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Botanizing with Darwin[1]

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INTRODUCTION

Today, we tend to think of Charles Darwin (1809-1881) primarily as a zoologist, who used evidence from the relationships of the Galapagos finches to work out his theory of evolution by natural selection. Neither of these assumptions is correct.

After his return from the *Beagle* voyage in 1836, the British Museum ornithologist John Gould pointed out to Darwin that his collection of darkish birds from the archipelago, which he thought represented several different families, actually were quite closely related and represented a single family new to science. Darwin was never able to work out their relationships, because he had neglected to label the specimens as to which islands they had been collected upon. But he recognized that they had evolved from a common ancestor.

The only time that Darwin ever called himself anything but a naturalist in print, it was to refer to himself as a geologist. And this was in a botanical journal (Darwin 1855). Indeed, Darwin's career can be divided into three phases: first as a geologist, secondly as a zoologist, and thirdly as a botanist. However, these phases overlap, and an interest in botany can be traced to his childhood. In his *Autobiography*, first published in 1887 (F. Darwin 1887), Darwin stated that by the time he went to school at age eight, "my taste for natural history, and more especially for collecting, was well developed. I tried to make out the names of plants, and collected all sorts of things, shells, seals, franks, coins,, and minerals. The passion for collecting which leads a man to be a systematic naturalist, a virtuoso or a miser was very strong in me, and was clearly innate, as none of my sisters or brother ever had this taste." (Barlow 1958, pp. 22-23).

One of Darwin's boyhood friends, William Allport Leighton, who became a botanist himself, remembered Darwin's "bringing a flower to school and saying his mother had taught him how by looking at the inside of the blossom the name of the plant could be discovered. ..."""This greatly roused my attention and curiosity, and I inquired of him repeatedly how this could be done?""----but his lesson was naturally enough not transmissible." (Barlow1958, p. 23n). I think that Darwin's mother must have been trying to teach him Linnaeus' sexual system, by counting the numbers and forms of stamens and pistils in a flower in order to name the plant.

In this paper, I will take a look at Darwin's life and some of his botanical and other interests. I will also indicate where his and my paths have crossed during my own career as a botanist.

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BOYHOOD TO MANHOOD

Charles Robert Darwin was born in Shrewsbury, England on 12 February 1809, the same day as Abraham Lincoln. However, Darwin was born under somewhat better circumstances than Lincoln. His father, Robert Waring Darwin (1766-1848), a successful physician, was the son of the famous physician, philosopher, poet, and evolutionist Erasmus Darwin (1731-1802). His mother, Susannah Darwin (1765-1817), was the eldest child of Josiah Wedgwood (1730-1795), the founder of the Wedgwood pottery firm. As the second son and fifth of six children, Charles was not his father's primary heir. However, his marrying in 1839 his first cousin Emma Wedgwood (1808-1896) helped to make him financially independent and not beholden to a job.

Following schooling at home and at Rev. Case's day school, where Darwin tried to tell Leighton the mystery of flower identification, in 1818 he entered Shrewsbury School. In his *Autobiography*, Darwin relates stories about this time of his life and of the wretchedly classical curriculum of Shrewsbury School, but he has nothing to say about plants.

In October 1825, when he was 16, Darwin entered Edinburgh University to join his brother Erasmus Alvey Darwin (1804-1881) in the study of medicine. Although Erasmus eventually qualified as a physician, the experience proved a failure for Charles, who could not stand to watch the carnage of an operating theater before the days of chloroform. During his time at Edinburgh, Darwin should have taken the Materia Medica class at the Royal Botanic Garden. I searched in vain in its library for the professor's book for 1826-1827 that students had to sign in order to attend lectures. The one for 1825-1826 is there, but Darwin's name is not in it. However, in his *Autobiography*, Darwin wrote cryptically, "Lectures ... were intolerably dull ... Dr. Duncan's lectures on Materia Medica at 8 o'clock on a winter's morning are something fearful to remember." (Barlow 1958, p. 47).

Realizing that his son would never become a physician, Robert Darwin sent him to Cambridge University at Christmas 1827 to enroll for the Lent Term 1828. Now Charles was set for a career as a clergyman. He accepted this without argument, as the English clergy had a long history of interest in natural history. When a schoolboy, Darwin had read Rev. Gilbert White's *Natural history of Selborne* (White 1789) and commented, "'From reading White's *Selborne* I took much pleasure in watching the habits of birds ... In my simplicity I remember wondering why every gentleman did not become an ornithologist." (Barlow 1958, p. 45). He was to pay great attention to birds while on the *Beagle* voyage.

At Cambridge, Darwin soon became acquainted with Rev. John Stevens Henslow (1796-1861), Professor of Botany. Henslow kept a weekly open house for students and faculty. Darwin attended regularly, and Henslow soon became his mentor. Darwin must have shown some potential as a scientist. Not only did he attract the eye of Henslow, but also those of Rev. Adam Sedgwick (1785-1873), Woodwardian Professor of Geology, and the great historian and philosopher of science Rev. William Whewell (1794-1866), Master of Trinity College. Darwin later geologized with Sedgwick, as we shall see below, and wrote that, "Dr. Whewell was one of the older and distinguished men who sometimes visited Henslow, and on several occasions I walked home with him at night." (Barlow 1958, p. 66). One would like to know what they discussed.

Darwin attended Henslow's botanical lectures while at Cambridge, "and liked them much for their extreme clearness, and the admirable illustrations; but I did not study botany." He also participated in Henslow's class field trips to view plants and animals in the Cambridge area: "these excursions were delightful." (Barlow 1958, p. 60). Darwin and Henslow became close friends, and Henslow "influenced my whole career more than any other." (Barlow 1958, p. 64). This influence and friendship are discussed more fully in Darwin's "Recollections of Professor Henslow" (Darwin 1862a). One botanical anecdote bears repeating (Barlow 1958, p. 66):

> "I cannot resist mentioning a trifling incident, which showed his kind consideration. Whilst examining some pollen-grains on a damp surface I saw the tubes exserted, and instantly rushed off to communicate my surprising discovery to him. Now I do not suppose any other Professor of Botany could have helped laughing at my coming in such a hurry to make such a communication. But he agreed how interesting the phenomenon was, and explained its meaning, but made me clearly understand how well it was known; so I left him not in the least mortified, but well pleased at having discovered for myself so remarkable a fact, but determined not to be in such a hurry again to communicate my discoveries."

He would show such reticence later in first publishing his evolutionary ideas.

The Rev. Jerry Falwell once spoke of Darwin as "a theological school dropout." Falwell was wrong on both counts. Cambridge was not a theological school, although a man had to have a degree from Cambridge or Oxford in order to become a priest in the Church of England. Darwin graduated from Christ's College, Cambridge at the end of Easter Term in 1831. Although he later wrote that, "During the three years which I spent at Cambridge my time was wasted, as far as the academical studies were concerned, as completely as at Edinburgh and at school." (Barlow 1958, p. 58), Darwin graduated tenth out of 178 students who did not take an honors degree that year (Shipley 1924).

Following graduation, "Henslow then persuaded me to begin the study of geology." (Barlow 1958, p. 68). Darwin soon found himself in the field with Sedgwick, mapping the surface geology of North Wales. On his return from this short trip in August 1831, the fateful letter from Henslow announcing that Captain Robert Fitzroy (1805-1865) was seeking a gentleman naturalist to accompany him on a two-year surveying voyage to South America awaited him. Henslow had recommended Darwin. After overcoming his father's objections and several delays, Darwin set sail from Devonport on HMS *Beagle* on 27 December 1831.

THE *BEAGLE* VOYAGE

"The voyage of the *Beagle* has been by far the most important event in my life and has determined my whole career" (Barlow 1958, p. 76). While on this almost five-year voyage, Darwin paid close attention to geology and zoology. But he did not neglect botany, beginning his plant collecting in the Cape Verde Islands, the first landfall (Porter 1983). His *Beagle* "Geological Diary" and "Geological Notes" cover 1383 pages and the "Zoological Diary" 368 pages. There is no "Botanical Diary", but about 20% of the pages of the "Zoological Diary" are devoted to plants, including fungi and lichens (Porter 1987). Darwin's geology notebooks were the source materials for the

three books subtitled *the geology of the voyage of the Beagle* (Darwin 1842, 1844, 1846) and 12 papers in journals. (Barrett 1977). Likewise, the zoology notebooks produced the five-part *Zoology of the Beagle* (Darwin 1839-1843) and a further 4 papers (Barrett 1977). The book now known as *The voyage of the Beagle* (Darwin 1839, 1845) was drawn from his personal journal, parts of which were sent home to his family from time to time. It has been continuously in print since 1839.

Before Darwin left England, Henslow apparently had agreed to identify the plants that he collected. However, because of the press of other duties, Henslow never seemed to have much time to do so and called on his friend William Jackson Hooker (1785-1865), Regius Professor of Botany at Glasgow University for help (Porter 1980a, 1984a). Hooker identified some collections, mainly Asteraceae, and helped Henslow write two papers on some of Darwin's specimens (Henslow 1837, 1838). Later, some of the collections were identified by Hooker's son, the botanist Joseph Dalton Hooker (1817-1911), in his *Flora Antarctica* (Hooker 1844-1847). Darwin was particularly keen to have his Galapagos Islands plants identified, and J. D. Hooker, who soon became Darwin's best friend and confidant and Henslow's son-in-law, did so (Hooker 1847a). He also used them to write the first phytogeographic study of the archipelago (Hooker 1847b).

This is where our paths begin to cross. After I received my Ph.D. in 1967, the late Ira L. Wiggins, Professor of Botany at Stanford University, under whose guidance I had received my M.A., invited me to become a postdoctoral assistant on a study of Galapagos plants. Our collaboration resulted in *Flora of the Galapagos Islands* (Wiggins & Porter 1971). Curious about how our flora compared with that of Hooker (Wiggins and I authored different families and had 19 collaborators; I had not seen any but my own contributions before the book was published), I compared the two. I was horrified to find that 47 of the names used by Hooker were not in our flora. I later established that all but one or two of the differences were due to Hooker's misidentifications or use of names that are now considered synonyms. This led to a desire to see Darwin's Galapagos specimens.

In 1973, my wife and I had a vacation in Britain. During this time, we visited the Cambridge University Herbarium, where the first set of Darwin's *Beagle* vascular plant collections reside. Peter Sell, then Assistant Curator, brought out what looked like some old over-sized shoe boxes and revealed the specimens. I looked at a dozen and said, "Most of these havn't been identified." Peter answered, "No one here at Cambridge has ever been much interested in the flora of South America. Why don't you identify them?" I pondered a bit, took Peter's advice, and got a grant from the American Philosophical Society. The summer of 1976 was spent at Cambridge and the Royal Botanic Gardens, Kew, where the second set resides, and the Hookers worked, studing Darwin's Galapagos plants. This resulted in an historical and taxonomic study (Porter 1980b). At the same time, I had followed Hooker's lead and studied the phytogeography of the islands (Porter 1976). This latter interest led to a series of papers, culminating in one presented at a meeting of the Linnean Society in 1983 (Porter 1984b).

Being a taxonomist, I was also interested in the history of Darwin's plant collections. This led to a paper presented at the Natural History Museum in London in 1979 (Porter 1980a). After my presentation, I went to lunch with three Darwin experts (David Kohn, the late Sydney Smith, and the late David Stanbury), who told me that I should now identify the rest of his *Beagle* plants. The next year, with a grant from the National

Geographic Society, my family and I spent ten months at Cambridge while I did so. This resulted in a paper that filled a single issue of the *Botanical Journal of the Linnean Society* (Porter 1986). While we were in Cambridge, Darwin's notes on his *Beagle* plants, which I had hypothesized might turn up some day (Porter 1980a), along with those of Henslow, were discovered by herbarium assistant Rita I'Ons (Porter 1981). Rita's discovery led me to search out all Darwin's manuscript materials on his *Beagle* plants and publish them (Porter 1987). Along the way, the histories of all his collections, botanical (including algae and fungi), geological, and zoological were ferreted out (Porter 1985).

While he was on his voyage, Darwin collected 1445 specimens of vascular plants. Although he was in the Galapagos for only six weeks, he made 224 collections there. In contrast, in Chile, where he spent a total of 22 months, he made only 248 collections (Porter 1999). Not only the geology and the zoology of the Galapagos appear to have caught his interest there. Indeed, evidence from all three fields helped lead Darwin to become an evolutionist.

BOTANY AFTER THE VOYAGE

Following his return to England in October 1836, Darwin's time initially was spent in putting his collections in order and trying to find experts to identify them. The plants he left to Henslow and later Hooker, as we have seen above. Much of his time was devoted to working up the geology and zoology. There were a few letters of inquiry to the *Gardeners' Chronicle* in the 1840s regarding flowers, seeds, and leaves but nothing of great import. However, following discussions with J. D. Hooker in 1855 on dispersal mechanisms in plants, Darwin began a series of experiments in which he immersed seeds in salt water for various lengths of time. These experiments resulted in several notes in the *Gardeners' Chronicle* (Barrett 1977) and a longer paper (Darwin 1857). Earlier, in 1846, Hooker had told Darwin that one could not truly understand how species arose until he had done a taxonomic study of a large group of organisms. This resulted in Darwin's eight year, four volume study of barnacles (Darwin 1851a, 1851b, 1854a, 1854b), a classic monograph.

After the barnacle research was completed, Darwin returned to gathering information on how species were formed, research begun in 1836. He wrote to a number of naturalists around the world and continued combing the literature for useful data. One of his correspondents in the Dutch East Indies, the naturalist and collector Alfred Russel Wallace (1823-1913), had recently published a paper (Wallace 1855) that the geologist Sir Charles Lyell (1797-1875) had brought to Darwin's attention. Lyell, an old friend, was one of the few privy to Darwin's evolutionary ideas (Porter 1993). Realizing that Wallace was thinking along the same lines as Darwin, Lyell was afraid that Wallace might scoop him and urged Darwin to get his ideas down on paper. This led Darwin to begin work on what he called his "Big Book," titled *Natural selection*, most of which was not published until 1975 (Stauffer 1975).

It was while writing *Natural selection* in June 1858 that Darwin received the fateful letter announcing Wallace's ideas about species change that resulted in the publication of their so-called "joint paper" (Darwin & Wallace 1858). Darwin began immediately to write an abstract of *Natural selection*, which he first envisioned as a 30 page paper, but which grew into the 511 page *On the origin of species* (Darwin 1859). Following its publication, Darwin was criticized by many for not citing the sources of his many

data. Readers were unaware that the citations were in the bibliography of *Natural selection*. In 1860, Darwin began to mine this work for the first of three projected books intended to supplement *The origin*. Because of illness off and on during the 1860s, *Variation under domestication* was not published until 1868 (Darwin 1868), while the other two were never written. *Variation*, based on the first three chapters of *Natural selection*, had plenty of information on plants in it, both from the literature and from personal observation. What it lacked, like *The origin*, was any discussion of human evolution. This lack was later rectified by the publication of *The descent of man* (Darwin 1871), his second most controversial book after *The origin*. *The expression of the emotions* (Darwin 1872) resulted from data that were too voluminous to be included in *Descent*. Darwin wrote on the evolution of his own family in a preliminary essay to a translation of a scientific biography of his grandfather Erasmus by the German botanist Ernst Krause (1839-1903). Darwin's essay (Darwin 1879) was longer than Krause's original contribution.

It was after the publication of *The origin* that Darwin's botanical research came to the fore. Searching for adaptations arising through natural selection, Darwin discovered the pollination mechanisms of orchids. Several years of data gathering and experimentation yielded another book, *Fertilisation of orchids* (Darwin 1862b). Interest in pollination led to more experiments and the publication of papers on primroses (Darwin 1862c), flaxes (Darwin 1863), and loosestrifes (Darwin 1864). The first two explained the phenomenon of distyly in flowers, the third announced the discovery of tristyly. These papers, plus data from further experiments in the 1860s and '70s, eventually resulted in another book, *Forms of flowers* (Darwin 1877). The year before, Darwin had published the results of a long series of crossing experiments with other plants, begun in the 1860s, as *Cross and self fertilisation* (Darwin 1876). "This survey of the nature of the mechanisms favouring cross fertilisation and the advantages to be gained by it was considered by Darwin to form a complement to that on the "Fertilisation of Orchids." (Freeman 1977, p. 152).

With all these plant experiments being undertaken, Darwin decided that he needed a hothouse, which was built early in 1863. The hothouse was first used to house tender plants borrowed from the Royal Botanic Gardens, Kew, where J. D. Hooker was now Assistant Director to his father. Growth phenomena were studied in these plants, particularly their adaptations for climbing. This study originated when Darwin read a short paper by his friend Asa Gray (1810-1888), Fisher Professor of Natural History at Harvard University, on the movement of tendrils in the wild cucumber (Gray 1858). Darwin obtained seeds from Gray and began observations on climbers, which culminated in another book, *Climbing plants* (Darwin 1865). Further experiments on stem and leaf movements led to yet another, *Power of movement in plants* (Darwin 1880).

As if this wasn't enough, while on holiday in 1860, Darwin had noticed a sundew on the edge of a path that had trapped some insects on the sticky trichomes (he called them "tentacles") of its leaves. Hence was born another long-term study, worked on over a series of years, to investigate how small amounts of substances could make these trichomes move. *Insectivorous plants* (Darwin 1875), then, was not a study in natural history, as one might assume, but a study in plant physiology.

Darwin's final book, on earthworms (Darwin 1881), was also based on research begun long ago, this time in the late 1830s and '40s. In this eminently readable book, Darwin relates a number of personal observations on earthworms, both in the field and

lab. Noting that earthworms in his garden frequently dragged leaves into their holes in order to eat them, Darwin experimented with pieces of paper in order to work out the shapes of leaves that they preferred. They also showed a preference for the leaves of *Rhododendron*. Darwin had his son Francis (1848-1925), who served as his research assistant, play his bassoon to them to check the acuity of their hearing. Today, the parlor of Down House, Darwin's home in Kent, is set up to illustrate his earthworm experiments, including Francis' bassoon on display.

After Darwin's death, Francis Darwin edited six volumes on his father's letters (F. Darwin 1887, 1892; F. Darwin & Seward 1903). These included about 20% of Darwin's presently-known correspondence. Unfortunately, the letters were edited and censored by Francis Darwin, without indication of where omissions had been made. In 1974, Frederick Burkhardt and Sydney Smith began a new, unexpurgated edition of Darwin's correspondence, which has now published 11 volumes (Burkhardt, et al. 1985-1999). Volume 11 covers the year 1863, when crossing experiments and climbing plants kept Darwin's attention. The volumes to come will contain much botany.

EPILOGUE

Charles Darwin died on 19 April 1882, aged 73. During his lifetime, he had published 20 books, two of two volumes each. Nine of these were devoted to botany, wholly or in part. He produced second editions for eleven of his books; *The origin* went through six editions. After Darwin's death, second editions of two books and third editions of three other books were published, augmented with additional material that he had amassed. In addition, he published about 170 papers (Porter & Graham 1993). I figure that from 1837 to 1881 Darwin published an average of over 300 pages a year.

There are a number of persistent myths about Darwin. One is that he never would have gotten tenure in an academic position because he did not publish much after the *Beagle* voyage. Another is that he retired to Down House after the *Beagle* voyage, was sick a lot, and didn't do much. I hope that this presentation convinces you that these assertions are both false.

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