John Herschel and Charles Darwin: A Study in Parallel Lives*

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Geniuses are those who in their capacity to synthesize overwhelm.

F. Manuel

INTRODUCTION

It is appropriate that an essay dedicated to Frank Manuel should deal with books. But my concern will be with books as metaphors, and with metaphors as constraints and aids in elucidating the workings of nature. This dialectical aspect of metaphors has often been noted: a metaphor can be constraining to one thinker and simultaneously be the vehicle for a creative leap to another. Metaphors, analogies, and models are the means by which we use some pieces of our knowledge to help us structure and gain insight into other parts. Although I shall not define my usage of the term “metaphor,” let me remark that I will be primarily concerned with the visual evocation of metaphors rather than with their rhetorical dimension.1

Metaphors, like paradigms, come in all sizes. Some govern all aspects of a person’s intellectual life. Others are more limited in scope. The fruitfulness of the latter seems to stem from the fact that the boundaries of their domain of applications are not fixed: they can be altered to explore new applications. The metaphor of the mechanical clock in Newton’s construction of the heavens and its legacy illustrate the power of metaphors in the development of scientific thought. Another example is the well-known metaphor of the two books, which states that God wrote the Book of Scripture and the Book of Nature in different characters. God’s words were

* For Frank Manuel — teacher, friend, colleague. With respect and affection.


made known to man through revelation; the understanding of
God's works was to be attained through the decipherment of the
operation of nature. Both books attest to God's infinite wisdom,
omnipotence, and goodness, but they refer to different domains
and were to be kept separate — thus guaranteeing theological and
scientific autonomy. The metaphor first received its wide currency
in Francis Bacon's *Advancement of Learning*. It became the offi-
cial doctrine of the Royal Society and was accepted by almost all
English men of science. Its hold on the minds of these practitioners
well into the nineteenth century can readily be documented.

One of the two aphorisms that Charles Darwin set facing the
front page of the first edition of the *Origin of Species* was from
Bacon's *Advancement of Learning*. Its message was "... let no
man ... think or maintain, that a man can search too far or be too
well studied in the book of God's word, or in the book of God's
works; divinity or philosophy; but rather let men endeavor an
endless progress or proficiency in both." Darwin was quoting
Bacon to bolster his case for the autonomy of scientific inquiry —
the liberating interpretation of the metaphor. Its constricting effect
is displayed in its use during the controversy that raged after the
publication of the *Essays and Reviews*.

In 1860, several liberal theologians issued a plea to the
Anglican clergy to reexamine some of their beliefs in the light of
biblical criticism. Coming on the heels of the publication of the
*Origin*, the *Essays* created a storm. The anger of the conservative
prelates of the Anglican church was enormous, and at the instiga-
tion of the Bishop of Oxford, Samuel Wilberforce ("Soapy Sam"),
the essayists and reviewers were prosecuted. Their case came to
the House of Lords, where they were vindicated. Three years later
the bishop's forces rallied once again and won the condemnation
of liberal bishop J. W. Colenso. In 1864, soon after the appear-
ance of a declaration signed by many of the Anglican clergy
protesting the opinions contained in the *Essays and Reviews*, a


3. Charles Darwin, *On the Origin of Species by Means of Natural Selection,
or, The Preservation of Favoured Races in the Struggle for Life* (London: John
Murray, 1859; reprint ed. with introduction by E. Mayr, Cambridge, Mass.:

4. See, for example, J. R. Moore, *The Post-Darwinian Controversies* (Cam-
bridge: Cambridge University Press, 1979); P. Appleman, A. Madden, and M.
Wolff, eds., *1859: Entering an Age of Crisis* (Bloomington: Indiana University
document of similar intent was circulated among men engaged in scientific pursuits. It declared:

We the undersigned students of the Natural Sciences desire to express our sincere regret that researches into scientific truth are perverted by some in our own times into occasion for casting doubt upon truth and authenticity of the Holy Scriptures. We conceive that it is impossible for the Word of God, as written in the Book of Nature, and God's Word written in Holy Scripture, to contradict one another, however much they may appear to differ. We are not forgetful that Physical Science is not complete, but is only in a condition of progress, and that at present our finite reason enables us only to see as through a glass darkly and we confidently believe that a time will come when the two records will be seen to agree in every particular. We cannot but deplore that Natural Science should be looked upon with suspicion by many who do not make a study of it, merely on account of the unadvised manner in which some are placing it in opposition to Holy Writ.

The metaphor of the two books was part of the metaphysical baggage carried by everyone educated at Cambridge or Oxford during the first half of the nineteenth century. How was Charles Darwin able to free himself from its hold and come to the conclusion that a new interpretation of the Book of Nature had to be written? (It is no accident, I believe, that he often referred to his large manuscript on species and speciation, as my "Big Species Book." I shall address this question by comparing Charles Darwin with John Herschel, another eminent Victorian scientist, who in his day was considered by his countrymen to be the outstanding scientist. A man of polymathic interests, Herschel made important contributions to mathematics, astronomy, geology, light, sound, electricity, magnetism, chemistry, photography, and a host of applied fields. His astronomical researches are still

5. The declaration was circulated by Herbert McLeod of the Royal College of Chemistry. It may be found in Charles Daubeny's Miscellaneous: Being a Collection of Memoirs and Essays on Scientific and Literary Subjects Published at Various Times, 2 vols. (Oxford and London: James Parker, 1867), II, 129—130. Daubeny's letter to McLeod indicating the reason for his withholding his signature from the declaration is to be found in that volume on pp. 130—133.

valuable, and his catalogs of star clusters and nebulae were unmatched in their accuracy and thoroughness. Although his scientific investigations did not secure him a place alongside Faraday and Maxwell, his mathematical investigations set the standards for mathematical research in England for the subsequent generation. His *Encyclopaedia Metropolitana* articles on "Physical Astronomy," "Light," and "Sound" were the paradigms upon which the mathematical physics tradition at Cambridge were founded. His *Preliminary Discourse on Natural Philosophy* deeply influenced the generation of aspiring scientists of early Victorian Britain. The *Preliminary Discourse* also shaped the philosophical debates on the methodology of science in Great Britain during the half century following its publication. His essays in the *Quarterly Review* and the *Edinburgh Review* have become classics. His popular scientific books and his entries in the *Encyclopaedia Britannica* were important vehicles for disseminating to the literate public the advances of science, particularly those in astronomy, physical geography, and meteorology.  

Both John Herschel and Charles Darwin were Cambridge products. Both had an abiding interest in geology and in natural history. During the 1830s their scientific researches converged on that "mystery of mysteries": the question of how new species arose. At that time, Herschel could publicly state that he believed that this process might well be a *natural* one, but he could go no further; in 1860, after the publication of the *Origin*, he criticized natural selection, and rejected its claims. Darwin, on the other hand, partly stimulated by Herschel's remarks condoning natural interpretations of the origin of species, spent over twenty years after his return from his voyage on the *Beagle* accumulating the evidence for natural selection, the mechanism for speciation that he advanced in the fall of 1838. How could these two remarkably gifted men looking at the same data in the 1830s see part of the world so similarly, yet give such different accounts for the dynamics of its change?  

It was Frank Manuel's remarkable biography of Newton⁸ that

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shattered the long-held image of the physical scientist as the "solitary embodiment of pure reason" and demonstrated the value and relevance of a psychohistorical approach in the writing of scientific biography. Subsequently, Howard Gruber's impressive study of the young Darwin\(^9\) gave further proof of the importance of trying to write the history of science in a way that encompasses the affective springs of scientific interest and inquiry.

Having studied the lives of both John Herschel and Charles Darwin, I became intrigued with the possibility that a comparative approach might yield insights that a study of each one individually could not.\(^10\) Even though they belonged to different generations — Herschel was born in 1792, Darwin in 1809 — their cultural, economic, and social backgrounds and their education were sufficiently similar to warrant the attempt. There are indeed many parallels between the Herschel and Darwin families. Both had benefited from the industrial revolution and the demographic explosion that had propelled England to the position of being the dominant economic power in Europe. Both Herschel’s and Darwin’s families were well off, allowing them to cultivate their polymathy as independent amateurs. Both families could be judged "outsiders"; the Darwins because of the liberality of their political and religious views, the Herschels because of their Jewish ancestry and because John’s father, William, had deserted the Hanoverian army (in fact, his sentence was commuted only after his discovery of Uranus).\(^11\) Both families belonged to what Noel Annan has called the British aristocracy of intellect of the nineteenth century.\(^12\)

I should stress at the very outset that I am not in search of a single causality, nor of a canonical explanation for their creativity. Herschel and Darwin were remarkable individuals, too singular in their gifts to be fitted into a ready formulaic explanation. Yet I do believe that hints toward possible interpretations can be obtained by trying to delineate their world-views and seeking to understand how their metaphysical beliefs shaped key aspects of their work. Not unexpectedly, perhaps, we shall find that Herschel and


\(^10\) I was clearly influenced in this by Steve J. Heims's sensitive and erudite study, *John von Neumann and Norbert Weiner: From Mathematics to the Technologies of Life and Death* (Cambridge, Mass.: MIT Press, 1980).


Darwin attached very different importance to time and history by virtue of their metaphysical commitments.

My paper is organized as follows: After biographical sketches of John Herschel and Charles Darwin (sections I and II), I consider briefly Herschel's reaction to his father's and Laplace's nebular hypothesis (section III) and outline how his scientific productions were shaped by his "metaphysics" concerning time and history (section IV). Herschel's views are then contrasted with those of Charles Darwin (section V). The essay concludes with some remarks on fathers and father figures (section VI).

I. JOHN HERSCHEL

John Herschel was an only child. When he was born on March 7, 1792, in Slough, his father, the great astronomer William Herschel, was fifty-four years old. William was an autodidact who pursued his intellectual interests single-mindedly. He had taught himself mathematics, astronomy, and optics while earning his living as an organist in Bath. Later, after he discovered the Georgian planet and a royal pension allowed him to give up his musical activities and become a full-time astronomer, he spent every night, whenever the weather permitted, peering through his telescopes; his daytime activities were divided between building telescopes — whose sale substantially supplemented his pension — and writing up his observations.

William was an obstinate man, and "once his mind was made up, he allowed nothing — and no one — to stand in his way." At the time of the discovery of Uranus, neither a series of disasters during the construction of his telescopes — the glass disks for his mirrors kept on breaking — nor the pressures of combining his astronomical passions with the demands of his livelihood as a musician altered his course. In the process he sacrificed "almost without noticing" the career of his sister Caroline as a singer. His stubbornness and his inability to listen or to take his friends' advice led him constantly into unhappy controversies.

John's mother, Mary Baldwin, had been married to a prosperous London merchant, John Pitt, before her marriage to William, and had had a son by him who had died. She was forty-two at the time of John's birth. She was described as a "woman of singular amiability and gentleness in spirit." Caroline Herschel,

William’s sister, who became his associate in his astronomical researches and an eminent observational astronomer in her own right,\textsuperscript{15} and who had devoted herself to looking after his household from the time she had come to England in 1772, was much distressed when William married and she “detached herself from the family circle” when John was six. Caroline was strong-willed, energetic, and quite gifted. John, as a young boy, spent many holidays with his aunt, after her departure from the household, “dedicated to making experiments in chemistry.” A visitor to the house in 1799, a Dr. Burney, referred to the “delicate blue-eyed, little boy” John as “entertaining, promising, and comical.” When he was ten, John went to Eton, whose schoolmaster at the time was Dr. Gretton. Eton, like other public schools of those pre-Arnold days, was “better fitted for the development of bullies than for the production of true gentlemen.”\textsuperscript{16} As Eton was close to Slough, his mother visited him often; upon becoming aware of the treatment he had to endure there, she had him removed from the school and educated at home until he entered Cambridge in 1809. There may have been hidden costs to John’s mother’s attempts to protect her son, for it requires courage to survive on one’s own terms in such surroundings. A student in an English public school — even though these schools catered to certain class interests and were highly regimented — was exposed to a variety of life-styles and views through the background of the other students. It has been suggested that such an experience can encourage independence and help develop autonomy;\textsuperscript{17} by being educated at home, Herschel found himself enmeshed in a strong relationship of dependency. But he grew up in a rigorous home environment, feeling the responsibility of being a Herschel and fully conscious of the expectations that had been invested in him.

Charles Babbage, who became a close friend of John Herschel after they met at Cambridge, recalled in his autobiography that in one of their trips together to the continent, he, Babbage, alluded to the advantages of inheriting a distinguished name — and Herschel disagreed. Babbage quotes him as asserting: “For my own part, I think it a great disadvantage. Such a man must feel in the position

\textsuperscript{15} A. Clarke, \textit{The Herschels and Modern Astronomy} (London: Cassell, 1895).
\textsuperscript{16} Quoted from the \textit{Dict. Natl. Biog.} entry for John Herschel.
\textsuperscript{17} The role of schools in fostering independence has been expounded by C. Camic, \textit{Experience and Enlightenment: Socialization for Cultural Change in Eighteenth-Century Scotland} (Chicago: University of Chicago Press, 1983), as a factor to account for the clustering of the talents responsible for the Scottish Enlightenment.
of one inheriting a vast estate, so deeply mortgaged that he can never hope, by any efforts of his own, to redeem it."\textsuperscript{18}

John exhibited remarkable abilities at a young age; the private tutoring he obtained at home and the stimulating family surroundings enabled him to develop his talents. Thus in his first year at St. John's College Herschel mastered the entire \textit{Principia} in Latin, whereas most students read the few required sections of it in an English translation. He was at that time described by the poet Thomas Campbell as "a prodigy in science, and fond of poetry, but very unassuming."\textsuperscript{19} He distinguished himself by graduating in 1813 as the senior wrangler and the first Smith's Prizeman, and he was elected to a fellowship at St. John's and also made a fellow of the Royal Society. There is ample evidence that much was expected of him, and not only by his father. Laplace, upon receiving a copy of the \textit{Memoirs of the Analytical Society} — the journal of the mathematical society that Herschel, George Peacock, and Babbage had organized as undergraduates — wrote William Herschel in July 1814: "I have only scanned, so to say, the \textit{Mémoires} of your son, but what I have read, suffices to make me see that he is destined to make for himself a similar reputation in the mathematical sciences as that of his father in astronomy."\textsuperscript{20}

William Herschel wanted his son to enter the church, whereas John — who had been confronting his religious beliefs and practices while at Cambridge — favored a career as a barrister. The letters from William to John in the fall of 1813 reveal the tensions between father and son. It required the efforts of John's mother to restore a modicum of good will to their relationship. In January 1814 John did enroll in Lincoln's Inn, and he was eventually admitted to the bar. Although father and son made their peace, the victory was hollow, the psychological cost to John of asserting himself and standing by his decision was high. When, during the summer of 1814, Babbage married against his father's will, John wrote him a letter that betrayed "his horror" at Babbage for having quarreled with his father.\textsuperscript{21}

\textsuperscript{18} C. Babbage, \textit{Passages from the Life of a Philosopher} (London: Longmans, Green, 1864), pp. 1–2.
\textsuperscript{19} Quoted from the \textit{Dict. Natl. Biog.} entry for John Herschel.
\textsuperscript{20} Laplace to W. Herschel, July 17, 1814. The letter is on deposit at the Library of the Royal Astronomical Society in London; it is also to be found in the microfilm collection of the papers of William and John Herschel that the RAS and the Royal Society of London have issued.
\textsuperscript{21} "Your step has been decided — you plunge deep indeed. 'I am married, & have quarrelled with my Father' — Good God Babbage — how is it possible for a man calmly to sit down and write those sentences — add a few more which look like self-justification — and pass off to functional equations" (J. Herschel to C. Babbage, August 7, 1816, Babbage Correspondence, British Museum).
It became clear to Herschel quite early while at Lincoln's Inn, that he was not cut out to be a lawyer. A good deal of his time thereafter was spent working with William Hyde Wollaston, whose extensive chemical and optical researches had won him wide acclaim. Wollaston had invented the *camera lucida*, had discovered the absorption lines in the solar spectrum, and had made a small fortune in developing chemical methods for refining platinum. Herschel also spent many nights while in London using James South's telescopes.

The period from 1813 to the summer of 1816 — when his father became ill and he decided to become his apprentice and assistant — was one of great stress for John. His personal crisis centered around problems of career, sexuality, and conflicts with his father. Unusually gifted in music, in mathematics, and in the sciences, John resisted making a total commitment to any one field. This was in marked contrast to his father, who first as a professional musician, and later as an astronomer had thrown himself into the task at hand with single-mindedness. John also developed very strong feelings against doing science "as a matter of duty & profession." 22

Herschel's letters to John William Whittaker, one of his closest friends at Cambridge, reveal the deep ambivalences he was experiencing. 23 The following excerpts are illustrative:

**Summer 1812**

Dear Whittaker, Behold thou are destined to be greatly honoured, I have chosen thee as a *vessel of wrath*, wherein I mean to discharge the overflows of my anger. . . .

Why the deuce did I ever leave Cambridge. . . . I make it a point of conscience to get drunk every day, and live in other respects a very irregular life, although travelling — I was this evening at Stonehenge, but having a head none of the clearest, saw not a single stone. . . .

A letter dated July 20, 1813, reads in part:

Every moment that I have nothing else to do I devote (at the utmost not 3 hours in the day) to the only study which affords me full and entire satisfaction — But analysis is not the object of human existence, nor the bond of human society. . . .

22. J. Herschel to W. Whewell, August 17, 1826, Add Ms a 207 12, Trinity College Library.

23. These letters are in the archives of the library of St. John's College at Cambridge. I thank the archivist of St. John's for permission to quote from them.
Meanwhile my habits are daily becoming more sedentary & insulated and my reflections daily of a more sombre cast. If this lasts (as I do not think it will) I know not, nor care not what will come of it.

Two days later, he added:

When I look back on my college existence, short as is the period which has separated me from it, it seems but as the vivid & evanescent dream of a child — just so I used to look back on the time I spent at school — and just so shall we all, one time or another, look back on the period of our present existence, with a mixture of pleasure and pity. We work our way onwards through a fog which magnifies trifles, which dilates the circle of objects immediately around us into a wide amphitheatre in which we stand like the hero of a fairy tale surrounded with giants and dwarfs and disproportionate existences.

His depression and despondency during that period were often total, and he saw the whole world despairingly:

Do you not perceive in the present situation of our domestic affairs every symptom which has been held forward as the characteristic of decaying greatness — Indecision in our measures abroad, pusillanimity in our conduct at home. With famine and discord gnawing at out vitals, we fancy ourselves arbiters of the destiny of Europe. . . . Look at our overgrown Metropolis and the hundred tumours of the second magnitude which have arisen in every limb of this diseased & corrupted body. . . . The nation is apoplectic. — Choked with its own population — overloaded with its useless manufacturers & decayed commerce, it stands in need of no simple or common remedy. — The sin has been crying, and the expiation must be vast, & sweeping and satisfactory.

There were also manic periods. Sometime during 1815, Herschel wrote Whittaker:

Sunday morning, Date unknown — Latitude and Longitude not determined. Wind NNE. Current of ideas but 2 knots an hour.

By what I have written you will be enabled to form a pretty correct estimate of the state of my head, which is at present full of the most incongruous phantasm. — I am this moment reading the 2d vol of Lacroix' new edition — analysing a series of
metallic alloys, calculating the orbits of the satellites of Uranus from about 500 observations of my Father — making a course of experiments on the solubility of salts — reading Newton’s Optics, & learning Italian for the purpose of cramming up some MSS OF Ruffini on the resolution of Algebraic = m [equations] which have fallen in my hands. Add to this that I am composing 3 treatises in Greek against Arianism, & correcting the proofs of a novel entitled

The
VIC'TIM OF VILLAINY
or
Travelling Tetrahedrons

the production of a particular friend of mine.

When immersed in his work, and in a happy mood, Herschel’s output was enormous. Interestingly, he had an insight into the stimuli for his creativity. In the spring of 1818 he wrote Babbage:

By the bye what a beautiful toy that same kaleidoscope is. Do you not think the principle might be extended. Invention consists in rapidity and variety of combination, backed by a discriminating judgment to select the best — Many a man of excellent taste & judgment is not inventive for want of a fluency (if one may use such a phrase) in the art of combination. Now if you can make accident do the work of association (wch is nine tenths accidental?) and do it quickly, so as to run through ten times the same variety of combinations in the same time, you furnish such a man with the very thing he wants. I have often I think mentioned to you the assistance I have derived from reading down the table of contents of some extensive work. It suggests a variety of combinations with great rapidity, & I have more than once been indebted to it for a good idea, a thing one would not be very ready to confess but for the good of Science.24

The letters from Herschel to Whittaker also reveal his anti-clericalism, and his struggles with the meaning of religion. They shed light on the reasons he was so opposed to his father’s sugges-

24. J. Herschel to C. Babbage, April 27, 1818, Babbage Correspondence, British Museum.
tion that he enter the church. In a letter in the summer of 1813, Herschel ranted against fellow labourers in the beehive of the church. For verily the church is the Lord's beehive, and many are the drones which do infest the same... 

Join with me, Whittaker, in the wish and prayer that religion, as established by law may never entirely usurp the superiority & control over religion, established by nature.

That same summer, in a postscriptum to one of his letters, he informed Whittaker that "[d]uring these last two or three months I have thought more than in all my life before, and I venture to hope to good purpose. Do not however suppose from this that I am going to turn Methodist or high churchman, or even religionist in the received sense of the word. Heaven forbid! But I will not trouble you with my creed at present...." He did remain a firm theist, becoming more conservative and more staunchly devout as he grew older.

Herschel's correspondence suggests possible homosexual overtones to his friendship with Whittaker. His letters in the summer of 1813 are addressed "Dearly beloved Whittaker" or "My sweet Whittaker" or "My sweetest, prettiest, loveliest and most adorable Whittaker." Early Victorian modes of addressing close friends were effusive. It would not, however, have been unusual for students at Eton and Cambridge to be lovers. In one of his letters to Whittaker, Herschel informed him that "[i]n short I must know all that is going at Cambridge or (as one should say with propriety) 'in the flesh.'" But in another letter, he advised Whittaker to "leave Cambridge and Mathematics to shift for themselves, and mix more in the society of females than you seem to do...." Whatever his ties to Whittaker, John also confided to him that he longed for "a kiss, or a squeeze of the hand" from a woman.

Ideological issues were also perturbing Herschel at that time. In a letter to Babbage in 1812 he had expressed his admiration for the aims of the French Revolution.25 In the summer of 1814, Herschel wrote Whittaker: "I have been these three weeks in London, . . . I have lived long enough. — What should such a poor sniveling democratic dog do in this aristocratic world? — I found all the population in Town frantic & in high monarchy spirit. . . ."

25. Herschel addressed his letter to Babbage "Citizen: Your letter of 20th reached me . . .," and signed it "I remain Citizen; yours sincerely, J. Herschel" (Herschel to Babbage, July 1, 1812, Babbage Correspondence).
There existed an unresolved tension between Herschel's identification with democratic bourgeois ideals — in which merit, industry, and talent were rewarded — and his attraction to aristocratic and religious values — which he felt were necessary for the stability of the social order, and which allowed him to do science "en amateur."

The picture of Herschel that emerges from his letters is that of an amazingly gifted young man with a melancholic disposition, whose psychological equilibrium was delicately balanced between periods of depression and periods of mania. This was to be the case throughout his life. Maria Edgeworth, who became acquainted with Herschel during his Cambridge days, observed in 1827 that "[Herschel] is not only a man of the first scientific genius, but his conversation is full of information on all subjects, and he has a taste for humor and playful nonsense, though with a melancholy exterior. . . ."26 After Herschel married in 1829, Maria Edgeworth became a close friend of the family. She gave the following assessment of Herschel to Harriet Butler in 1843, after having visited the Herschels:

Refined he is highly in sentiment and conversation and sensitive far too much for health and happiness — mimosa sensitiveness that shrinks from every touch not merely of blame, but even from the very intimacy he most wishes to have. Captain Beaufort well observed "Herschel's great want in life is sympathy and yet he repels it. His shyness or reserve of manner is so great even to me," said Captain Beaufort, "that I cannot get at him and am tired of trying." I can only say it was not so with us. The light within burst through the dark visage and in the 4 days we learned more of his character than I have done with others in 4 years — and there was more to learn. He is on the verge of the dreadful danger of over wrought intellect — over excited sensibility. In his earlier life when disappointed in love he shut himself up in darkness for I don't know how many weeks and would let no mortal see him and even at later times when vexed in friendship or when scientific things go wrong he

26. Augustus J. C. Hare, ed., The Life and Letters of Maria Edgeworth, 2 vols. (Boston and New York: Houghton Mifflin, 1895), II, 503. Herschel's lighter side is revealed in the following excerpt from Maria Edgeworth's letter: "Have you heard of the live camelopard, 'twelve foot high if he's an inch, ma'am'? Herschel is well acquainted with him, and was so fortunate as to see the first interview between him and a kangaroo: it stood and gazed for one instant and the next leaped at once over the camelopard's head, and he and his great friend became hand and glove" (II, p. 504).
betakes himself to darkness and solitude and in abstraction shuts himself up from the external universe. Very very dangerous! Solitary confinement even to the innocent — and even to the stupid a very hazardous experiment! 27

In 1816 when his father became gravely ill, John committed himself to completing William’s astronomical work, thus accepting the role of the dutiful son. In September 1816 he wrote Whittaker and Babbage of “going under my father’s direction to take up stargazing” and “to take up the series of his observations where he had left them.” The decision implied that he would perform certain scientific activities out of a sense of duty rather than love.

By inclination, and by his own admission, optics and chemistry were his first loves. He was in fact almost elected to the chair of chemistry at Cambridge in 1816, a position he had applied for when it became vacant upon its incumbent’s death. Yet his father’s illness entrained him in a path that shackled his energies to astronomical researches, in which his obligation to complete his father’s work always played a large role. The magnitude of this enterprise — a sweep of both the northern and southern skies — was staggering. That Herschel was able to complete the project successfully — and do much else besides — is proof of his remarkable energies, powers of concentration, and abilities. But it seems reasonable to suggest that this decision to follow in his father’s footsteps affected his creativity: it robbed him of the sense of his own specialness, and he never developed a sense of identity as a creative person. Perhaps for this reason, his intellectual productions were for the most part either derivative or critical. His powers were enormous and he could mold coherent syntheses of vast areas of knowledge, but his energies were always diffused and he never concentrated them on a problem for an extended period. He was always taking on new projects and always involved in a multiplicity of enterprises that were not mutually reinforcing; there was no cognitive coherence in the choice of his tasks.

Alternatively, it is quite possible that the assumption of filial responsibilities — that is, taking on the obligation of completing his father’s astronomical works — allowed John to achieve the delicate mental balance necessary for completing all the works he undertook. In 1839, before moving from Slough to Kent, on the occasion of the dismantling of his father’s great telescope, Herschel wrote a poem entitled “Requiem of the Forty-Feet

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Reflectors, at Slough.” Its tone is genuinely mirthful and conveys Herschel’s happiness. The poem reflects a host of feelings: gladness at moving away from Slough, and thus severing his ties with much that was identified with his father, but also a deep satisfaction for having discharged the commitment he had undertaken:

REQUIEM

of

THE FORTY-FEET REFLECTOR,

at Slough

The Herschelian Telescope Song

Sung on New-Year’s Eve, 1839—40, by the whole family in the Tube thereof assembled.

I.

In the old Telescopes tube we sit,
And the shades of the past around us flit;
His Requiem sing we with shout and din,
While the old year goes out and the new comes in.

Chorus

Merrily Merrily let us all sing,
And make the old Telescope rattle and ring.

II.

Full fifty years did he laugh at the storm,
And the blast could not shake his majestic form;
Now prone he lies, where he once stood high
And searched the deep heaven with his broad-bright eye.

Chorus

III.

There are wonders no living wight hath seen,
Which within this hollow have pictured been;
Which mortal record can ne’er recall,
And are know to Him one who made them all.

Chorus
IV.

Here watched our Father the wintry night,
And his gaze hath been fed with pre-Adamite light;
While Planets above him in mystic dance,
Sent down on his toils a propitious glance.

Chorus 28

John's relationship to his father also looms large when trying to understand the stance he took toward science. Science became his church. He became a priest in the "temple of science," thus fulfilling his father's wish that he enter the church. Scientific activities took on aspects of those of a mission. Just as the true evangelical Christian comports himself with total devotion, so did Herschel in his scientific researches.

What Einstein said of Planck might be said as well for John Herschel (Fig. 1): it was indeed "the longing to behold this pre-established harmony" that was the source of "the inexhaustible perseverance and patience" with which Herschel toiled over his catalogs, laboriously checking all his calculations by hand. He gave himself over to his scientific endeavors almost entirely, and gave of himself to those engaged in the cultivation of science in a totally selfless and undemanding manner. His vast correspondence reveals a man of complete integrity whose scientific genius was "absolutely untainted by the egotism of the discoverer." This selflessness was a trait that Herschel cultivated. Although he could have strongly differing views with members of the committees he served on, such divergences of opinion never led to personal animosity nor antagonism on his part — even in the face of strong provocation. In one of his letters to Joseph Hooker, Charles Darwin commented perceptively that all the leading British scientists always seemed to be embroiled in disputes with one another — but that John Herschel was the exception. In his Autobiography Darwin also recalled: "He never talked much, but every word which he uttered was worth listening to. He was very

shy and often had a distressed expression. . . . I felt a high reverence for Sir J. Herschel. . . .” 32

II. CHARLES DARWIN

The close ties between the Darwins and the Wedgwoods were first established with the friendship between Erasmus Darwin, Charles's paternal grandfather, and Josiah Wedgwood I, his maternal grandfather. During his lifetime, Erasmus Darwin (1731—1802) was considered the greatest physician in England. He was the embodiment of the Enlightenment polymath whose interests covered the whole of natural philosophy; his writings were well known and attracted wide attention. Josiah Wedgwood I (1730—1795) was the founder of Etruria, the pottery that brought him wealth and fame. Erasmus Darwin and Josiah Wedgwood were both members of the Lunar Society, and both identified strongly with French Enlightenment views on education and politics. The familial bonds were cemented when Erasmus and Josiah agreed that Robert Darwin (1766—1848), Erasmus's youngest son, would marry Susannah (Sukey) Wedgwood (1765—1819), Josiah's oldest daughter. In the next generation, two pairs of first cousins intermarried: Charles's older sister Caroline (1800—1888) married her cousin Josiah Wedgwood III (1795—1880), and Charles (1809—1882) himself married his cousin Emma Wedgwood (1808—1882).

When Robert Darwin married Susan Wedgwood in 1796 she brought him £25,000, a considerable sum, and in 1800 he built "The Mount," the Darwin residence in Shrewsbury. In her book on the younger Wedgwoods, Eliza Meteyard indicated that

[t]here can be little doubt that when Robert Darwin first settled in this stronghold of the orthodoxies — political, social and religious — he had much to encounter from the prejudices of those who, from education and interest, often combined and held the narrowest opinion on every point. For he was known to be the son of the famous author — for the views promulgated in Zoonomia and Botanic Garden were "more obnoxious than Natural Selection in 1870."  

 Nonetheless, Robert Darwin continued the family tradition and was "largely liberal in every opinion and view." He never gave up

35. Ibid., p. 260.
his progressive views, and in the early 1820s his daughter, with his financial help, at considerable cost opened the first infant school for the poor in Shrewsbury, “supplied with the then novel applications of black boards, arithmetical beads and frames and the devices of Pestalozzi and others.”

Robert Waring Darwin’s liberal stand must be assessed against the political background of the times. The period from 1790 to the 1830s was one during which strong anti-Jacobin feeling animated the political scene, and a repressive Tory government cast a pall over all debates. The English middle and upper classes, being conscious of the means by which their tradition of political and intellectual freedom had been established and maintained, for the most part supported the Tory measures. They had been deeply disturbed by the excesses of the French Revolution and, like their counterparts in the rest of Europe, were trying to find a new equilibrium in the wake of the onslaught of Enlightenment and the new political and economic realities engendered by industrialization and urbanization.

Neither Charles’s father Robert, nor his grandfather Erasmus, was religious, leaning instead toward agnosticism. Erasmus was a deist and a materialist. Robert considered himself a “freethinker,” and even though his wife was a Unitarian he, being a practical man, had both his sons baptized into the Church of England.

Charles grew up in a house dominated by his father. In the Autobiography he composed in 1876 he spoke of his father as “the largest man whom I ever saw.”

A huge man, Robert Darwin stood over six feet, three inches tall and weighed more than 300 pounds at age forty — the last time he weighed himself. He would send his footman jumping up and down the stairs and on the floorboards of a new patient’s residence to make sure that they would carry his weight. The pictures of him give the impression of a self-confident, opinionated, priggish person, somewhat effeminate in facial expression. Although immensely bulky, he was surprisingly agile and quick moving. He had a thin, high-pitched voice, and like his father, Erasmus, he “enjoyed attention and affected eccentricities.”

Also like Erasmus, he was interested in botany and zoology; he raised pigeons and spent a good deal of his spare time in his greenhouse. He was an able and respected physician — “psychiatrist” would be a better, though anachronistic, description — whose practice in Shrewsbury was one of the largest and most successful outside of London. He was as shrewd a businessman as

36. Ibid., p. 261.
he was doctor: he invested heavily and successfully in stocks, bonds, and real estate and became quite wealthy. As had been the case with their fathers, Robert Darwin and Josiah Wedgwood II (1769—1843) became close friends. Robert became not only Josiah's doctor and confidant but also his financial adviser, and he often helped him with loans when the pottery was experiencing difficulties.

Both the Darwins and the Wedgwoods had familial histories of ill health and mental instabilities. Robert's mother became demented, and his older brother, Erasmus, committed suicide following a history of mental illness. Robert was prone to being depressed and he dealt with his frequent bouts of depression by being hyperactive. As he grew older, his depressions, fits of anger, and spells of rapid talking became more pronounced and more intimidating. “The doctor, good as he is, is so tiresome that he takes away every feeling of liberty,” his niece Fanny Allen noted after a visit to the Mount in 1836. “I found it was a gain when I got behind every pillar of the sitting room so that I was out of his observation.”

Tough, forthright, intimidating, Robert Darwin was by disposition inclined to seek rather than shrink from confrontation. But he was also hypersensitive, and he felt deeply the deaths of his patients and of his friends. Endowed with an “extraordinary memory” that gave him total recall of past events, he never forgot the dates of these losses, and “every road out of Shrewsbury [became] associated in [his] mind with some painful event.” From the time he would come home in the late afternoon after visiting his patients, until the time he retired, it was Robert's habit to harangue the members of his family continuously. Yet the young Charles managed to find ways to call attention to himself. Some of Charles's earliest memories were those of vanity — thinking that people were admiring him, in one instance for perseverance and in another for boldness for climbing a low tree — and, “what is odder, a consciousness, as if instinctive, & contempt of myself that I was vain.”

While growing up, Charles was not considered exceptional in intellectual abilities. What does stand out in reading his reminiscences is the remarkable attachment to nature that he developed as a child. In an autobiographical fragment written in 1838, he

39. Ibid., p. 226.
42. This point has been stressed by Gruber in his Darwin on Man.
asserted that he did not remember any mental pursuits as a boy of eight "excepting those of collecting stones, etc. — gardening"; he recalled "about this time often going with my father in his carriage, telling him of my lessons, and seeing game and other wild birds, which was a great delight to me. — I was born a naturalist." 43

When Charles's older brother Erasmus decided against practicing medicine, Robert took Charles on his rounds hoping to instill in him a love for medicine. But at Edinburgh, where Charles had been sent for his medical studies, he was revolted by the suffering of young children subjected to surgery, which was then performed without anesthesia. He, too, rebelled at the idea of becoming a physician. His revulsion at dissecting cadavers was movingly conveyed to his father: "I cannot but help thinking that these wretched people lying on the slabs had once been, like ourselves, lovers and beloved. That they should have come to such an end, to be hacked by students and made the subject of coarse jokes, defeats the imagination." 44

Note that it was the degradation of human relations implied by the dissections of these "lovers and beloved" that Charles deplored, not their death. Note that his identification with the living is as a lover and as a beloved. But note also the association of lovers and death.

If his communion with nature was one of Charles's remarkable traits, so was the deep affection and loyalty he elicited from his family and friends. One of the striking impressions one obtains from reading the letters to him — be they from the friends he made at Shrewsbury, Edinburgh, or Cambridge, from his brother Erasmus, from his sisters, or from his teachers — is how much all these people liked him and how much they valued his friendship. His friends at Cambridge were ready to do things for him much beyond the call of ordinary friendship: J. N. Herbert anonymously gave Charles a microscope as a gift, and several of Charles's friends went out to collect beetles for him!

Susannah (Sukey), Charles's mother, had been her father's favorite child. She was sent to a boarding school near Manchester at age seven and subsequently attended school in London. When she was fourteen, she and her two sisters received instruction at home from Mary Wollstonecraft's sister Everina. 45 She was

artistically inclined, displaying talents as an embroiderer and a musician, and she became an accomplished spinet player. As a young woman, she was quite interested in intellectual matters and often visited Erasmus Darwin at Derby.

Pictures of her suggest an open, extroverted, lively person; her letters reveal her to be quick-witted and strong-minded. She seems, however, to have inherited some of the psychological ailments that plagued the Wedgwoods. Her mother was a hypochondriac and had been chronically ill, and both Sukey and her brother Tom — the most gifted of that generation of Wedgwood children — suffered from similar disabilities. “She was never quite well and never very ill.” Already as a young adult, she frequently consulted doctors for her real or imagined illnesses. After her marriage to Robert, childbearing proved to be difficult and depressing and she spent most of her pregnancies confined to bed. Her husband believed that she should have aborted her pregnancy with Catherine, Charles’s youngest sister, because it was so difficult and he feared for her life. Charles remembered his mother primarily as an invalid; she died of peritonitis when he was eight-and-a-half years old. In his autobiography, Charles noted that it was “odd” that he could remember hardly anything about her, except her “death-bed, her black velvet gown and her curiously constructed work-table.” The “death-bed” is perhaps the source of Darwin’s association of love with death. In an earlier autobiographical fragment, he indicated that he “scarcely recollected anything of her appearance, except one or two walks with her. I have no distinct remembrance of any conversation, and those only of a very trivial nature.”

At a very early age, Charles developed a deep fear of death and dying. One of his earlier recollections, from when he was four-and-a-half years old, was listening at his aunt’s house to the talk of a woman named Betty Harvey: “I remember with horror her story of people being pushed into the canal by the towing rope, by going on the wrong side of the horse. — I had the greatest horror of this story — keen instinct against death.” In his Autobiography, Darwin also remembered “the horror which I felt as a schoolboy in reading about Pliny (I think) bleeding to death in a warm bath. . . .” One of his most vivid memories throughout his life was the
burial of a dragon soldier a few months after his mother’s death. He may have come to fear that he himself would die young.  

Already as a youth, Charles was suffering from physical and psychophysiological symptoms, and these symptoms seem to have manifested themselves more markedly whenever he came in contact with illness and death. The topic of his father’s harangues must often have been the illnesses and afflictions of his patients. The death of children and young women after childbirth was common during Charles’s youth. Epidemics of smallpox and other infectious diseases still occurred at frequent intervals, often killing large fractions of the population.

When confronted with unpleasant events or troubling thoughts, Charles displayed, even as a teenager, a tendency to become physically or psychosomatically ill. In the face of a domineering and dominating father and of an almost total dependence on his older siblings, Charles coped by developing an accommodating good nature and a tendency for self-deprecation. Yet behind this outward manifestation of acquiescence lurked intense desires for self-assertion. As a boy and as a young man, Charles struggled with his feelings of competitiveness, his need for self-assertion, his need for approbation, and his resentment at his father’s lack of recognition. His father often accused him of wasting his time and despaired whether Charles would ever amount to anything. Perhaps he developed psychophysiological symptoms in reaction to his father’s criticism and seeming insensitivity. In his teens he was already plagued by the stomach symptoms that were to afflict him for the rest of his life. He also suffered from sores on the hand and the lips, which led him in February 1829 to seek the advice of Dr. Henry Holland, a prominent London physician and a second cousin of the Darwins and the Wedgwoods. Maria Edgeworth pointed out:


52. The best and most convincing account of Darwin’s illnesses is to be found in Ralph Colp, Jr., M.D., To Be an Invalid (Chicago: The University Press, 1977).

53. “To my deep mortification my father once said to me, ‘You care for nothing but shooting, dogs, and rat-catching and you will be a disgrace to yourself and all your family.’ But my father, who was the kindest man I ever knew and whose memory I love with all my heart, must have been angry and somewhat unjust when he used such words” (Darwin, Autobiography, p. 28).
You know that he [C. D.] says he was ill in consequence of the sea voyage — that he was never a single day free from seasuffering. But Dr. Holland tells us that the voyage was not the cause, only the continuance of his suffering — for before he went to sea he was subject to the same. His stomach rejects food continually, and the least agitation or excitation brings on the sickness directly, so that he must be kept as quiet as it is possible and cannot see anybody....”

Charles probably also suffered from agoraphobia, which is interpretable as the fear of leaving a safe situation. In his Autobiography he indicated that his first sight of the Beagle — that seemingly frail little vessel whose companion ship had sunk on an earlier voyage — had stirred deep anxieties in him. The cramped quarters he was assigned to were “an evil” nothing could surmount. He also feared being “killed by infectious diseases or hostile natives.” He was “troubled with palpitations and pain about the heart” — but he asserted, “I did not consult any doctor as I fully expected to hear the verdict that I was not fit for the voyage and I was resolved to go at all hazards.”

What is striking about Charles Darwin is not so much his illnesses — it is his courage, his strength and determination in overcoming his fears and apprehensions. Courage is also the quality that characterizes his intellectual inquiries into the species question. As Gruber puts it, he had the courage to go the limit. He dared to pose questions and accept answers that in many quarters were considered seditious. He overcame his fear of being ostracized for his materialist evolutionary views. He confronted his religious beliefs and became a deist, and later, an agnostic. Freeing himself from theism was, in fact, a precondition for arriving at natural selection, his naturalistic mechanism for the origin of new species.
Before concluding this brief sketch, I would like to comment on Charles's work and working habits. Whereas Herschel was always involved in a multiplicity of diverse tasks that seemed somewhat haphazard, Darwin was the paradigm of Gruber's model of creativity: the person whose impressive effectiveness and "singular
outcomes" are generated by the continual reorganization of the manifold possibilities in the pluralistic tasks he is always working on, tasks that are interrelated and have an overall coherence. In Darwin's case, these tasks were indeed always connected in one way or another with his species theorizing. Their interrelation allowed the transference of insights, solutions, and problems from one enterprise to another, thus generating new tasks and inquiries. Darwin worked with a definite daily routine: his work habits became routinized. The readings, the gathering of notes, the writing of books, the dissections, the experiments, the writing of letters, all acquired a certain repetitive quality. He was able to accomplish much by concentrating his great energies and intellectual powers on the tasks at hand — even though he did not spend that much time on them. He also never lost his passion for the work he was doing — a passion that was a source of great enjoyment. I am struck by the characterization that Charles gave to his own work at three different times in his scientific career, each instance being at a crucial junction in the structuring of the network of his enterprises. The first occurred when he boarded the Beagle, the second when he obtained his Malthusian insight, and the third when he had convinced himself that his explanation for the diversity of species — divergence of character — was satisfactory.

On October 13, 1831, after having taken up his quarters on the Beagle, he wrote in his Diary a brief outline of his plans for work during the voyage:

I am often afraid I shall be quite overwhelmed with the number of subjects I ought to take into hand. It is difficult to mark out any plan and without method on shipboard, I am sure little will be done. The principal objects are first, collecting, observing and reading in all branches of Natural history that I possibly can manage. Observation in Meteorology, French and Spanish, Mathematics, and a little Classics, perhaps not more than Greek


Testament on Sundays. I hope generally to have some one English book in hand for my amusement, exclusive of the above mentioned branches. If I have not energy enough to make myself steadily industrious during the voyage, how great and uncommon an opportunity of improving myself shall I throw away. May this never for one moment escape my mind and then perhaps I may have the same opportunity of drilling my mind that I threw away whilst at Cambridge.\textsuperscript{60}

In a famous section in his \textit{Autobiography} in which he commented on his publications, Darwin recorded:

My first notebook [on transmutation of species] was opened in July 1837. \ldots When I see the list of books of all kinds that I read and abstracted, including whole series of Journals and Transactions, I am surprised at my industry. I soon perceived that selection was the keystone of man's success in making useful races of animals and plants. But how selection could be applied to organisms living in the state of nature remained for some time a mystery to me.

In October 1838, that is fifteen months after I had begun my systematic inquiry, I happened to read for amusement Malthus on \textit{Population}, and being well prepared to appreciate the struggle for existence which everywhere goes on from long-continued observation of the habits of animals and plants, it at once struck me that under these circumstances favourable variations would tend to be preserved and unfavourable ones to be destroyed. The result of this would be the formation of new species.\textsuperscript{61}

In the fall of 1854, while addressing the problem of how to account for the enormous diversity of life on the surface of the earth, he had the insight that more life is supported in any region if the inhabitants are diversified. He noted at that time: "It is indispensable to show that in small and uniform areas there are many Families and genera. For otherwise we cannot show there is a tendency to diverge \ldots in offspring of every class.\textsuperscript{62} To this end,

\begin{itemize}
  \item \textsuperscript{60} Charles Darwin's Diary of the Voyage of H. M. S. Beagle, ed. N. Barlow (Cambridge: Cambridge University Press, 1933), p. 14.
  \item \textsuperscript{61} Darwin, \textit{Autobiography}, pp. 119–120.
\end{itemize}
in the spring of 1855, Darwin and Miss Thorley, the governess of his children, collected and counted plants from a nearby field. In a letter to Hooker on June 5, 1855, Darwin indicated that

Miss Thorley and I are doing a little Botanical work! for our amusement, and it amuses me very much, viz. making a collection of all the plants, which grow in a field, which has been allowed to run waste for fifteen years, but which before was cultivated from time immemorial; and we are also collecting all the plants in an adjoining and similar but cultivated field; just for the fun of seeing what plants have survived or did not.

The characteristic I am alluding to is that of "amusement." As Darwin himself noted, he had fun doing his work. By amusement, he meant the pleasure of verifying and anchoring his conjectures. There is an exhilarating, buoyant, and optimistic quality to Darwin's work — in contradistinction to Herschel's more somber, rigid, and pietistic approach.

III. HERSCHEL AND THE NEBULAR HYPOTHESIS

Two years after Herschel entered Cambridge, together with Babbage and Peacock he organized the Analytical Society — a mathematical "club" whose aim was to introduce the continental mathematical notation for the differential calculus into Great Britain and thereby to reform British mathematics. Their efforts were successful; to a large extent, the Analytical Society was responsible for the adoption of the Liebnitzian notation and for the dissemination of continental mathematical methods in Great Britain. The confidence and élan that the members of the society gained from their initial success was equally important. They went on to challenge the leading scientific institutions, such as the Royal Society, and helped to reform scientific practice in England. Herschel, J. Wilkinson, William Whewell, and Peacock — all members of the Analytical Society — were influential in the formation of the Cambridge Philosophical Society in 1819; Babbage, Herschel, and Peacock were the driving force in organizing the Astronomical Society in 1820, and in getting Cambridge to establish its observatory later that decade. Herschel also allowed his name to be entered as a candidate for the presidency of the Royal Society in 1830, when efforts were being made to reform that institution.

The activities of the Analytical Society were revolutionary. Although there were good “internal” reasons for revamping British mathematics, which had become moribund by being saddled with a highly constricting Newtonian notation, there were also other factors at work. The revolution had dramatically changed scientific practice in France, and this had been clearly apprehended and widely commented upon in the British periodicals — particularly in the *Quarterly Review* and the *Edinburgh Review*. The new French teaching institutions, notably the Écoles Centrales and the Polytechnique, had given mathematics new importance and had introduced a much wider class of students — the cadres of the new army and civil service — to its utility and power. Similarly, the benefits of what seemed to be a novel institutional way of doing research — the Société d’Arcueil — had been noted in the reviews on the state of science in France that were being published in these elite magazines. I would suggest that for the young Herschel mathematical reform was the vehicle for identifying with the initial aims of the French Revolution. The institutional frameworks in which the sciences were studied, assessed, and disseminated became a focus of Herschel’s activities during his early manhood. I believe that during this period, when mathematics and mathematical reform were at the center of his interests, his psychological dispositions and his intellectual and ideological propensities all reinforced one another. The various enterprises he was engaged in nurtured one another, and although each had its problematic aspects, each was suffused with energy and vitality and together they gave purpose and cohesion to his psychic and intellectual life. Doing mathematics for Herschel became part of his social discourse: it was an expression of his ideological aspirations; it helped structure his personal discursive formation.

I want to contrast Herschel’s early “revolutionary” efforts in mathematics with his later “conservative” productions in astronomy. If his mathematical activities represent his attempts at molding a sense of identity as a creative individual, then his later astronomical researches are indicative of the transformations that were wrought when he accepted his father’s request to become his assistant and complete his life’s work. *Reading the Book of Nature* became the focus of John’s researches in astronomy. I believe that his acquiescence to his father’s demands also fixed his religious

64. For a history of the Analytical Society see Schweber, prefatory Essay in *Aspects of the Life and Thought of Herschel* (above, n. 7). For a typical review see “Laplace’s Mécanique Céleste,” *Edinburgh Rev.*, 11 (1808), 243—284, which was written by Playfair.

outlook. When he first entered Cambridge he was theistically inclined, but he grappled with the problem of the meaning of religion in his life during the next few years; this was part of his attempt to delineate his own sense of self. When he became his father's helper he also became a firm theist and a devout religionist — and nowhere is Herschel's "conservative" outlook thereafter better revealed than in his stand against the nebular hypothesis. That hypothesis, originally advanced by Buffon and Kant to account for the formation of the solar system, and further expanded into a sidereal nebular hypothesis by John's father, William Herschel, became widely accepted when Laplace expounded it in his *Exposition du système du monde*. In the first edition of the *Exposition*, Laplace, in a brief account of a planetary nebular hypothesis, had postulated an already formed sun surrounded by a vast nebula extending beyond the orbits of the planets. By the fourth and fifth editions he had extended his nebular hypothesis so that the starting point was a totally nebulous state; his hypothesis for the solar system became but a special case of William Herschel's sidereal nebular hypothesis that stars resulted from the condensation of extended, self-luminous, incandescent, nebular fluids. William Herschel had advanced this hypothesis following his extensive observations of nebulae and star clusters.

The greatest impact of the nebular hypothesis was on geological tenets. Fourier's explanation of the observed geothermal gradient in mines as a consequence of the earth's central heat secured the position of the nebular hypothesis as the most plausible explanation for the origin of this central heat. Moreover, the linking of the nebular hypothesis to the doctrine of central heat allowed a synthesis that was at once an explanation of the history of the earth and the "case" history for all planets. The relation of the Laplacian planetary nebular hypothesis to Herschel's sidereal nebular hypothesis also linked geology to cosmic history, thereby contributing significantly to the acceptance during the first half of the nineteenth century of evolutionary history as a mode of


67. See Hoskin, *Herschel and the Construction of the Heavens* (above, n. 13); the relevant parts of William Herschel's original articles are reprinted in this volume.

scientific explanation. William Herschel, in fact, had considered himself a natural historian.

It should be stressed that there was no element of chance or randomness in the progressive and directional process encompassed by the nebular hypothesis: everything was the result of the deterministic unfolding of the secondary laws of nature. It was this feature that made the investigation of the geological and astronomical consequences of the nebular hypothesis acceptable; this was a necessary condition because of the "scientific" metaphysics of the period. In France, with its relatively well developed institutional frameworks and specialized academic disciplines — as exemplified by the Institut, the Muséum, the École Polytechnique — the matter was pursued "internally" by geologists and astronomers. In England, with its more gentlemanly style of doing science — as evidenced by the Astronomical and Geological Societies and the background of its practitioners — the deterministic aspect of the hypothesis was the element that allowed "design" to enter. However, if the determinism of the nebular hypothesis allowed it to be interpreted as manifesting a divine designing hand, the hypothesis was also vulnerable to the charge of fostering irreligion because of its challenge to the Bible. Both Herschel's and Laplace's hypothesis implied that creation "was a long process not a sudden and completed act" and thus posed problems for the literal interpreters of Genesis. Moreover, the association of Laplace's name with the nebular hypothesis added to its vulnerability to the charge of fostering atheism. Laplace's reply to Napoleon's query why he never even mentioned the Creator in his Système du monde — "Je n'avais pas besoin de cette hypothèse-là" — was well known. In 1824, John Herschel had to write Giuseppe Piazzi:

I understand from M. Arago that an article has appeared in the Bibliothèque Universelle from the pen of Prof. Pictet of Geneva, in which my father's doctrines respecting the condensation of the nebulous matter are characterized as tending to irreligion. The charge would be contemptible were it not associated with the name of Pictet; but I hope you will take care to let it be distinctly understood that my Father, so far from contemplating such consequences, was a sincere believer in, and worshipper of, a benevolent, intelligent and superintending Deity, whose glory he conceived himself to be legitimately forwarding by investigating the magnificent structure of the Universe.70

Behind the accusations of irreligion loomed a further specter: the conflation of the nebular hypothesis, and its consequent geological history, with an evolutionary history of species, and more particularly with transmutation viewed as a natural phenomenon resulting from the operation of the secondary laws of nature. Thus in a letter to Adam Sedgwick, John Herschel characterized the nebular hypothesis as stating that “this firmament with its stars, suns, planets, mountains, seas and little fishes have all crystallized from a hot fog in vacuo.”

John Herschel, ever sensitive to this possible conflation, was guarded in his acceptance of the sidereal nebular hypothesis and always rejected the planetary nebular hypothesis. As far as John was concerned, “unless the individual objects are seen condensing, unless changes are observed and noted in the separate masses, the [nebular] hypothesis cannot be received.” The conflation of the nebular hypothesis and transmutation was explicitly made in Robert Chambers’s Vestiges of Creation, whose publication in 1844 created a furor in England. Its cosmic developmental hypothesis was pegged on the Laplacian nebular hypothesis. One of the sharpest attacks on the Vestiges came from Herschel. Using the podium of the British Association for the Advancement of Science meeting in Cambridge in June 1845, Herschel in his presidential address strongly criticized evolutionary theorizing and rejected the Laplacian nebular hypothesis as without empirical foundation. In that same address he also castigated the transmutationism that Chamber’s Vestiges had popularized.

Herschel was willing to consider the introduction of new species a natural process. In a widely publicized letter to Charles Lyell in 1836 concerning “that mystery of mysteries, the replacement of extinct species by others,” Herschel had indicated that

[for my own part — I cannot but think it an inadequate conception of the Creator, to assume it as granted that his combinations are exhausted upon any one of the theatres of their former exercise — though in this, as in all other works we are led by all analogy to suppose that he operates through a series of intermediate causes and that in consequence, the origination of fresh species could it ever come under our cognizance would be

71. J. Herschel to A. Sedgwick, 1844, Herschel Correspondence, Herschel papers microfilm, Royal Society of London.
73. J. Herschel, Address to the British Association for the Advancement of Science, June 19, 1845, in Essays, pp. 634–684.
found to be a natural in contradistinction to a miraculous process — although we perceive no indication of any process actually in progress which is likely to issue in such a process.\textsuperscript{74}

But Herschel was never able to go beyond this level of generality. In a letter to Babbage — written at the same time as his letter to Lyell — he appended to the previous remarks the observation that as marvelous as the introduction of new species may be, the process “can hardly be more so than that by which individuals are brought upon the earth every day.”\textsuperscript{75}

Darwin, on the other hand, readily accepted the nebular hypothesis as the best explanation for central heat and volcanic activities — even though he considered himself a Lyellian geologist, and Lyell in his Principles had rejected the nebular hypothesis as being contrary to his uniformitarianism. The geological notebooks,\textsuperscript{76} which Darwin compiled during the voyage of the Beagle, give proof of his acceptance of the hypothesis. They also give proof of his ability — even as a neophyte — to hold beliefs at arm’s length and to make judgments of the merit of a given hypothesis based on the extent and cohesion of the explanation that results from its adoption.

IV. HERSCHEL’S SEARCH FOR THE TIMELESS

Herschel’s vast correspondence, his many articles, and his detailed diaries give ample proof of his wide interests, boundless energies, and impressive powers. Yet I have suggested that his scientific endeavors lacked coherence; that his mature scientific endeavors seem disconnected, resulting in an achievement that, impressive as it is, is less than the sum of its parts.

Herschel in 1834 had gone to South Africa at his own expense to make a sweep of the southern sky. His diaries from 1834 to 1838 record his activities during his stay there.\textsuperscript{77} While at the Cape, he made an extensive study of the flora, fauna, and geology of the region, a study that included such details as a record of the

\textsuperscript{75} J. Herschel to Babbage, 1836, Herschel Correspondence, British Museum.
songs of the local birds, observation of the mating habits of the wildlife, and the discovery of puzzling features of some of the invertebrate species in a nearby archipelago. Every day he made a large number of meteorological and magnetic measurements, recorded observations on sunspots,78 timed the ebb and flow of the tides, and registered their height. He also carefully observed the indigenous population, the Kaffirs, and in particular studied their institutions, language, religion, and agricultural practices, and acquainted himself with their art and history. He also helped reform the curriculum of the English schools on the Cape.79 All this while observing every night.

Charles Darwin, who met Herschel when the Beagle anchored at the Cape, wrote Henslow of his visit with him:

> At the Cape Capt. Fitz Roy & myself enjoyed a memorable piece of good fortune in meeting Sir J. Herschel. — We dined at his house & saw him a few times besides. He was exceedingly good-natured, but his manners, at first, appeared to me rather awful. He is living in a very comfortable country house, surrounded by fir & oak trees, which alone, in so open a country, give a most charming air of seclusion & comfort. He appears to find time for every thing; he shewed us a pretty garden full of Cape Bulbs of his own collecting, I afterwards understood that everything was the work of his own hands. . . . 80

If Herschel's multifarious concerns at the Cape and his later scientific inquiries seem inchoate on the surface, a coherence can be detected if these are viewed from the vantage of his affective structure. From that perspective all his endeavors have a common feature: they can be interpreted as an attempt to annihilate time, as a search for the constant amidst change. Let me illustrate this contention by considering three enterprises in which he invested a great deal of effort at various stages of his life: his camera lucida drawings, his investigations of the photographic process, and his philosophical writings.

78. "He [Herschel] has shewn us innumerable drawings he took at the Cape — 1835 — of the spots in the sun and changes unaccountable! from day to day" (Edgeworth, Letters from England, p. 595).


80. Burkhardt and Smith, Correspondence of Charles Darwin, I, 500.
Herschel was introduced to the camera lucida by its inventor, Wollaston, when he worked with him in London. The camera consists of a four-sided prism mounted on a small stand above a sheet of paper. The prism acts like a set of two mirrors: by placing his eye over the edge of the prism, an observer can see the reflected image of objects situated in front of the prism as apparently lying on the paper and can trace the image. Herschel improved the camera by adding a lens between the prism and the paper, thereby focusing the image more sharply on the paper. Extremely accurate pencil sketches can be made with this improved camera. Herschel made a large number of such drawings while at the Cape, recording the geological formations as well as the more picturesque features of his surroundings.81 (See Figs. 3 and 4).

Herschel's interest in capturing and recording momentary reality was not confined to the camera lucida. In his chemical researches during 1819, he had discovered that sodium thiosul-

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81. In 1815 W. G. Horner suggested adapting the camera lucida for use with either a microscope or a telescope (Ann. Phil. 6 (1815), 281–282); Babbage independently made the same suggestion in 1836 in Athenaeum (1836), p. 274. Herschel had probably been using a camera lucida with a telescope both at Slough and at the Cape.
phate had the property of dissolving the salts of silver. When he was informed early in 1839 that Daguerre had developed a process for producing pictures of great precision and clarity by exposing to light, in a camera obscura, paper soaked in photosensitive silver salts, Herschel undertook similar experiments. On January 29, 1839, he recorded in his "chemical experiments" notebooks that he had "tried hyposulphite of soda to arrest the action of light, by washing away all the chloride of silver or other silvery salt. Succeeds perfectly. . . ." That silver salts were sensitive to light had been known for a long time. Thomas Wedgwood (1771–1805), Josiah Wedgwood's youngest son, and Humphrey Davy had actually produced photographic pictures by exposing paper and leather coated with a silver nitrate solution; but as they were unable to prevent the gradual destruction of the images by the further action of light, their results were forgotten. What Herschel discovered in 1839 was that hyposulphite of soda (sodium thiosulphate) "fixes" the picture by dissolving the silver salts not exposed to light, thus making the photograph insensitive to further exposure. Knowing that William Talbot was experi-

menting with producing photographic pictures, Herschel communicated these findings to him. Talbot incorporated Herschel’s process in the patent he took out. Similarly Daguerre, who had read of the fixing process in the “Note on the Art of Photography” that Herschel had submitted to the Royal Society, adopted sodium thiosulphate as the fixing agent in his patent. From January to April 1839, working at a feverish pitch, Herschel essentially invented all the techniques upon which modern photography is based. His results of that period were summarized in a paper he submitted to the Royal Society — but which he later withdrew. The following year, in a publication in which he introduced the terms “positive” and “negative” into the photographic nomenclature, Herschel reported on his further researches. He announced


86. L. Schaaf, “Herschel, Talbot and Photography: Spring 1831 and Spring 1839,” J. Hist. Photog., 3 (1980), 181–204. Herschel had invited Talbot to his house at Slough to show him his new process of fixing, or “washing out,” as Herschel called it. The visit is recorded in Herschel’s notebook as follows: “Friday, Feb. 1. Mr. Talbot came to Slough. . . . Explained to him all my processes — He also showed me his specimens of results but did not explain his process of what he called ‘fixing’ — By way of trial of the power of my process of ‘washing out’ he gave me one of his unfixed specimens. In two minutes I brought him half of it washed the other not and on exposing both the washed half unchanged and the other speedily obliterated and at length grew quite dark.” The two halves are still preserved in the notebook, which is to be found among Herschel’s papers in the library of St. John’s College.

87. J. Herschel, “On the Chemical Action of the Rays of the Solar Spectrum on Preparations of Silver and Other Substances, Both Metallic and Non-Metallic, and in Some Photographic Processes,” Phil. Trans. Roy. Soc., 130 (1840), 1–60. Writing from Herschel’s house on November 26, 1843, Maria Edgeworth commented that Herschel showed her “a great number of his Daguerreotypes in all the varied states — where the light was first darkness and then in the next state where after lying by some time the dark turn to light and then where it all fades away and seemingly leaves no trace behind — and then upon certain incantations or applications it all returns. . . . he told us of a strange delusion or disease of his sight which comes on at night sometimes when he is sitting up reading. The fartherest part of the room vanishes and by degrees the circuit of the sight diminishes so that he can see only the table before him and just the space occupied by the candles. This should warn him not to overwork and it does warn Lady Herschel to take all means to prevent his overstraining his great faculties” (Edgeworth, Letters from England, p. 594).

During February 1839 Talbot tried several fixatives including hypo, but from this date until about April 1842 he continued to fix his photographs with common salt, potassium bromide, or potassium iodide — salts that left silver halides on the paper. An entry in Herschel’s notebook dated March 25, 1838, suggests why Talbot was unimpressed by the use of hypo: “Talbot’s sensitive paper will not fix well. It is too full of silver for the Hyposuli. soda [hypo]. But
that photographs could be taken on glass plates — thereby eliminating the difficulties introduced by the organic substances contained in paper. He also gave the results of his experiments with silver bromide, which he had found to be the most light sensitive of the silver salts. In addition, he indicated the possibility of photography in natural colors, having obtained a good photograph of the spectrum of sunlight, without, however, succeeding in fixing the colors. Herschel immediately recognized the possibilities that photographic plates presented in astronomical observations, and he made many suggestions for their use. Throughout the rest of his life he remained fascinated by photography and befriended many of the outstanding photographers of the day. Julia Cameron's remarkable photographic portrait of the aged Herschel (Fig. 5) is testimony both to his abiding interest in that art and to the enduring power of the record thus produced.

It was in his philosophical writings that Herschel gave the most revealing accounts of his Weltbild. In his introduction to the Memoirs of the Analytic Society (1813) he explained the power of mathematics as an instrument of reason stemming from the accuracy and simplicity of its language and the conciseness, symmetry, and "immutability" of its notation. It was the ahistoric nature of mathematics that allowed it to capture the essential features of the fixed and immutable laws of nature; these laws, when apprehended at their most fundamental level, could be axiomatically formulated and their consequences inferred deductively.

the H.S.i. Ammonia will fix it — as the H.S. Ammonia and silver is excessively soluble which that of Soda and silver is not." Herschel's photogenic drawings from this period are even more faded than Talbot's, apparently because he did not realize the necessity of washing away all traces of hypo from them after fixing.

At the beginning of May 1839 Herschel went to Paris. He described to Talbot the daguerreotypes he had seen in Paris in a letter dated May 9, 1839: "It is hardly saying too much to call them miraculous. Certainly they surpass anything I could have conceived as within the bounds of reasonable expectation. The most elaborate engraving falls far short of the richness and delicacy of execution every gradation of light and shade is given with a softness and fidelity which sets all painting at an immeasurable distance. His times also are very short — In a bright day 3m. suffices. . . . In short if you have a few days at your disposition I cannot commend you better than to come and see. Excuse this ebullition. P.S. The pictures are on very thin sheets of plated copper, neither expensive nor very cumbersome" (D. B. Thomas, The First Negatives, Science Museum Monograph [London: Her Majesty's Stationary Office, 1964], p. 6).

In the introductory remarks to his "Physical Astronomy," Herschel gave a succinct statement of the aims of scientific inquiry:

The object of the philosopher in the investigation of nature is to arrange and classify facts and phenomena, with a view to trace the agency of their remote, or at least, their proximate causes and ascend as high as the imperfection of human means.
of observation, and the limited power of the human intellect will allow us in the scale of generalization.

To beings endowed with more perfect faculties, and more comprehensive intelligence than ourselves, much of that complication we observe in natural phenomena would disappear: many effects, which seem to us independent of each other, and linked by no natural connection, would be in their eyes collateral results of one and the same principles: much that to us seems fortuitous would to them appear predisposed and regularly arranged. The laws of nature would at once be reduced in number and enlarged in extent; and that higher order of generalization which would consist in classifying together laws of the same kind, and referring them to others yet more universal, would exercise their power and constitute their science. That such would be the case with more perfect beings, our experience limited as it is, amply shows. The man who has learnt to regard the fall of a leaf and the precession of the equinoxes as results equally certain and unavoidable of a law capable of being stated in three lines, and understood by a child of ten years old, has made already a considerable step in this way — the patient exercise of his natural reason has stood him in the stead of a sharper intellect; and secrets which an angel might penetrate perhaps at a glance become revealed to many by the slow, yet sure, effects of persevering thought.

The progress of modern science has done more than the keenest metaphysical reasoning, and has given us the most convincing proofs of the agency of one general and intelligent cause throughout the whole system of nature. When we see on all sides phenomena grouping themselves under laws intelligible and simply expressed, which are themselves subordinate to others, yet more simple and extensive; when we see every anomaly which threatened destruction to a theory, becoming, in the progress of our knowledge its firmest support; every inequality disappearing when viewed from a higher level; every exception proving a rule of greater generality; all, in short, conveying more and more towards order and simplicity the more severely we scrutinize it; it is impossible not to allow that that last great step, which unites all the phenomena of the universe under one general head, and refers them to one all-pervading agency — however inconceivably remote, and surpassing probably the utmost limits of the human intellect to comprehend, if explained, would still be but the continuation and final completion of a chain of reasoning whose first links we hold within our grasp — the consummation of a process
actually begun — the termination of a career into which we are fairly entered.

It is difficult to avoid such contemplations at the outset of an essay on physical astronomy; they crowd upon us; and in rejecting them we should reject the noblest use of the sublimest of sciences. For scarcely in any are the phenomena presented by nature more various and more complicated; in none is the generalization so complete, the final result so simple, or the object more imposing.89

This statement is quite remarkable. It explicitly affirms Herschel's belief in the Great Chain of Being: for him angels are real beings, and he looks forward to a future life in a higher state of existence. In a presidential address delivered to the Astronomical Society in 1827, he was equally forthright about the metaphysical meaning of his astronomical researches: "The stars are the landmarks of the universe; and amidst the endless and complicated fluctuations of our system, seem placed by its Creator as guides and records, not merely to elevate our minds by the contemplation of what is vast, but to teach us to direct our actions by reference to what is immutable in his works."90

Herschel's search for the immutable, invariant features of the universe did not limit his interest to astronomy and physics. In his Preliminary Discourse he made a distinction between observational and experimental sciences and indicated his preference for the observational ones, because they were more complex and did not permit simply re-creating an artificial situation. He became attracted to the observational sciences, particularly those of the "physique du globe" — that is, meteorology, geology, terrestrial magnetism, the tides, etc. — because these phenomena exhibited not only cyclical changes but also complex secular ones. They also, incidentally, allowed his great powers as an observer and as a theorist to complement one another. In an essay on "Terrestrial Magnetism" Herschel explained his attraction to the observational sciences:

[T]o the incoherent particles of historical statement which make up the records of a science of observation, theories are as a framework which binds together what otherwise would have no unity. . . . In these [sciences], then, it is perhaps not using too

90. Herschel, Essays, p. 469.
strong an expression to assert that the theory is the science. In it alone we must look for indications that we are on the safe track toward the detection of efficient causes, — from it only we can receive hints to guide us in our choice both of things to be observed, and of the best and most available mode of making and recording our observations — and to it we must look for our only means of reproducing the past, and recovering the lost history of bygone time.91

Similarly, Herschel’s belief that constant efficient causes governed social phenomena involved him in a lifelong study of probability theory. By the beginning of the nineteenth century, probability theory had been widely accepted as the correct calculus for the description of complex phenomena, and statistics as the data upon which the observational sciences — understood in their broadest sense to include political economy and natural history — were to be based. Herschel’s 1849 review of “Quetelet on Probabilities” was an important landmark in the discussion of the foundations and uses of probability; it was a bridge from the world of Laplace to that of Francis Galton and Karl Pearson, from that of John Herapath to that of Maxwell and Boltzmann.92

These examples, I believe, are indicative of Herschel’s deep commitment to a metaphysical position that shaped both the questions he posed and the answers he could accept. His Weltbild was founded upon his Christian faith that an immanent Creator superintended the universe through fixed, immutable laws. It implied that ultimate meaning was to be found in fixity, in immutability, in the timeless. It led him to try to see the world sub species aeternitatis.

In a revealing drawing in one of his letters to Babbage during the summer of 1817 — written while he was somewhat inebriated — Herschel sketched himself as “Dionysius the God of Functions” — standing before a tree (the tree of knowledge), the fruits of which are mathematical symbols. (Fig. 6). The admonition at the top of the drawing instructs Babbage: “Interpret this hieroglyphic, it contains a great discovery.”93

Herschel’s Dionysius bears a remarkable resemblance to the Satan that John Baptist Medina and Henry Aldrich had drawn for

91. Ibid., p. 66.
93. J. F. W. Herschel to C. Babbage, May 15, 1817, Babbage papers, British Museum.
the first illustrated editions of Milton's *Paradise Lost* (see Figs. 7 and 8)\textsuperscript{94}: Herschel's Dionysius is similarly drawn with tail, and with staff in hand. Except for the fact that Medina's Satan at times has wings, the two are identical.

94. For a discussion of these illustrations see M. R. Pointon, *Milton and English Art* (Toronto: University of Toronto Press, 1970); Helen Gardner,
Fig. 7. Illustration to Book III of *Paradise Lost* by John Baptist Medina (1688).

Fig. 8. Satan encounters Sin and Death after Aldrich.

The striking feature of Herschel's drawing is that it concretizes his belief that the signs needed to decipher the Book of Nature are the timeless produce of the eternal tree of knowledge — there to be seized, with all their dire consequences. Interestingly, as in Milton's *Paradise Lost*, it is the nobler intellectual sense of sight that is supreme: Dionysius's staff points downward; it is the eye that incites. In Milton's Paradise, before the Fall, it was the pleasure of touch that animated carnal knowledge between Adam and Eve: "The enjoyment of touch and taste and smell, the purely sensuous senses, is the mark of Paradise, and the end of innocence. . . . After the Fall, it is the roving lascivious eye. . . ."\(^{95}\)

Dionysius, "alias the genius of abstract numerical magnitude," having perceived and apprehended the fruits of the tree, is able to concoct new numerical magnitudes. Expressed in a notation that Herschel and Babbage had devised, these magnitudes raised to the power of \(\sqrt{-1}\) times (muriate of exchequers bills) constitute deep new insights.\(^{96}\)

In Marsilio Ficino's preface to the *Mystical Theology* of Dionysius the Areopagite, the name Dionysius offered the occasion for describing as bacchic the approach of God through a negation of the intellect. Ficino there explained that the spirit of the god Dionysius was believed by the ancient theologians and Platonists to be the ecstasy and abandon of disencumbered minds, who partly by innate love, partly at the instigation of the god, transcend the natural limits of intelligence and are miraculously transformed into the beloved god himself. Inebriated by nectar and by an immeasurable joy, they rage in a bacchic frenzy. Ficino went on:

In the drunkenness of this Dionysiac wine our Dionysius expresses his exultation. He pours forth enigmas, he sings in dithyrambs. . . . To penetrate the profundity of his meaning . . . to imitate his quasi-Orphic manner of speech we too require the divine fury. And by the same prayers let us implore the Trinity that the light which God infused into Dionysius, in answer to his pious wish that he might penetrate the mystery of the prophets and the apostles, that the same may also be infused into us, who made a similar supplication.\(^{97}\)

It is interesting to note that one of the poems of Schiller that


\(^{96}\) Herschel to Babbage, May 15, 1817.

\(^{97}\) Dionysius the Areopagite, *Mystical Theology*, with an introduction by Ficino. (Augsburg: Johann Miller, 1519).
Herschel chose to translate was an ode to Bacchus entitled “Dithyrambics”; in it the poet implores the gods to allow him to imbibe their “choicest draught of immortality and by drinking the nectar to forever dwell with bliss and love”:

Fill the cup and fill it high!
And let the poet taste of joy,
And feel that heaven was made for him.

For Herschel, the tree metaphor was the iconic representation of the fixity of the Book of Nature. There is no genuine novelty; all is contained in the immutable symbols attached to the tree — all else, mere fluctuations.

V. DARWIN AND THE TEMPORAL

If for Herschel the metaphor of the tree was associated with images of immutability and timelessness, for Darwin trees and tree diagrams were the representation of change, growth, arborescence, branching, and life and death. Such diagrams were used repeatedly by him throughout his life. Gruber has perceptively illuminated the importance and meaning of the tree image in Darwin’s thinking. But before turning to the exploration of the tree imagery in Darwin, let me make some general remarks. Looking over Darwin’s early notebooks dating from the voyage of the Beagle, one is struck by the fact that the pictures he drew were not concerned with momentary reality: they were drawn to exhibit change. It is as if when looking at geological phenomena Darwin only saw how the features came to be the way they are. Diagrams taken from his Red Notebook illustrate my point. Fig. 9 indicates the action of the sea on coastlines; Fig. 10 illustrates the dynamics of crater formation in volcanoes. The theory of atoll formation, which Darwin formulated during the voyage of the Beagle after he witnessed the aftermath of the great earthquakes in Peru before he had ever seen an atoll — and which he corroborated

100. In his Autobiography Darwin indicates that he associated the observed earthquakes with the “elevation of the land”; this “necessarily” led him “to reflect much on the effects of [the associated] subsidence [elsewhere]” (pp. 98—99). See Appendix V of Burkhardt and Smith, Correspondence of Charles Darwin, vol. I, for Darwin’s early notes on coral reef formation. For an insightful account of the young Darwin as a geological theorist, and the role of subsidence and elevation in his theory of atolls, see Herbert, Darwin as a Geologist.
When sighting the atolls of the South Pacific, is a further indication of the role played in his thinking by what could be called “dynamic visualization.” The contrast between Herschel and Darwin should be clear: One seeks constancy in the fleeting, momentary reality, while for the other, change is the only reality.
Darwin and Herschel had a *psychological* affinity for the particular sciences that became the primary focus of their interest. In the Newtonian tradition, the physical sciences had been so constructed that, given the present state of a physical system, its past was irrelevant in order to describe its evolution — that is, to predict its future. On the other hand, following Buffon, natural history had become the history of nature: the investigation of what exists at present, and the explanation of how this came to be. The domain of the physical sciences was those systems which could be considered isolated from the rest of the world, and the aim of these sciences was to find and use an ontology — the elements that constituted the system — that was ahistorical. Thus the explanation of the motion of the planets and the stability of the planetary system made no references to how the planets came to be what they were at present. Similarly, how the atoms were formed was not part of the enterprise of natural philosophy. Herschel, in fact, had adduced the strict identity and immutability of all atoms everywhere as proof of their manufacture by a superintending deity. By contrast, the past — history — was at the very center of natural history.

How to make history a science, or rather how to make a historical science, was the problem that Darwin confronted and solved. Geology was his model. When certain fossils were found in certain strata of the earth's crust, geologists presumed that they would find similar fossils in similar strata in other regions of the


earth at the same level. They thus transformed a prediction about the past into a prediction about experiments that could be carried out in the present.\textsuperscript{104} But Darwin went further. The essential aspect of his evolutionary theorizing was crystallized in his views regarding classification. In some sense, he too believed in a Great Chain of Being. “I believe,” Darwin wrote to George Waterhouse in 1843, “that is every organism, which ever had lived or does live, were collected together . . . a perfect series would be presented, linking all, say the Mammals, into one great quite indivisible group — and I believe all the orders, families and genera amongst the Mammals are merely artificial terms highly useful to show the relationship of those members of the series, which have become extinct.\textsuperscript{105} In an earlier letter to Waterhouse he had forcefully stated his views regarding classification:

It has long appeared to me, that the root of the difficulty in settling such questions as yours — whether number of species &c&c should enter as an element in settling the value or existence of a group — lies in our ignorance of what we are searching after in our natural classifications — Linnaeus confesses profound ignorance. — Most authors say it is an endeavor to discover the laws according to which the Creator has willed to produce organized beings — But what empty high-sounding sentences these are — it does not mean order in time of creation, not propinquity to any one type, as man — in fact it means just nothing. According to my opinion . . . classification consists in grouping beings according to their actual relationship, i.e. their consanguinity, or descent from common stocks.\textsuperscript{106}

Establishing the criteria and rules for a classificatory scheme based on genealogy — that is, on history — was the problem that Darwin addressed constantly throughout his life.

I would like to suggest that these deep differences in the aims and structure of the science of natural history and of the physical sciences were precisely what attracted Herschel to chemistry, physics, and astronomy, and Darwin to geology and evolutionary


\textsuperscript{106}. Burkhardt and Smith, \textit{Correspondence of Charles Darwin}, II, 375—376. The letter is listed as number 684 in the \textit{Calendar} and is dated July 26, 1843.
biology. Moreover, their activities reinforced certain psychological dispositions. The successful explanations of a wide range of phenomena by the deterministic physical sciences — based, as they were, on building blocks that were immutable, on description in which past and future were interchangeable, in which motions were reversible, and in which the microscopic, the macroscopic, and the cosmological could all be similarly treated — provided Herschel the serenity he was looking for in his quest for certainty and ultimate meaning.

Darwin, on the other hand, could live and thrive in an uncertain world. He could accept a world in which small contingencies could result in large perturbations. He found meaning in the search for meaning and could accept the proposition that perhaps only history provided meaning.

Nowhere is the fruitfulness of Darwin’s historical approach better illustrated than in his tree diagrams. They first appeared in his First Notebook, an outgrowth of his monadic theory of evolution.\(^\text{107}\) (see Figs. 11 and 12). Already in that context, their suggestive power was enormous. Interpreted as species the branches, if unchecked, became indicative of exponential growth. Darwin also took the branches to represent the classificatory relationship between organisms.\(^\text{108}\) The tree diagrams, then, depicted the historical relationship between species: a horizontal line across the tree indicated contemporaneous species; the vertical axis represented the temporal dimension. The tree embodied the evolution of species. A picture of such a branching process is the only illustration in the *Origin*;\(^\text{109}\) this diagram is often referred to and plays a central explanatory role in the book. There are many other uses of the tree imagery to be found among Darwin’s unpublished notes (see Fig. 13). The tree was indeed an image of wide scope\(^\text{110}\) for Darwin.

The discordance in the imagery evoked by the tree metaphor in Darwin and Herschel and the contrast in their use of the tree image reflect, I believe, the different sources they associated with the parable of the tree of knowledge. Herschel, in consonance with the German background of his family, was raised on the Bible. The account of the fall of Adam and Eve and the meaning of the tree of knowledge that molded his perception was that given in the

\(^{107}\) Gruber, *Darwin on Man*, pp. 142—143.

\(^{108}\) Ibid., p. 197.


\(^{110}\) Gruber, “Darwin’s ‘Tree of Nature’ and Other Images of Wide Scope.”
Fig. 11. Darwin's first two tree diagrams, on page 26 of the First Notebook. Immediately preceding the upper tree the MS reads, "The tree of life should perhaps be called the coral of life, base of branches dead; so that passages cannot be seen. — (end of p. 25, beginning of p. 26) this again offers ((not only makes it excessively complicated)) contraction to constant succession of germs in progress." Words in double parentheses were inserted above the line by Darwin.

Immediately preceding the lower tree the MS reads, "Is it thus fish can be traced right down to simple organization-birds-not."

book of Genesis. Darwin’s vision, on the other hand, was shaped by Milton’s *Paradise Lost*. In his *Autobiography* Darwin made a point of stressing that he had deeply steeped himself in Milton’s poetry as a young man: *Paradise Lost* had been his “chief favourite,” and in his excursions on the voyage of the *Beagle* Milton was the book that he took along when he could take “only a single small volume.”

Not much attention has yet been paid to the influence of Milton

Fig. 12. Darwin’s third tree diagram, on page 36 of the First Notebook. The MS reads, “I think” followed by the diagram. Then, “Thus between A & B immense gap of relation, C & B, the finest gradation, B & D rather greater distinction. Thus genera would be formed, – bearing relation (end of p. 36, beginning of p. 37) to ancient types.” The marginal insertion alongside the tree diagram reads, “Case must be that one generation then should have as many living as now. To do this & to have many species in same genus (as is), requires extinction.” Courtesy of the Syndics of Cambridge University Library.

on Darwin. I believe that an extensive study of “Milton and Darwin” would richly repay the effort. At the end of the eighteenth century Milton was carefully and extensively read in Dissenting,

and particularly in Unitarian, circles. Blake, Shelley, and Mary Wollstonecraft had acclaimed him not only as a great poet but also as a courageous political and religious figure. I will here only briefly point to what seemed to me some of the more obvious features of *Paradise Lost* that might have struck Darwin.\(^{113}\)

The vividness and grandeur of Milton's images surely must have appealed to Darwin's aesthetic sensibilities. When he witnessed the great volcanic eruptions of the Osorno and "a long square column

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of burning matter was thrown very high from the Mountain top, &
very large flash of lightning from the cloud struck it & stopt its
ascent, it formed itself into a round globe & burnt, scattering its
fragments in every direction," it appeared to Darwin to be "a tragic
representation of Milton's battle of the Angels in Paradise Lost." 14
Milton's description of Paradise is lush, and hauntingly beautiful.
Paradise is filled with abundant life and suffused with languid and
fragrant smells. It is a paradise of the senses. The descriptions of
the tropical forests in Humboldt's travelogues, which so delighted
Darwin, pale by comparison. Nor could the vastness of Milton's
imagery have escaped the notice of Darwin, the budding geologist.
The immense scope of Paradise Lost, from before the beginning of
time till after the end of time, parallels the geologist's more modest
temporal interests. Similarly its almost boundless spatial arena,
from the edge of Heaven to the depth of Hell, is the geologist's
province magnified to the cosmic scale. 15 One of Milton's con-
cerns in writing Paradise Lost was "the contrast between what we
can imagine as human, and what is so here and now", this too is
the problem facing the geologist who is trying to imagine the past
from what he sees here and now. In intent and in execution,
Paradise Lost is a historical work. By elaborating the prehistory of
the Biblical account of Genesis, Milton emphasized the historical
dimension of the Creation story. And history is, of course,
Darwin's abiding concern.

In Paradise Lost the "concrete" story of the fall of man was to
illuminate the "abstract" meaning Milton had given to the history
of the world. On a more modest scale, but in an apposite fashion,
Darwin was the investigator of individual living forms and
histories, who studied these concrete details to confront the
abstract theories that he had proposed to account for all the
features of the organic world.

I am not able to assess the impact of Milton's epic on the
evolution of Darwin's theological beliefs. 17 However, it may not

14. Burkhardt and Smith, Correspondence of Charles Darwin, I, 479.
15. While at sea off the coast of Chile on July 23, 1834, Charles wrote his
friend Whitley: "I find in Geology a never-failing interest, as (it) has been
remarked, it creates the same grand ideas respecting this world, which
Astronomy does for the universe. We have seen much fine scenery, that of the
Tropics in its glory and luxuriance, exceeds even the language of Humboldt to
describe" (ibid., p. 397).
17. It may be of interest to note that in the 1837—39 period, when Darwin
reexamined his religious beliefs, one of the books he studied was Burke's
Philosophical Inquiry into the Origin of Our Ideas of the Sublime and Beautiful.
This essay contains an extensive analysis of the feelings of the religious
be too farfetched to suggest that the magnitude and magnificence of Milton's accomplishment may have helped "naturalize" the Biblical account and undermine its uniqueness for Darwin. In Darwin's day, Milton was widely recognized as a precursor of the eighteenth-century Unitarians and deists, among whom Darwin's grandfather Erasmus had counted himself. God in Paradise Lost is a distant God, who is not a priori superior to Satan. Milton gave Satan an essential nobility and made him a heroic and courageous figure, thus associating rebellion with courage. In Paradise Lost courage and perseverance stand out as the noblest qualities. They were also Darwin's outstanding qualities. What Milton ascribed to Abdiel could have been said of Darwin when he was courageously pursuing his species theorizing:

Nor number, nor example with him wrought
To swerve from truth, or change his constant mind
Though single. . . .

(Paradise Lost, Book V, 900—903)

It is likely that Darwin as a young man was aware that Shelley had called Satan the hero of Paradise Lost.118 Darwin's passionate indictment of Christianity in his Autobiography echoes Shelley's hatefulness toward Christianity as a theological system:

I can indeed hardly see how anyone ought to wish Christianity to be true; for if so, the plain language of the text seems to show that the men who do not believe, and this would include my Father, Brother, and almost all my best friends, will be everlastingly punished.

And this is a damnable doctrine.119

I would also suggest that Milton's elevation of the love between man and woman as one of the highest achievements of human experience (e.g., sublimity, terror) and how these are elicited in painting and poetry. Burke held up Milton as the English poet most capable of evoking the sublime and analyzed Hogarth's "Satan Confronting Death" for his visual evocation of terror and confrontation.

118. "Nothing can exceed the energy and magnificence of the character of Satan as expressed in Paradise Lost. It is a mistake to suppose that he could ever have intended for the popular personification of evil. . . . Milton's Devil as a moral being is. . . far superior to his God. . . . Milton has so far violated the popular creed . . . as to have alleged no superiority of moral virtue to his God over his devil" (P. B. Shelley, Defence of Poetry [Boston: Ginn and Company, 1891], pp. 30—31).

potentialities and his association of love with death resonated with the young Darwin's romantic disposition. In *Paradise Lost*, Eve asks Adam to eat of the fruit of the tree of knowledge as an act of love:

> Thou, therefore, also taste, that equal lot  
> May join us, equal joy, as equal love. . . .  

(*PL*, Book IX, 880—881)

Overcoming his initial horror, Adam eats the fruit as an act of love, and poignantly tells Eve:

> How can I live without thee; how forgo  
> Thy sweet converse, and love so dearly joined,  
> To live again in these wild woods forlorn?  

(*PL*, Book IX, 908—910)

Recall Darwin's identification of himself in Edinburgh with the dead "lovers and beloved"! For Milton, as for Darwin, love and sex were inextricably tied to mortality.

One further observation concerning *Paradise Lost*. I have been struck by the fact that Adam and Eve's lovemaking always takes place on a *bank*. Before Adam and Eve ate the fruit,

> . . . hand in hand they passed, the loveliest pair  
> That ever since in love's embrace met —  

> . . . To their supper-fruits, they fell —  
> Nectarine fruits, which the compliant boughs  
> Yielded them, sidelong as they sat recline  
> On the soft downy bank damasked with flowers.  

> Fair couple linked in happy nuptial league,  
> Alone as they. About them frisking played  
> All beasts of the earth, . . .  

(*PL*, Book IV, 321—335)

The bank teemed with life — but also, close by,

> . . . the serpent sly,  
> Insinuating, wove with Gordian twine  
> His braided train, and of his fatal guile  
> Gave proof unheeded. . . .  

(*PL*, Book IV, 347—350)
After Adam had partaken of the fruit, Eve’s

... hand he seized, and to a shady bank
Thick overhead with verdant roof embowered,
He led her, nothing loth; flowers were the couch,
Pansies, and violets and asphodel
And hyacinth — Earth’s freshest, softest lap.
There they their fill of love and love’s disport
Took largely, of their mutual guilt the seal,
The solace of the sin, till dewy sleep
Oppressed them, wearied with their amorous play.

(PL, Book IX, 1037—1045)

Milton’s “shady bank” becomes an “entangled bank, clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth,” in the concluding paragraph of the *Origin*. Death — the fruit of the tree of knowledge — and the fruit of love, as well as famine, are also to be found on Darwin’s bank. Yet from the fruits of this earthly love “the most exalted object which we are capable of conceiving, ... directly follows.”\(^\text{120}\) (Note the double meaning of “conceiving”!)

For Herschel, too, the imagery of the garden was powerful. Its meaning to him was conveyed by the Goethe poem with which he concluded his lengthy and influential essay on “Whewell on the Inductive Sciences”:

Thou, my love, art perplexed with the endless seeming confusion
Of the luxuriant wealth which in the garden is spread. . .
All the forms resemble, yet none is the same as another.
Thus the whole of the throngs points at a deep-hidden law, —
Points at a sacred riddle. Oh! could I to thee, my beloved friend,
Whisper the fortunate word by which the riddle is read.\(^\text{121}\)

Finally, it is worth noting that poetry had given great pleasure to Darwin in his youth. As an old man he could not endure reading a single line of poetry, and found Shakespeare intolerably dull and nauseating\(^\text{122}\) — yet he could wax poetic and write rhapsodically about communing with nature. Thus in April 1858,

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while taking a break in Moor Park from writing the *Origin*, he wrote his wife:

The weather is quite delicious. Yesterday, after writing you, I strolled a little beyond the glade for an hour and a half, and enjoyed myself — the fresh yet dark green of the grand Scotch firs, the brown of the catkins of the old birches, with their white stems, and a fringe of distant green from the larches, made an excessively pretty view. At last I fell asleep on the grass, and awoke with a chorus of birds singing around me, and squirrels running up the trees, and some woodpeckers laughing and it was a pleasant and rural a scene as I ever saw, and I did not care one penny how the beasts or birds had been formed.123

Herschel, on the other hand, took to writing formal poetry and in his later years found solace in translating and setting into verse Homer, Goethe, and Schiller.124 Here, too, their paths diverged.

VI. FATHERS, FATHER FIGURES, AND ROLE MODELS

In *The Future of an Illusion*, Freud claimed that religion was a sign of man’s mental immaturity: an indication of his need to find substitutes for his infantile dependency on the protection of a father against the terrors of nature, the frustrations and threats of life, and his fear of death. When man rejects the consolation of the religious illusion — that he is the center of creation, and the object of the tender care of a benevolent providence — he places himself in the same position as the child who has left the parental house where he was so “warm and comfortable.” But according to Freud, that is his destiny: “Men cannot remain children forever, they must in the end go out into a hostile life.” Freud hoped that they would be able to stand up to the hard test. Scientific knowledge and its benefits were to be the only crutches to support them on this journey. “And, as for the great necessities of Fate, against which there is no help, they will learn to endure them with resignation.” Freud believed that by freeing themselves from the false consciousness of otherworldly expectations and concentrating all their “liberated energies” on this earthly life, men will attain a state of things in which life will become tolerable for everyone and civiliza-

tion will no longer be oppressive to anyone. Then, with one of our fellow unbelievers we will be able to say without regret:

Let us leave the heavens  
To the angels and the sparrows.125

It would surely be incorrect to conclude that Herschel's inability to free himself from the yokes of his fathers — earthly and heavenly — and to leave the heavens to the angels, was responsible for limiting and constraining his creativity. Similarly, it would be an oversimplification to assume that Darwin's courage in challenging his father, in leaving home, in taking his voyage, in shedding the consolation of religion allowed him to realize his creativity. For both Herschel and Darwin the situation is more complex. The psychoanalytic explanations explain too much! Otto Rank's insight — that the creative potentials of individuals are liberated when, by an act of will directed toward immortality, they overcome their fear of death — is probably relevant in the case of Darwin and Herschel. Darwin did achieve immortality through creativity. Herschel believed he would achieve immortality through his faith. Yet after these generalities have been stated, we are still faced with the uniqueness of Herschel's and Darwin's personal history: the paths taken, the vagaries, the constraints.

Consider Herschel's and Darwin's relation to their domineering fathers. Whatever hostility Herschel felt toward his father eventually may have been dissipated by the constant public approbation that waslavished upon him for having taken on his father's mantle. Thus, at a welcoming dinner tendered by the Crown and attended by all the leading personages of the realm on the occasion of Herschel's return to England in 1838 from his stay at the Cape, the Duke of Sussex, who presided over the occasion, not only toasted Herschel as a natural philosopher of the first rank but also commended him for "that sense of filial duty which prompted him to follow the example of his distinguished relative . . . in adopting and discovering means by which we have been enabled to examine the deepest recesses of the universe; and thereby . . . obtaining additional means of coming nearer to the footstool of the Architect of the Universe. . . ."126 But despite the public


126. *Athenaeum*, (1838), pp. 423–428. In a letter dated May 22, 1822, Maria Edgeworth informed her mother: "At Captain Kater's breakfast yesterday we met Greenough, Captain Beaufort, Warburton, and young Herschel, a man of
acclaim Herschel constantly received and the deep respect he had earned from his peers, one senses his loneliness. Unable as a young man to become close to his father, unable to adopt other men as father figures, and incapable of allowing himself to be touched deeply by other human beings, he retreated and found comfort in the religion of his "beloved Church."  

A case has been made that Charles Darwin harbored great hostility and anger against his father when he was a child, and that these feelings account for his passion for shooting game as a young man. However, what I find remarkable in the relationship between Charles and his father is the transformation that took place. Charles's early fears of his father became replaced by affection, and later by a deep love for the man. One of the notable features of the letters between Charles and his family from the Beagle period is that they record the burgeoning of the love and respect between father and son. Perhaps the most poignant entry in that entire correspondence is the one and only letter that Robert Waring Darwin sent his son during the entire voyage. At Charles's suggestion Robert had bought a banana tree, which flourished "so as to promise to fill the hothouse." This huge, six-foot-three, 350-pound man wrote his letter sitting under the banana tree in his hothouse thinking of his son "in similar shade." Charles "almost cried for pleasure" when he received his father's note. He deeply appreciated his father's attempts to empathize with him in the pleasure he obtained contemplating and communing with nature. Before this letter, Charles had always been apprehensive and apologetic whenever he requested money from his father. There is a mishievous quality to his expressions of genuine gratitude when he took money thereafter. On one occasion, he wrote home: "my Father will believe, that I will not draw money in crossing the Pacific, because I can not — I verily believe I could spend money in the very moon. . . ."  

great abilities, to whom Sir Humphry Davy paid an elegant compliment the other day in a speech as President of the Royal Society 'His father must be doubly rejoiced in such a son, who secures to him a double immortality?" (Hare, Life and Letters of Maria Edgeworth, II, 426).

127. On October 30, 1852, Herschel asked Peacock, who had become the dean of the cathedral at Ely, to officiate at the wedding of his daughter, this "in the double capacity of an old and most valued friend and an ornament of our beloved and venerable church" (Herschel Correspondence, Royal Society).


129. Robert's letter is in Burkhardt and Smith, Correspondence of Charles Darwin, I, 301; Charles's letter is on pp. 447—448.
Neither Charles nor John could bury his father. Charles could not do so either figuratively or literally: he was with his father when he died in Shrewsbury in 1848, and he was so distressed thereafter that he was unable to attend the funeral. In 1869, he went back to Shrewsbury and visited the Mount with one of his daughters. The new tenant showed them the house and with mistaken hospitality remained with them during the entire visit. As they were leaving, Charles, with "a pathetic look of regret," told his daughter: "If I could have been left alone in that green-house for five minutes, I know I should have been able to see my father in his wheel-chair as vividly as if he had been there before me." 130

John Herschel's previously quoted "Requiem of the Forty-Feet Reflector" was clearly a requiem for his father. Yet its dismantling did not lay his father's ghost to rest. In 1843 Maria Edgeworth related that "[Herschel] shewed us a Daguerreotype of the stand of the great instrument before it was taken down. The impression of that frame as it stood was so strong on his eyes that when he was gone he sometimes afterwards saw it in its place so plainly before him that he thought he could have touched it. There it is still he complains — no, he never complains. . . ." 131

The contrast between Darwin and Herschel in their association with potential father figures merits comment. My impression is that Herschel never was able to allow anyone to become a father surrogate. Judging from the extant correspondence, his relationship with Wollaston and with South, the two persons he worked with in London after completing his undergraduate studies at Cambridge, was formal and professional.

Darwin, on the other hand, adopted a whole series of father surrogates at different stages of his life. His uncle Jos was probably the first such figure; later, when Charles was at Cambridge, Henslow assumed this position; and when he returned from his voyage on the Beagle, Lyell took on this role. It is interesting to note that they all remained father figures even as Charles became closer to his own father or rejected the model they presented. It is probable that at one stage he had hoped that Herschel might also assume this position. In his Autobiography, Darwin indicated that during his last year at Cambridge he read "with care and profound interest Humboldt's Personal Narrative. This work and Sir J. Herschel's Introduction to the Study of Natural Philosophy stirred in me a burning zeal to add even the most humble contribution to

the noble structure of Natural Science. No one or a dozen other books influenced me nearly as much as these two." When the Beagle docked at the Cape, he conveyed to his sister, Catherine, his excitement at the prospect of meeting "the great Man." Subsequently, their paths crossed on several occasions. During Charles's stay in London in the late 1830s, he called on Herschel a few times. Thereafter their interaction was primarily professional. In 1848, Herschel asked Darwin to contribute the chapter on "Geology" for the Manual of Scientific Inquiry that he was preparing for the Admiralty, and Darwin fulfilled this request.

Shortly after the completion of the assignment, Robert Darwin died, and Charles was deeply affected by his father's death. His illness flared up and he became progressively more incapacitated. He placed himself under Dr. Gully's care and went to Malvern to undergo hydropathic treatments, which greatly alleviated his symptoms for a while. From Malvern, Darwin wrote Herschel of the "astonishingly renovating action" of the cold water cure; his long, very personal letter, detailing the treatment, would probably have been written to his father had he been alive. He must have sensed the transference that was taking place, because he expressed the hope that Herschel would not find his letter too forward.

The last meaningful interaction between Herschel and Darwin of which I am aware took place after the publication of the Origin. Darwin had sent Herschel a copy of his book and he was very

133. Burkhardt and Smith, Correspondence of Charles Darwin, I, 498.
134. A Manual of Scientific Inquiry Prepared for the Use of Officers in Her Majesty's Navy and Travellers in General ed. by Sir John F. W. Herschel, Bart. (London: John Murray, 1849). The collaboration between Herschel and Darwin was not altogether a happy one. Darwin initially had doubts as to his success; when he finished his MS he feared it was too long and "did not much like it" but felt he could do no better. "[It] cost me some trouble," Darwin wrote Hooker (More Letters of Charles Darwin: A Record of His Work in a Series of Hitherto Unpublished Letters, eds. F. Darwin and A. C. Seward [London: John Murray, 1903], I, 62). The MS was lost in the mail and a second copy needed to be made; and in the first edition of the Manual some of the pages of Darwin's "Geology" section were wrongly set (pp. 171—190). In 1870 Herschel asked Darwin to revise his contribution to the Manual. But Darwin declined, being "unwell and leaving for rest"; he suggested that Professor John Phillips be asked, since Phillips's geological knowledge was more up to date than his (Herschel Correspondence, Royal Society of London). This was in fact done: the 1871 edition lists the "Geology" article as "By Charles Darwin Esq. (revised by Professor J. Phillips)."

135. Colp, To Be an Invalid, pp. 35—43. The letter from Darwin to Herschel is to be found in the Herschel Correspondence at the Royal Society of London.
eager to find out Herschel’s reaction to it. He requested Lyell, “if you should meet him after he has read me, pray find out what he thinks, for, of course, he will not write; and I would excessively like to hear whether I produce any effects on such a mind.”

After reading the Origin, Herschel commented that he thought that the book was “the law of the higgledy-piggedly,” which greatly distressed Darwin. “What this exactly means I do not know,” Darwin wrote Lyell, “but it is evidently very contemptuous. If true, this is a great blow and discouragement.” But since Herschel’s castigation was private, Darwin kept quiet out of a sense of “filial” respect.

However, in January 1861 Herschel appended a footnote to the second edition of his Physical Geography, which stated:

We can no more accept the principle of arbitrary and casual variation selection as a sufficient account, *per se*, of the past and present organic world, than we can receive the Laputan method of composing books (pushed *à l’outrance*) as a sufficient one of Shakespeare and the *Principia*. Equally in either case an intelligence, guided by a purpose, must be continually in action to bias the directions of the steps of change — to regulate their amount, to limit their divergence and to continue them in a definite course. We do not believe that Mr. Darwin means to deny the necessity of such intelligent direction. But it does not, so far as we can see, enter into the formula of his law, and without it we are unable to conceive how the law can have led to the results. On the other hand, we do not mean to deny that such intelligence may act according to a law (that is to say, on a preconceived and definite plan). Such law, stated in words, would be no other than the actual observed law of organic succession; a one more general, taking that form when applied to our own planet, and including all the links of chain which have disappeared. *But the one law is a necessary supplement to the other, and ought, in all logical propriety, to form a part of its enunciation.* Granting this, and with some demure as to the genesis of man, we are far from disposed to repudiate the view taken of this mysterious subject in Mr. Darwin’s book.

Herschel sent Darwin a copy of his book, with the footnote attached. Darwin acknowledged the gift in a letter that reflected the vehemence of his reaction:

Down  
Bromley  
Kent, S.C.

May 23rd

Dear Sir John Herschel:

You must permit me to have the pleasure to thank you for your kind present of your Physical Geography. I feel honoured by your gift and shall prize this book with your autograph. I am pleased with your note on my work on species, though apparently you go but a little way with me. The point which you raise on intelligent Design has perplexed me beyond measure; and has also been discussed with Prof. Asa Gray, with whom I have had much correspondence on the subject. I am in a complete jumble on the point. One cannot look at this Universe and man without believing that all living production has been intelligently designed; yet when I look to each individual organism, I can see no evidence of this. For, I am not prepared to admit that God designed the feathers on the tail of the rock-pigeon to vary in a highly peculiar manner in order that man might select such variations and make a Fantail; & if this be not admitted (I know it would be admitted by many persons) then I cannot see design in the variations of structure in animals in a state of nature, — those variations which were useful to the animal being preserved & those useless or injurious being destroyed. But I ought to apologize for thus troubling you — you will think me very conceited when I say I feel quite easy about the ultimate success of my views, (with much error, as yet unseen by me, to be no doubt eliminated); & I feel this confidence because I find so many young & middle-aged truly good workers in different branches, either practically or wholly accepting my views, because they find that they can thus group & understand many scattered facts. This has occurred with those who have chiefly or almost exclusively studied morphology, geographical distribution, Systematic Botany, Simply Geology & Palentology. Forgive me boasting, if you can; I do so
because I th' value your partial acquiescences of my views, more than that of almost any other human being.

Believe me with much respect.

Yours sincerest & obliged

Charles Darwin¹³⁹

Darwin also wrote Lyell a letter in which he elaborated his disdain and defiance of Herschel's position. "Herschel," Darwin told Lyell,

has a sentence [in his Physical Geography] to the effect that the higher law of Providential Arrangement should always be stated. But astronomers do not state that God directs the course of each comet and planet. The view that each variation has been providentially arranged seems to me to make Natural Selection entirely superfluous, and indeed takes the whole case of the appearance of new series out of the range of science. . . . I must think that such views of Asa Gray and Herschel merely show that the subject in their minds is in Comte's theological state of science. . . .¹⁴⁰

Having banished the heavenly Father and excluded him from intervening in the operations of nature, and having conquered the

¹³⁹. Darwin to Herschel, May 23, 1861, Herschel Correspondence, Royal Society of London.

¹⁴⁰. Darwin, Life and Letters, I, 190—192. After reading the speech in which Kelvin stated that "Sir John Herschel, in expressing a favourable judgment on the hypothesis of zoological evolution (with however, some reservations in respect to the origin of man), objected to the doctrine of natural selection, that it was too much like the Laputan method of making books [by random combination of words] and that it did not sufficiently take into account a continually guiding and controlling intelligence. This seems to me a most valuable and instructive criticism. I feel profoundly convinced that the argument of the design has been greatly too much lost sight of in recent zoological speculations," Darwin wrote Hooker that these remarks by the famous physicist reminded him that Herschel's "sneer" that the doctrine of natural selection is like the Laputan method of making books, made him put in "the simile about Raphael's Madonna when describing in the Descent of Man the manner of formation of the wondrous ball-and-socket ornaments" (Life and Letters, I, 330n2; Kelvin's address, "The Structure of Matter and the Unity of Science," is reprinted in G. Basalla, W. Coleman, and R. H. Kargon, eds., Victorian Science [Garden City, N.Y.: Doubleday, 1970], pp. 98—128). For an account of Darwin's earlier encounter with Comte see S. S. Schweber, "The Origin of the Origin Revisited," J. Hist. Biol., 10 (1977), 229—316.
doubts of his own mortal father and earned his love, it should come as no surprise that Darwin would have the courage to also reject Herschel as a father figure when the latter disapproved of his scientific views.

My emphasis on fathers and father figures should not be taken to mean that "mothers" did not play a significant role in the lives of Herschel and Darwin. The emphasis does reflect the paternistic nature of their society and the fact that early nineteenth-century England was primarily a man's world. Doing justice to those who "mothered the mind" of Herschel and Darwin would require a separate, even lengthier study than the one I have written, because it would have to address their conception of man's place in nature. Certainly in Darwin's mind, nature was intimately associated with mothering and fecundity. When Darwin married Emma — who incidentally was a year older than he — he acquired not only a "nice, soft wife," a constant "companion, (friend in old age) who will feel interested in one, object to be beloved and played with," but also a mother who nurtured him and attended to his needs as well as those of the ten children he fathered. But if Darwin married a "mother," Herschel married a "daughter" — a woman nearly twenty years younger than he.

142. C. Darwin's own mother had also been a year older than his father.
143. The reference is to the penciled notes entitled "This is the Question" that Darwin wrote out in April 1838, which contain his musings on the subject of marriage. The paper is in the form of two columns headed "MARRY" and "Not MARRY" and concludes with "Marry-Marry-Marry Q.E.D"; see Darwin, *Autobiography*, pp. 232–233, or Appendix IV of Burkhardt and Smith, *Correspondence of Charles Darwin*, II, 443–445.
144. Maria Edgeworth, who met Herschel's wife in 1831, described her at the time as follows:

Mrs. Herschel who by the by is very pretty — *which does no harm* — is such a delightful person — so suited to him, with so much simplicity and so much sense — so fit to sympathise with him in all things, intellectual and moral — without any pretension or thought about herself — trying only — no not *trying* but making all her guests comfortable and happy without any apparent trying or effort or trouble. . . .

Of all the people I have seen and of all the society I think the Herschels are the best worth cultivating . . . in their ways of living . . . so comfortable and well regulated and neither too much or too little — all managed by a woman of sense and taste, for a man of sense who never *meddles nor makes* in the matter but takes it all as Heaven sends and his guardian angel. I really think she looks very like an angel as well as I can judge by the most approved pictures of angels (Edgeworth, *Letters from England*, p. 500).

In December 1843 Maria Edgeworth, commenting on the state of John
I conclude my essay with a comment on Herschel’s and Darwin’s relationship to the one role model they had in common: Isaac Newton.

The singular importance of Newton in the development of mathematics and the physical sciences had been deeply impressed during the eighteenth century into the history and the practice of British science. However, by the beginning of the nineteenth century it had become apparent that the rigid adherence to Newton’s notation for the calculus was impeding the development of British mathematics. I have noted that some of Herschel’s most imaginative productions stemmed from his early challenge to Newton. After 1816, Herschel gradually stopped doing research in mathematics, although he kept abreast of developments in the field.¹⁴⁵ His decision to devote himself to astronomy — and by implication, to the verification of the Newtonian program — altered the psychic meaning of the Newtonian image.

When Herschel was asked by Whewell in 1826 to offer himself for the candidacy of the Lucasian chair, which had become vacant, he answered Whewell not only to thank him but also to inform him that “I have unequivocally and finally declined to become a candidate.” He explained the reasons for this decision as follows:

It is not that I am insensible to the credit of the thing — of filling (as you movingly put it) the chair which Newton and Barrow have held — neither is it any silly fret taken at my former unsuccessful attempts to obtain Professorships at Cambridge nor any undervaluing of the real utility and dignity of the situation — which led me to this determination — but simply “a truant disposition my Lord” (for which I think I can at this moment hear you scolding me) which makes me not wish to devote myself exclusively or par excellence to any one branch

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¹⁴⁵ Herschel’s extensive correspondence with Peacock, W. R. Hamilton, de Morgan, and Boole attests to his mastery of the subject and to the help and encouragement he gave these mathematicians.
of science — perhaps too a consciousness that I prefer physical to mathematical sciences, and that the preference is increasing as I get to know more of one and less of the other. I don’t know whether there is not a little vanity too at the bottom of it (which to you, who are not a Minos or Rhadomanthus to your friends, I may confess) that what little I may hereafter do for science, I had rather should be considered as done en amateur than as a matter of duty and profession, and possibly too a kind of obscure consciousness that I am not destined (like great hardheaded thinkers such as yourself) to make giant inroads into great branches of human knowledge — but rather to loiter on the shores of the ocean of science and pick up such shells and pebbles as take my fancy for the pleasure of arranging them and seeing them look pretty.  

Herschel was, of course, alluding to Newton when he indicated that he would rather “loiter on the shores of the ocean of science.” The phrasing “[to] pick up such shells and pebbles as take my fancy for the pleasure of arranging them and seeing them look pretty” (italics mine) reflected Herschel’s views that theories were man-made constructions. His letter reveals that by 1827 he had in some sense “given up,” that he was consciously withholding a total, single-minded commitment to a given field or connected set of problems.

The specter of Newton haunted Herschel throughout his life. As Newton had, he attempted to make time absolute; also like him, he devoted considerable efforts to chemical experimentation. In 1850, Herschel followed Newton’s path and accepted the Mastership of the Mint. As Newton had done a century and a quarter earlier, he threw himself into that task in toto: he attempted to reform the British currency by converting it to the decimal system, and sought to improve the efficiency of the Mint. He suffered a nervous breakdown for his troubles and resigned in 1855.

146. Herschel to Whewell, August 17, 1826, Add MS a 207, Trinity College Library. I thank the Librarian of Trinity College for permission to quote from this MS.

147. “I do not know what I may appear to the world; but to myself I seem to have been only like a boy, playing on the seashore, and diverting myself, in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me!” (I. Newton, quoted in Manuel, Portrait of Isaac Newton [above, n. 81, pp. 388–389). The quotation first appeared in J. Spence’s papers in 1728–1730; see his Anecdotes, Observations, and Characters of Books and Men (London: W. H. Carpenter, 1820), p. 54. For later comments by Herschel on Newton, see his review “Whewell on the Inductive Sciences,” in Herschel, Essays, pp. 143–257, esp. pp. 163–165.
Darwin, too, was aware of the long shadow that Newton had cast. That chemistry might have had its Newton in Dalton or Davy and had entered a new era was a widely held belief in Darwin’s day. That biology was still in need of its Newton was also clear to Darwin’s generation — notwithstanding the eulogies of Cuvier calling him the Newton of biology. I have suggested elsewhere that after he had apprehended the Malthusian mechanism of natural selection in the fall of 1838, Darwin saw himself as the Newton of biology. 148 His annotations to Whewell’s History of the Inductive Sciences suggest he believed that natural selection constituted a revolution — a “metamorphosis” — of biological thought, and that his theory was a “neighbor” in “depth and width” to Newton’s theory. Like Newton, he kept his theorizing and findings private. As with Newton, there was a twenty-year interval between the annus mirabilis and the publication of his findings. Lyell in 1855 was Darwin’s Halley. What Darwin undertook when he assembled his “Big Species Book” was to write his Principia.

From 1838 on, Darwin never wavered from the view that natural selection was a law of nature having universal applicability in the organic world, in the same sense as Newton’s laws of motion and of gravity in the inorganic. Although natural selection by itself was not sufficient to explain the pattern of life on earth — geological, geographic, generational, and other factors must be brought into the explanation — nevertheless, all properties of living organisms are due, at least in part, to natural selection. The period from 1838 to 1858 can best be understood as a constant confrontation of Darwin the grand theoretician, the unifier, whose driving passion is to account for all of the features of the organic world in terms of general principles — as Newton had done for the inorganic — and Darwin the diversifier, the investigator of individual processes, studying the details of the organic world’s diversity, disentangling the complex pattern of particular species and individual organisms to see whether his principles do, in fact, explain the observed phenomena, just as Newton had done in his studies of the tides and lunar motion.

S. F. Cannon has suggested — correctly, I believe — that Darwin could have published his initial version of the theory in 1839 without adverse reaction if he had been prepared to limit its scope to biogeographical and other zoological and botanical questions without raising the issue of man. 149 But like Newton,

Darwin wanted to publish a statement that had a universal character, applicable to all aspects of all living organisms including man and his "higher faculties" — which was very likely not acceptable at that time. It is no accident that the *Origin* closes with a vision of "this planet cycling according to the fixed laws of gravity" on which "endless forms most beautiful and most wonderful have been, are being, evolved." Newton had explained the dynamics of the former, Darwin that of the latter. But note: Newton’s vision was one of cyclicity — a form of constancy; Darwin’s was one of novelty and change.

In death, however, all three — Newton, Herschel, and Darwin — were united. They lie alongside one another in Westminster Abbey.

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