay by him on consanguineous marriages.

References: EB13.

Tyndall, John

August 2, 1820 – December 4, 1893

Leighlinbridge, County Carlow, Ireland – Hindhead, Surrey, England

Irish physicist, natural philosopher and popular science writer. He was a close friend of Thomas Henry Huxley and Herbert Spencer and an advocate of scientific naturalism.

References: MacLeod in DSB, EB13.

U

Unger, Franz

November 30, 1800 – February 13, 1870

Near Leutschach, Austria – Graz, Austro-Hungarian Empire

Austrian botanist and paleontologist, professor at Graz, and from 1850 in Vienna. He was author of *Versuch einer Geschichte der Pflanzenwelt* (Vienna, 1852). Darwin mentions him in the *Historical Sketch* in later editions of the *Origin*.

References: Olby in DSB.

V

Van Mons, Jean Baptiste

November 11, 1765 – September 6, 1842

Brussels, (now) Belgium – Louvain, Belgium

Chemist and horticulturist.

References: BDB.

Vilmorin, Henri Leveque de

February 26, 1843 – August 23, 1899

Paris, France – Verrières-le-Buisson, France

Son and successor of of Louis Vilmorin.
References: BDB.

Vilmorin, Pierre Louis François Leveque de

April 18, 1816 – March 21, 1860
Paris, France – Paris, France
French plant breeder, the proprietor of Vilmorin-Andrieux et Cie, an important seed dealership.
References: Simpkins in DSB.

Vines, Sydney Howard (Dr.)

December 31, 1849 – April 4, 1934
Ealing, England – Exmouth, England
English botanist on the staff of Cambridge University.
He provided Darwin with information about plant physiology for such topics as insectivorous plants.
References: RBF.

Virchow, Rudolf Carl

October 13, 1821 – September 5, 1902
Schivelbein, Germany – Berlin, Germany
German physician and pathologist, professor at Berlin. His important book on cellular pathology was of interest to Darwin in relation to theories of generation and development.
References: Risse in DSB.

Vogt, Carl Christopher (Professor)

July 5, 1817 – May 5, 1895
Giessen, Germany – Geneva, Switzerland
German zoologist. A professor at Giessen, he had to relocate in Geneva for political reasons after 1848. He was an influential materialist philosopher and a strong supporter of Darwin. Although not an evolutionist at the time, he had translated Robert Chambers' *Vestiges of the Natural History of Creation* into German. There are extensive references to his contributions to physical anthropology in *The Descent of Man*.
References: Pilet in DSB.

Vries, see De Vries

W

Wagner, Johann Andreas

March 21, 1797 – December 17, 1861
Nürnberg, Germany – München, Germany
German zoologist and paleontologist, professor at München. He was strongly critical of Darwin's views.
References: GHG.

Wagner, Moritz

October 3, 1813 – May 31, 1887
Beyreuth, Germany – München, Germany
German zoologist. He considered isolation a necessary condition for evolutionary change, an idea that Darwin rejected.
References: RBF, Mayr in DD.

Walker, Alexander

December 20, 1779 – December 6, 1852
Edinburgh, Scotland – Edinburgh, Scotland
Scottish medical writer. His book on *Intermarriage* (1838) attracted Darwin's attention early on and he annotated his copy heavily. He was also author of books on neurophysiology and related topics.
References: Hartley in DNB.

Walker, Francis

July 31, 1809 – October 5, 1874
Arno's Grove, Southgate, England – Wanstead, Essex, England
English entomologist who worked at the British Museum. For taxonomic descriptions he was paid a schilling per new species and a pound per new genus. The result was a world record of 20,000 species. As one might expect, the quantity of his output was to some extent offset by the amount of harm he did. Walker described many of the insects from the *Beagle* voyage and identified Diptera for Darwin's work on orchids.
References: Lindroth 1973, obituary in *Entomologists' Monthly Magazine* 11:140-141 (1874).

Wallace, Alexander

1830 – October 1, 1899
London, England – Colchester, England
English physician and lepidopterist. Darwin refers to his publications and personal communications about insect reproduction in the *Descent*.
References: RBF, Anonymous in *Entomologist's Monthly Magazine* 35:275-276 (1899)

Wallace, Alfred Russel

January 8, 1832 – November 7, 1913
Usk, Monmouthshire, Wales – Broadstone, Dorset, England
British naturalist. Although best known as the co-discoverer of natural selection, Wallace was an outstanding biologist in his own right. His vast experience collecting natural history specimens in

South America and the Malaly Archipelago put him in an excellent position to support the theory of natural selection and to place biogeography on a solid evolutionary foundation.

References: McKinney in DSB, Marchant 1905, Wallace 1905.

Walsh, Benjamin Dann

September 21, 1808 – November 18, 1869

London, England – Rock Island, Illinois, USA

Entomologist. Born in England, he immigrated to the United States and ultimately had enough private means to devote most of his time to science. They were introduced when Darwin was a student at Cambridge, where Walsh became a Fellow. An important supporter of Darwin, he criticized the views of Louis Agassiz. Walsh provided Darwin with much useful information about insects, particularly with respect to sexual selection.

References: Howard in *Dictionary of American Biography*.

Waterhouse, George Robert

March 6, 1810 – January 21, 1888

Somers Town, England – ?

English naturalist. He was curator at the Zoological Society from 1836 to 1843, and until his retirement was on the staff of the British Museum. Waterhouse described the living mammals from Darwin's *Beagle* voyage and many of the insects as well. They engaged in important correspondence on principles of classification. Darwin reviewed Waterhouse's book on Mammalia in 1847.

References: CCD.

Watson, Hewett Cottrell

May 9, 1804 – July 27, 1881

Firbeck, Yorkshire, England – Thames Ditton, Surrey, England

English botanist and phrenologist. Watson studied Medicine at Edinburgh from 1828 to 1832. He resigned as editor of *The Phrenological Journal* in 1840. From 1859 onward he mainly worked on the distribution of British plants, a topic on which he was a leading authority. He was considered a curmudgeon. His early discussions of evolution are said to have impressed Darwin.

References: RD.

Way, Albert

June 23, 1805 – March 22, 1874

Bath, England – Cannes, France

Friend of Darwin as a Cambridge undergraduate.

They collected beetles together. An antiquary, he gave Darwin information about breeds of horses.

References: RBF, Wroth in DNB.

Weddell, Hugh Algernon (Dr.)

June 22 1819 – July 22, 1877

Plainswick, Gloucester, England – Poitiers, France

English physician and botanist. Darwin cited his work in *Flowers*.

References: RD.

Wedgwood, Emma

May 2, 1808 – October 2, 1896.

Maer Hall, Staffordshire, England – Down House, Kent, England

Daughter of Josiah Wedgwood II. A first cousin of Charles Darwin, she became his wife on January 29, 1839.

References: Litchfield 1915, Healey 2001.

Wedgwood, Francis

1800-1888

Maer Hall, Staffordshire, England – Barlaston, Staffordshire, England

The third son of Josiah Wedgwood II, older brother of Emma Darwin and Charles Darwin's brother-in-law as well as his cousin. He took over the Wedgwood pottery business upon the retirement of his father. He lived at Barlaston in Staffordshire.

Wedgwood, Henry

1799 – 1885

The second son of Josiah Wedgwood II. Older brother of Emma Darwin and Charles Darwin's brother in law.

Wedgwood, Hensleigh

January 22, 1803 – June 2, 1891

Gunville, Dorset, England – London, England

English barrister and philologist, author of *A Dictionary of English Etymology* and *The Origin of Language* (1866). The 4th (and youngest) son of Josiah Wedgwood II, and also Emma Darwin's older brother, he therefore was both Charles Darwin's brother-in-law and cousin. He became a spiritualist late in life.

References: Herford and Haigh in DNB.

Wedgwood, Josiah (I)

July 12, 1730 – January 3, 1795

Burslem, England – Etruria, England

English Industrialist, founder of the Wedgwood pottery firm. He was the maternal grandfather of Charles Darwin.

References: Dorn in ODNB.

Wedgwood, Josiah (II) (“Uncle Jos.”)

1769 – July 12, 1843

Etruria, England – Maer, England

Maternal uncle of Charles Darwin, brother of his mother and father of his wife. It was he who convinced Robert Waring Darwin that he should allow Charles to accept the invitation to serve as unofficial naturalist on the *Beagle*.

Wedgwood, Josiah (III)

1795 – 1880

Etruria, England – Leith Hill Place, England

The oldest son of Josiah Wedgwood II, and brother of Emma Darwin. Upon marrying Caroline Darwin in 1837 he became Charles Darwin's brother-in-law. He was a partner in the Wedgwood firm at Etruria from 1841 to 1844, after which time he moved to Leith Hill Place in Surrey.

Wedgwood, Susannah

January 3, 1765 – July 15, 1817

Etruria, England – Shrewsbury, England

Mother of Charles Darwin. She died when he was only eight years old. Evidently the experience was very traumatic and Darwin seems to have suppressed much of his memory of her.

Weir, John Jenner

1822 – 1894

English accountant and naturalist. He was an important source of information for aspects of bird reproduction discussed in *Descent*.

Weismann, August

January 17, 1834 – November 5, 1914

Frankfurt am Main, Germany – Freiburg im Breisgau, Germany

German zoologist and evolutionist, Professor of zoology at Freiburg. A strong supporter of natural selection, he denied the existence of the inheritance of acquired characters, and propounded the theory of the continuity of the germ-plasm to reject Lamarckian mechanisms generally. He is considered the founder of “neo-Darwinism” as a movement. Darwin wrote a preface to the English translation of one of his books.

References: Robinson in DSB.

Wells, William Charles (Dr.)

May 24, 1757 – September 18, 1817

Charleston, South Carolina, USA – London, England

British physician and natural scientist, author of a prize-winning *Essay on Dew* (1814). His *Account of A Female of the White Race of Mankind, part of whose Skin Resembles that of a Negro* (1818) attracted Darwin's attention as a proto-evolutionary work. Darwin considered Wells to have discussed natural selection in that work. However, the amount of change that Wells invoked was limited. Darwin mentions him in the *Historical Sketch* in later editions of the *Origin*.

References: Dock in DSB, Moore and Berg in DNB.

Westwood, John Obadiah

December 22, 1805 – January 2, 1893

Sheffield, England – Oxford, England

English entomologist, Hope Professor in Oxford University. Author of *A Modern Introduction to the Classification of Insects*, he was the most erudite entomologist of his day. Together with Darwin he was one of the signatories of the Strickland code of zoological nomenclature. He was opposed to Darwinism. Darwin cites him in the *Origin of Species* in connection with geographic variability of insects.

References: Lindroth 1973.

Wetherell, Nathaniel Thomas

September 6, 1800 – December 22, 1875

Highgate, Middlesex, England – Highgate, Middlesex, England

English surgeon and geologist. He owned an important London Clay fossil collection, and lent Darwin specimens of fossil barnacles.

References: GHG, George in DNB.

Whately, Richard (Archbishop)

February 1, 1787 – October 8, 1863

Dublin, Ireland – near Dublin, Ireland

British clergyman and philosopher, archbishop of Dublin.

References: Brent in DNB.

Whewell, William (Professor, Reverend)

May 24, 1794 – March 6, 1866

Lankester, England – Cambridge, England

Physicist and historian and philosopher of science, professor of mineralogy at Cambridge. His philosophy was influential on Darwin's thinking about scientific methodology. However, his philosophy,

influenced by Kant, seems to have been a bit too idealistic for Darwin's taste. Darwin was more strongly influenced by John Herschel. Darwin quotes him on laws of nature at the front of the *Origin of Species*. Likewise he quotes him on the value of hypotheses when he presents his ideas about pangenesis in *The Variation of Animals and Plants under Domestication*.

References: Butts in DSB, Yeo 1993.

White, Adam

April 28, 1817 – January 4, 1879

Assistant in the Zoology Department of the British Museum from 1835 to 1863, when he retired because of mental health problems. Darwin wrote a letter of reference for him for a chair at Edinburgh.

References: RBF.

White, Gilbert

July 18, 1720 – June 26, 1793

Selborne, Hampshire, England – Selborne, Hampshire, England

English clergyman and naturalist. His *Natural History of Selborne* was much admired by Darwin as it has been by many others.

References: Groves in DSB.

Wichura, Max Ernst

January 27, 1817 – 24 or 25 January, 1866

Neisse, Germany – Berlin, Germany

German lawyer and amateur botanist. He did important work on floral biology. Darwin annotated his book on plant hybridization and cited it.

References: DD.

Wickham, John Clements

1798 – January 6, 1864

English naval officer. He and his former shipmate from the *Beagle*, James Sullivan, visited Darwin at Down on October 21, 1861. In 1862 he retired to the south of France.

Wiesner, Julius von (Professor)

January 20, 1838 – October 9, 1916

Tschechen, Moravia – Vienna, Austria

Austro-Hungarian plant physiologist, professor at Vienna. After receiving his Ph.D. at Jena in 1860, he held various posts at Vienna until his retirement in 1909. He corresponded with Darwin about plant movement.

References: Biebel in DSB.

Wigand, Julius Wilhelm Albert (Professor)

April 21, 1821 – October 22, 1886

Treysa, Hessen, Germany – Marburg, Germany

German botanist, professor at Marburg. An opponent of Darwinism, he criticized, among other things, pangenesis.

Reference: BDB, Jahn 1998.

Wilberforce, Samuel (Bishop) (“Soapy Sam”)

September 7, 1805 – July 19, 1873

London, England – near Dorking, Surrey, England

English clergyman who had some background in mathematics. A debate in which he participated at the meeting of the British Association for the Advancement of Science at Oxford in 1860 has taken on somewhat of a legendary character. His exchange with Huxley created a sensation, but Hooker was more effective at debating the issues. He did not believe that he had been beaten.

References: Meacham 1970.

Wolf, Caspar Friedrich

January 18, 1734 – February 22, 1794

Berlin, Germany – St. Petersburg, Russia

German embryologist.

References: Gaissiovitch in DSB.

Wollaston, Thomas Vernon

March 9, 1821 – January 4, 1878

Scotter, Lincolnshire, England – Teignmouth, England

English entomologist. Although not an evolutionist or supporter of natural selection, he was a student of variation in nature and believed that species have locally-adapted races. He and Darwin discussed such matters both in conversation and in correspondence. Darwin asked him for information about sexual combat in insects and other topics. Important works by Wollaston include *Insecta Maderensia* (1854) and *On the Variation of Species* (1856), which was dedicated to Darwin.

References: BAE.

Wood, Searles Valentine

February 14, 1798 – October 26, 1880

Woodbridge, England – Martelsham, England

English geologist and banker.

References: GHG.

Woodward, Henry

November 24, 1842 – September 6, 1921

Norwich, England – Bushey, England

English paleontologist, the youngest son of Samuel Woodward. He worked at the British Museum, and was an expert on fossil arthropods.

References: GHG, EB13.

Woodward, Horace Bolingbroke

1848 – February 5, 1914

English geologist, the son of Samuel Pickworth Woodward. He worked for the Geological Survey.

References: GHG.

Woodward, Samuel

October 3, 1790 – January 14, 1838

Norwich, England – Norwich, England

English geologist and antiquary.

References: GHG.

Woodward, Samuel Pickworth

September 17, 1821 – July 11, 1865

Norwich, England – Herne Bay, England

English geologist and malacologist, author of *A Manual of the Mollusca*. He was the second son of Samuel Woodward. He worked at the British Museum.

References: GHG.

Wright, Chauncey

September 20, 1830 – September 12, 1875

Northampton, Massachusetts, USA – Cambridge, Massachusetts, USA

American mathematician and philosopher. He supported Darwin and defended natural selection against the attacks of Mivart.

References: RBF, EB13.

Wyman, Jeffries

August 11, 1814 – September 4, 1874

Chelmsford, Massachusetts, USA – Bethlehem, New Hampshire, USA

American paleontologist, trained as a physician, a Harvard professor. He corresponded extensively with Darwin about various possible examples of natural selection and some of these are cited in the *Origin*.

References: RBF, Dupree in DSB.

Y

Yarrell, William

June 3, 1784 – September 1, 1856

London, England – Yarmouth, England

London stationer, bookseller and naturalist. He helped Darwin to obtain equipment for the *Beagle* voyage. He was author of *A History of British Fishes* (1835 and 1836) and *A History of British Birds* (1843).

References: RBF, Edwards in ODNB.

Z

Zacharias, [Emil] Otto

January 27, 1846 – October 2, 1916

Leipzig, Germany – Kiel, Germany

German freshwater biologist. Darwin, in a letter to him written in 1877, says that he believed in the permanence of species while on the *Beagle*.

References: Freeman, Rupp-Eisenreich in DD.

Zollinger, Heinrich

March 22, 1818 – May 19, 1859

Dutch naturalist and scientific traveler. He worked on biogeography and the geology of islands.

References: DD.

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- Darwin, Charles, 1837. Notes upon the Rhea Americana. Proceedings of the Zoological Society of London, v. 5, p. 35-36.
- Darwin, Charles, 1837. Remarks upon the habits of the genera *Geospiza*, *Camarhynchus*, *Cactornis*, and *Certhidea* of Gould. Proceedings of the Zoological Society of London, v. 5, p. 49.
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- Darwin, Charles, 1838. Observations of proofs of recent elevation on the coast of Chili, made during the survey of His Majesty's Ship *Beagle*, commanded by Capt. FitzRoy, R.N. Proceedings of the Geological Society of London, v. 2, no. 48, p. 446-449.
- Darwin, Charles, 1838. A sketch of the deposits containing extinct Mammalia in the neighbourhood of the Plata. Proceedings of the Geological Society of London, v. 2, no. 51, p. 542-544.
- Darwin, Charles, 1838. On certain areas of elevation and subsidence in the Pacific and Indian Oceans, as deduced from the study of coral formations. Proceedings of the Geological Society of London, v. 2, no. 51, p. 552-554.
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- Darwin, Charles, 1838. On the connexion of certain volcanic phenomena, and on the formation of mountain-chains and volcanos, as the effects of continental elevations. Proceedings of the Geological Society of London, v. 2, no. 56, p. 654-660.
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- Darwin, Charles, 1840. On the formation of mould. Transactions of the Geological Society of London, v. 5, no. 3, p. 505-509.
- Darwin, Charles, 1840. On the connexion of certain volcanic phenomena in South America; and on the formation of mountain chains and volcanos, as the effect of the same power by which continents are elevated. Transactions of the Geological Society of London, v. 5, no. 3, p. 601-631; Pl. XLIX.
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- the ancient glaciers of Caernarvonshire, and on the boulders transported by floating ice. London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science, 3, v. 21, p. 180-188.
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