

Charles Darwin and John Herschel*

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The influence of John Herschel on the philosophical thoughts of Charles Darwin, both through the former's book, *Natural Philosophy*, and through their meeting in 1836 at the Cape of Good Hope, is discussed. With Herschel having himself speculated on evolution just a few months before he met Darwin, it is probable that he stimulated at least the beginnings of the latter's lifelong work on the subject.

Key words: evolution, Cape of Good Hope, Charles Darwin, John Herschel

He never talked much, but every word which he uttered was worth listening to.
Charles Darwin, about Sir John Herschel

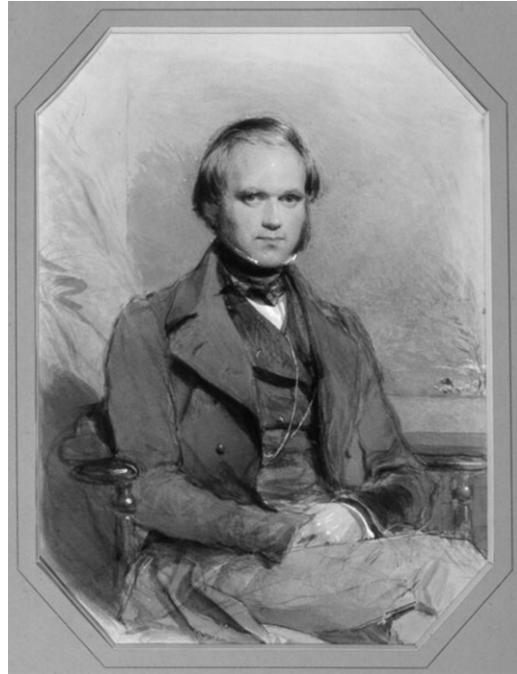
His Majesty's Ship *Beagle*, commanded by Captain Robert Fitz-Roy and carrying Charles Robert Darwin as the naturalist on board, arrived in Simon's Bay on 31 May 1836 on the final stage of a voyage around the world that had taken four and a half years and had still another six months to go. One of Fitz-Roy's duties was to check the accuracy of 22 marine chronometers, destined for use by the Royal Navy; the presence of the Royal Observatory in Cape Town gave him the finest opportunity to carry this out, with the result that the *Beagle* stayed in port for 18 days—longer than at any other port during the circumnavigation (they stayed for five weeks in the Galapagos, but island-hopped).

Darwin used much of his time studying the geology of the region, around Cape Town and beyond the mountains to Paarl and Franschhoek, returning via Sir Lowry's Pass. He took very little interest in the local flora and fauna, presumably because they had been well studied and collected by such previous visitors as the botanists Carl Peter Thunberg and Anders Sparrmann some sixty years before. But his geological interests were assisted by Dr Andrew Smith, who had recently returned from a two-year collecting expedition into the interior and had founded the South African Museum in 1825. Smith gave him a conducted tour of the geology around Cape Town and described the fauna of the interior.^{1,2} In later correspondence, over many years, he gave Darwin further assistance.

However, it was Herschel who interested Darwin most at the Cape. Sir John Frederick William Herschel, already had had, and would continue to have, a fundamental influence on Darwin's philosophy and attitude to research. John Herschel influenced Darwin's approach to scientific investigation in two ways: through his book *A Preliminary Discourse on the Study of Natural Philosophy*,³ published in 1831, the year that Darwin graduated, and by their meeting at the Cape of Good Hope.

Of his formative undergraduate years Darwin later wrote 'During my last year at Cambridge, I 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 up in me a burning zeal to add even the most humble

*A lecture given at the University of Cape Town on 12 February 2008, the bicentenary of Darwin's birth.



Charles Darwin as a young man. Watercolour by George Richmond, after the return of the *Beagle*.

contribution to the noble structure of Natural Science. No one or a dozen other books influenced me nearly so much as these two'.⁴ Darwin's annotated copy of Herschel's book is in the Darwin Library section of Cambridge University Library; he underscored parts that inspired him, including 'what may we not expect from the exertions of powerful minds called into action under circumstances totally different from any which have yet existed in the world' and 'It is only by condensing,



Sir John Frederick William Herschel, mezzotint by William Ward after an 1833 oil painting by H.W. Pickersgill. Courtesy MuseumAfrica.



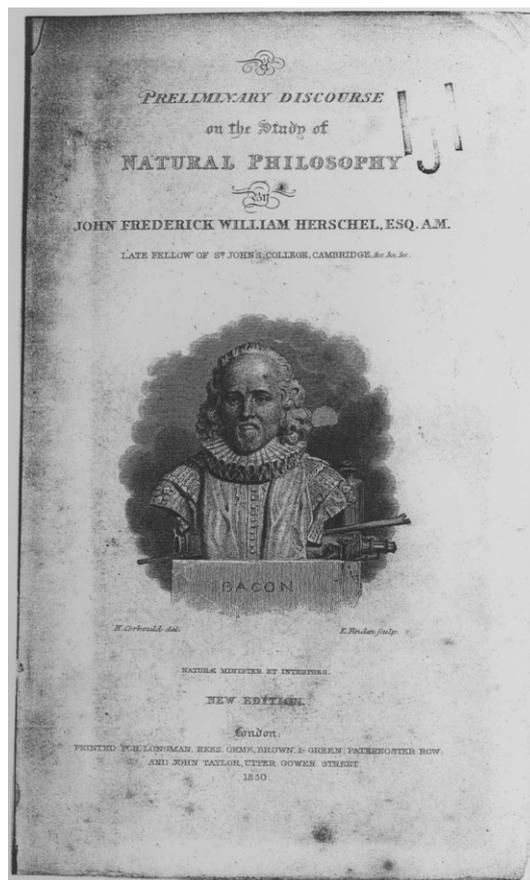
William Whewell: engraving from *The Life and Selections from the Correspondence of William Whewell*.

simplifying, and arranging, in the most lucid possible manner, the acquired knowledge of past generations, that those to come can be enabled to avail themselves to the full of the advanced point from which they will start'.

The book by Alexander von Humboldt,⁵ the last parts of which were published during Darwin's years at Cambridge, was no light read: 3 754 pages of scientific exploration of South America – but once hooked: 'I read & reread Humboldt'.⁶ In contrast, Herschel's *Preliminary Discourse*, hot off the press, was more compact and of sufficient interest and import to remain in print to this day.⁷ Furthermore, its influence in the mid-19th century was so great that it defined and established attitudes towards scientific research that led eventually, both directly and indirectly, to the structuring of Darwin's *Origin of Species*.

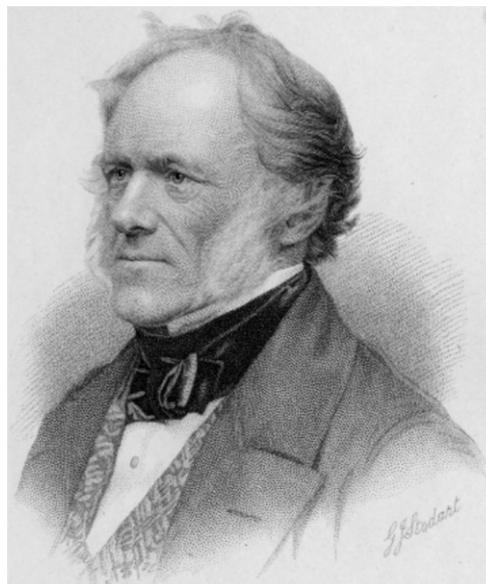
Modern assessments of the *Preliminary Discourse* emphasise that, although a portrait of Francis Bacon is used on its title page, its recommendations are far from 'Baconian' – which recommended the simple amassing of observations until new general properties or laws become self evident. To quote the historian of science Walter Cannon, Herschel's 'view of scientific method was that perhaps the best results come when the mind 'leaps forward', 'by forming at once a bold hypothesis'.⁸ This attitude was taken up by Herschel's Cambridge friend William Whewell, who published his *History of the Inductive Sciences*⁹ in 1837, which *inter alia* embraces the modern spirit that observations or measurements alone are pointless if there is no theory to interpret them. (Herschel's almost book-length review of this is a masterly summary and points out that 'the true *idea* ... often presents itself almost spontaneously'.¹⁰ In this article Herschel also states that Kepler tried 19 hypotheses for representing the orbit of Mars before hitting on an ellipse, which proved the simplest, and applicable to the other planets.)

Astronomy is the earliest science in which theory (in the form of mathematical orbits of planets and double stars) demonstrated its *predictive* power. John Herschel was a pioneer in this—his work on binary stars showed the universality of Newton's laws; but he was also a polymath, and recognised by his eminent contemporary researchers as their superior—see the comments collected by Walter Cannon,¹¹ who concludes that, in the England of the 1830s, 'to be scientific' meant 'to be like physical astronomy', or 'to be as much like Herschel as possible'.



Title page of Herschel's *Preliminary Discourse on the Study of Natural Philosophy*. This is Herschel's own copy, with his JH library bookmark. From the author's collection.

The importance of the *Preliminary Discourse* is acknowledged by many of the 19th century's greatest thinkers—notably John Stuart Mill, James Clerk Maxwell, William Thomson and Charles Darwin himself. (For a general discussion of the philosophy of science and the influence of the *Preliminary Discourse*, see chapter 13 of *Victorian Science*,¹² which contains Herschel's 1845 Address to the British Association for the Advancement of Science, expanding his views on the logic of scientific endeavour.)



Sir Charles Lyell: from *Images of the History of Medicine*.



Feldhausen, where Darwin and Herschel met in 1836. A photograph of the manor house taken in the 1890s.

There was another book strongly influencing Darwin at this time: Charles Lyell's *Principles of Geology*¹³—the first volume of which was given to Darwin by Captain FitzRoy, who read it during the initial phases of the voyage of the *Beagle*, which departed on its circumnavigation in November 1831. The second volume, which contained extensive discussion of the geographical distribution of species, ancient and modern, including speculations on their transmutation, caught up with him in Montevideo in October 1832, and the third volume was waiting for him on his return in 1836. Like Herschel's *Preliminary Discourse*, Lyell's book contained a large collection of examples with a purpose in mind—the title could have been expanded to become *Principles of Geological Reasoning*, as is made evident by its subtitle: *An attempt to explain the former changes of the Earth's surface, by reference to causes now in operation*. Lyell espoused the principle of uniformitarianism (a word invented by Whewell), appealing to currently observable physical processes to explain the past as recorded in the rocks. These volumes amplified the geological tour that Darwin had made with Adam Sedgwick, Professor of Geology at Cambridge, shortly before the departure of the *Beagle*. As a result, during the voyage Darwin largely considered himself a geologist, specialising in rocks and fossils, collecting botanical and faunal specimens as a supplementary interest. The powerful influence of Lyell is seen in Darwin's later admission to Leonard Horner, Charles Lyell's father-in-law; 'I always feel as if my books came half out of Lyell's brains & that I never acknowledge this sufficiently, nor do I know how I can, without saying so in so many words—for I have always thought that the great merit of the Principles, was that it altered the whole tone of one's mind & therefore that when seeing a thing never seen by Lyell, one yet saw it partially through his eyes.'¹⁴

Before describing the meeting with John Herschel at the Cape we jump ahead a little. Darwin arrived back in England on 4 October 1836, after 55 months at sea. He lodged in London and was soon immersed in scientific society, attending a meeting of the Zoological Society on 23 October with a rich store of knowledge to share, but evidently retained the memory of his meeting with Herschel as a highlight of his journey: the next day Elizabeth Ann, wife of George Robert Waterhouse (curator of the Zoological Society's museum and later to describe Darwin's South American insects and mammals) wrote to John Herschel's wife, Margaret: 'We heard of you yesterday evening from Mr Darwin, whom I dare say you remember – he was at the evening meeting of this Society & mentioned you & Sir John to Mr Waterhouse.... He expressed in terms which I must not repeat the pleasure he had had in your own and Sir John's Society'.¹⁵

The Herschels had collected insects for George Waterhouse and dispatched a box of them on 28 January 1837 with Dr Andrew Smith on the latter's departure for England. Accompanying them was a box of insects for H. Griesbach. John's aunt, Sophia Elisabeth Herschel, had married G. Griesbach, a member of the same regimental band as John's father William Herschel. Waterhouse's wife was a Griesbach, and so also a distant relation of John Herschel. Darwin was godfather to Waterhouse's son, Charles Owen Waterhouse, who became Assistant Keeper of coleoptera at the British Museum of Natural History.

Six days after the Zoological Society meeting, Darwin finally met, and dined with, Charles Lyell. That Darwin still considered himself largely a geologist is clear: he had written from Falmouth, ahead of arrival in London, asking the Cambridge mineralogist and botanist John Stevens Henslow to propose him for Fellowship of the Geological Society, the procedure for which was started immediately, and Darwin read his first paper to that Society on 4 January 1837. Despite his friendship with Waterhouse he did not join the Zoological Society until two years later; and he only joined the Linnean Society, the official authority on species, in 1854.

As a preamble to Darwin's meeting with Herschel, we may note that the latter was one of 14 men who had met at the Freemason's Tavern, Lincoln's Inn Fields, London on 12 January 1820, to found a 'Society for the encouragement and promotion of Astronomy',¹⁶ which, together with the establishment in 1821 of the Royal Observatory at the Cape of Good Hope,¹⁷ was the British astronomers' response to Herschel's taunt that at the beginning of the 19th century in Britain 'Mathematics were at the last gasp and Astronomy nearly so'.¹⁸ It was the existence of the observatory at the Cape that decided Herschel to move his telescopes and family there, where he arrived on 16 January 1834, to complete his survey of the sky. And thus it was that Darwin was able finally to meet the man who was lauded as the greatest living natural philosopher, and of whom Lyell said 'If ever there was a *heaven-born genius* it was John Herschel!'¹⁹

The *Beagle* arrived on 31 May 1836 and the next day Darwin rode to Cape Town, passing through Wynberg, where the Herschels lived, arriving in the evening. On 3 June Darwin wrote to his sister Catherine: 'Tomorrow morning I am going to call with Capt. F[itz] R[oy] on Sir J. Herschel. I have already seen the house which he has purchased; it is six miles from the town & in a most retired charming situation. I have heard so much about his eccentric but very amiable manners, that I have a high curiosity to see the great Man'.²⁰ The visit did not materialise on 4 June—on that day Darwin records in his diary that he started on a four day journey with Andrew Smith to Paarl and Franschoek—but on 15 June the diary tersely notes 'Sir J. Herschel'.²¹ The meeting is described in his letter to Henslow, written from St. Helena on 9 July 1836, after having left the Cape:

'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 and 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 sh[o]wed us a pretty garden full of Cape Bulbs of his own collecting; & afterwards I understood, that every thing was the work of his own hands. What a very nice person Lady Herschel appears to be, – in short we were charmed with every thing in & about the house'.²²

He noted in his diary that the meeting 'was the most memorable event which, for a long period, I have had the good fortune to

enjoy'—praise indeed from someone who had spent the previous four and a half years fulfilling his early ambition of exploring a largely unknown world!

It is frustrating that neither Darwin nor Herschel recorded many details of their meetings. In his autobiography Darwin simply remarks 'I felt a high reverence for Sir J. Herschel, and was delighted to dine with him at his charming house at the C. of Good Hope and afterwards at his London house. I saw him, also, on a few other occasions. He never talked much, but every word which he uttered was worth listening to. He was very shy and he often had a distressed expression'.²³ And Herschel, who would certainly have recognised that Darwin was more than ordinarily well informed, only states in his Cape diary that 'Capt F. & Mr D. came at 4 and we walked together up to Newlands'²⁴ and that they and other visitors dined at 6. In fact, Herschel's diary gives more attention to the discussion that he had with FitzRoy about Andrew Smith being ordered to Simon's Town and thus forced to leave his museum and expedition collections. As a result of this order, Herschel sent a letter on 20 June to the Director-General of the Army Medical Department, Sir James McGrigor, who happened to have been the person who accepted Smith into the Army Medical Service in 1815 and was a long-term acquaintance of Herschel, suggesting that Smith be given leave of absence in England to write up the expedition.²⁵ Smith's regiment was recalled a few months later anyway.

Margaret Herschel appears not to have noticed Darwin at all, having eyes only for FitzRoy, writing to her brother in England: 'You may soon expect to see a Capt. Fitzroy who has run off with all our hearts, & sundry husbands are very glad he has gone – he has been like an epidemic among us, but the erring wives are safe in the numbers affected'.²⁶

Herschel's apparent serious demeanour belied a light-hearted interior: Maria Edgeworth in 1827 wrote that he '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 humour and playful nonsense, though with a melancholy exterior'.²⁷ This is not the place to examine Herschel's character more fully; suffice it to say that in the 1820s the effect of two broken engagements resulted in his withdrawal from society and concentration on research, only terminated by his marriage in 1829. Nevertheless, the lifelong serious visage has led psycho-historians naively to diagnose manic-depressive behaviour and other disorders, in Herschel and also in Darwin.^{28,29}

Herschel must have remained fresh in Darwin's mind for the rest of the *Beagle's* voyage—in his diary for 26 September 1836, three months after leaving the Cape, he makes 'a short retrospective of the advantages and disadvantages the pain and pleasure of our five years' wandering', concluding 'it appears to me that nothing can be more improving to a young naturalist, than a journey in distant countries. It both sharpens and partly also allays that want and craving, which as Sir J. Herschel remarks, a man experiences, although every corporeal sense is fully satisfied.' That sentiment, as Darwin notes in the margin, comes from page 3 of Herschel's *Preliminary Discourse*. It later was carried out to good effect by, for example, the naturalists Joseph Dalton Hooker on James Clark Ross's Antarctic expedition in the *Erebus* and Thomas Henry Huxley in his circumnavigation in the *Rattlesnake*.

Although Herschel 'never talked much' it is probable that at the Cape he put a number of ideas into Darwin's mind. By a remarkable coincidence, in the months before Darwin's arrival, Herschel had been thinking about evolution of animals and plants. Thoughts on evolution ran in the family—his father, William Herschel, had tried to determine from his own

observations whether stars possibly evolved from gaseous nebulae, or vice versa, and had suggested that if rates of change could be measured then the dates of origin could be found. John Herschel had continued to work towards this, and early on expressed his justifiably cautious attitude towards evolution in general:

'...however completely a scale of gradation between a multitude of individuals existing simultaneously may be made out, this affords no ground whatsoever for supposing any one among them to have passed, or be capable of passing, through all the other states, or for concluding them to be in a course of progress from one state in the series to another. There are infinite varieties in the modes and forms of animal life, from man down to the lowest orders; and some naturalists would willingly establish a progression among them, beginning with the simpler, and going on to more complicated forms; but so long as no progress can be seen to go on – so long as for generation after generation every animal succeeds to all the imperfections of its parent, the utmost that we can admit is, that such a formative nisus may have once existed, and acted in the progressive manner supposed, but that all such progression has long since ceased in the present state of nature.'³⁰

This statement was made in the introductory section of a catalogue of binary stars, and may not have reached far beyond the eyes of astronomers. Herschel later reviewed knowledge of celestial evolution in his *Treatise on Astronomy*,³¹ which was another in Lardner's *Cabinet Cyclopaedia* series (the *Preliminary Discourse* had been the first), published just before his trip to the Cape and the best-selling popular book on astronomy throughout the 19th century. It was Herschel's observations at the Cape of the Large Magellanic Cloud, in which all stages of evolution of stars, nebulae and star clusters exist simultaneously, that later advanced the subject further. His careful drawings of nebulae were clearly intended as 'first epoch' delineations that could be used by posterity to discover changes and their rates; and it is probable that his almost photographic depiction of the eastern buttresses of Table Mountain was similarly destined.³²

His later thoughts on evolution among living organisms were partly initiated by the richness of the Cape flora, which had stimulated him and his wife to collect and paint them, especially the bulbous varieties. The 'pretty garden full of Cape Bulbs', mentioned by Darwin, contained in excess of 200 species, over 100 of which were illustrated by the Herschels.³³ With all these in close proximity Herschel was able to compare the morphology of flowers of similar species, and came to a novel conclusion: in a lengthy letter to Charles Lyell,³⁴ written four months before Darwin's arrival at the Cape, he says 'This is a beautiful country for studying the graduation of Botanical species – the families are so rich in species. I am little or nothing of a Botanist – but with one feature it is impossible not to be struck – namely, that when you find a species which fills up as you fancy a wanting link between two others – it does not *merely* fill it, but does so with the superaddition of some new characters – or some analogy with a 3rd species which the others do not offer'.

John Rourke has commented:³⁵ 'The depth of his insight as revealed by these comments is surprising especially when one considers they were conceived several decades before the principles of inheritance were established and 23 years before Darwin's theory of evolution had been published. Indeed, in terms of the theoretical basis of systematics, observations like these were really only given formal structure with the publications of Hennig'.^{36,37}

Herschel's letter to Lyell contained largely geological matters, in which he advances an hypothesis on the rise and fall of conti-

nents and concomitant sea level which embodies the principle of isostasy—a word only introduced much later in the 19th century. This is an item that we know he did discuss with Darwin, for in Darwin's notebook, written onboard the *Beagle* and used to record immediate reactions, there is the comment 'Sir J. Herschel's idea of escape of Heat prevented by sedimentary rocks, & hence Volcanic action, contradicted by Cordillera, where that action commenced before any great accumulation of such matter'.³⁸

But here we are more concerned with what Herschel had written to Lyell about evolution. It is worth noting, in any case, whether or not he shared these ideas with Darwin verbally, the latter certainly saw them in detail soon after his return to England because Charles Babbage (who had been an exact contemporary and friend of Herschel at Cambridge) read the letter sent to Lyell and published a major extract from it in an Appendix to his *Ninth Bridgewater Treatise*.³⁹ The *Treatise* was written largely as a cheeky rebuttal to the previous eight multi-authored volumes, which took as their commissioned theme the wonders of Nature as evidence for the (in the case of appearance of new species, the continued) work of a Creator, essentially as a 'tinkering miracle-monger'.⁴⁰ Many younger thinkers were beginning to dismiss them as the 'Bilgewater Treatises'.

What Herschel thought about the *Treatises* is not clear, but may be connected with a diary entry on board ship some ten days before arriving at the Cape in January 1834, where he was raised to such a fury that he poured scorn into his private diary: 'In Evening skimmed Sharon Turner's *Sacred History from Creation to Deluge*⁴¹ a vile trash-book, on the principle of 'bringing Science to support religion' as it is now called – i.e. 'proving' everything it is considered desirable to prove by mustering a roll-call of quotations misapplied and misunderstood out of books called scientific (all being held of equal authority) as the work described. He contends that the 6 days of Creation were really and truly 6 times 24 hours of the same length as at present – in which Geolog[ica]l work was done (Vide Lyell's 3rd Volume!!). He considers that the Atmospheric water if precipitated on the Earth *in toto* would re-drown the world whereas it would not raise the Ocean a foot & c'.⁴² This might have been the stimulus for a planned (but unwritten) work on ethics, with an empirical orientation, that Herschel announced to Whewell.⁴³

What Lyell had argued in the first edition of his *Principles* was that geological processes required at least millions of years to accomplish what was evident to any careful observer; Lyell was thus one of the founders of modern geology. On its publication, his book was treated very much in the same way as Darwin's *Origin* some 30 years later—only John Herschel and the geologist G. Poulett Scrope immediately came out in support of it. Others of his fellow geologists, astonished at Lyell's adoption of uniformitarianism rather than the in-vogue catastrophism, complained of his 'absurdities' and members of the church condemned its 'impiety'.

Near the beginning of his letter to Lyell, Herschel comments on an aspect of the third edition of *Principles of Geology* that he had just received from the author (that he had read the first edition is evident from his ship-board diary entry quoted above): '...by unveiling a dim glimpse of a region of speculation ... where it seems impossible to venture without experiencing some degree of that mysterious awe.... Of course I allude to that mystery of mysteries the replacement of extinct species by others. Many will doubtless think your speculation too bold – but it is as well to face the difficulty at once. For my own part I cannot 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 his other works we are led by all analogy to suppose that he operates through a series of intermediate causes & that in consequence, the origins of fresh species, could it ever come under our cognisance would be found to be a natural in contradistinction to a miraculous process – though we perceive no indications of any process actually in progress which is likely to issue in such a result'.

Darwin pounced on one aspect of this paragraph, written on page 226 of the *Bridgewater Treatise*, and wrote in his notebook 'Herschel calls the appearance of new species the mystery of mysteries, & has a grand passage upon the problem! Hurrah – 'intermediate causes''.⁴⁴ This demonstrates that Herschel probably did not show a copy of his Lyell letter to Darwin, otherwise the latter would have mentioned it at this point in his *Beagle* notebook. But another indication that Herschel did discuss aspects of evolution with Darwin is that the first mention of an evolutionary solution to the question of disappearance and creation of species is written in Darwin's ornithological notebook shortly after he sailed from Cape Town.⁴⁵

Continuing with Herschel's letter:

'Speaking of the destruction of species there is here a very lovely species of plant which seems verging rapidly to extinction – the *Disa Grandiflora*.⁴⁶ It grows only on the summit of Table Mountain, and as I am told on no other mountain in the Colony ... it may be contended that any given group observed to be confined to a particular district is in fact only the last surviving remnant of the same group universally disseminated, but in course of extinction – nor do I see how to distinguish supposing only one individual existed in the whole world – whether that species were just nascent – or just dying out. Perhaps both processes are going on at once – some groups may be spreading from their foci others retreating to their last strongholds'.

Herschel's philosophy was thus that species are dynamic entities, not static ones. This was not a new concept, but Herschel's emphasis undoubtedly stayed with Darwin, and he eventually struck on the mechanism that accounts for the dynamic nature of species. Twenty years later Darwin's opening paragraph of the *Origin of Species*⁴⁷ contains Herschel's phrase: 'When on board HMS *Beagle* as naturalist, I was much struck with certain facts on the distribution of organic beings inhabiting South America. These facts seemed to throw some light on the origin of species – that mystery of mysteries, as it has been called by one of our greatest philosophers'.

In his reply to Herschel's letter, Lyell admits his reluctance to carry speculation on transmutation further than he already had:

'In regard to the origination of new species, I am very glad to find that you think it probable that it may be carried on through the intervention of intermediate causes. I left this rather to be inferred, not thinking it worth while to offend a certain class of persons by embodying in words what would only be a speculation'⁴⁸ and to Adam Sedgwick at this time, he wrote 'the theory, that the creation of new species is going on at the present day ... I really entertain it ... but I have studiously avoided laying the doctrine down dogmatically as capable of proof'.⁴⁹ In fact, not until after the publication of Darwin's *Origin* did Lyell have the courage to support transmutation of species publicly—in the tenth edition of his *Principles*, which appeared in 1867.

Herschel's letter to Lyell contains a passage of relevance to what Herschel and Darwin discussed at the Cape: 'I hope your example will be followed in other sciences, in trying what *can* be done with existing causes, in place of giving way to the indolent weakness of a priori dogmatism.... In one subject (I mean

Philology) it strikes me this would be very desirable. An enquiry into the laws of verbal corruption & into the processes and rate by which words do actually change their meanings....' This passage illustrates Herschel generalising his thoughts on evolution to an apparently unrelated discipline, but it is of importance here because many years later Darwin wrote to Lyell: 'Your metaphor of the pebbles of pre-existing languages reminds me that I heard Sir J. Herschel at the Cape say how he wished some one would treat language as you had Geology, and study the existing causes of change, and apply the deduction to old languages',⁵⁰ which shows that this element too of Herschel's recent contemplations was communicated to Darwin.

In his letter to Lyell, Herschel went on to say 'Words are to the Anthropologist what rolled pebbles are to the Geologist – battered relics of past ages often containing within them indelible records capable of intelligible interpretation, and when we see what amount of change 2 000 years has been able to produce in the languages of Greece & Italy ... we naturally begin to ask how long a period must have lapsed since the Chinese, the Hebrew, the Delaware & the Malessas had a point in common with the German & Italian & each other. Time! Time! Time! We must not impugn the Scripture Chronology, but we *must* interpret it in accordance with *whatever* shall appear on fair enquiry to be the *truth* for there cannot be two truths. And really here is scope enough: for the lives of the Patriarchs may as reasonably be extended to 5 000 or 50 000 years apiece as the days of Creation to as many thousands of millions of years'. Herschel here is suggesting the use of the rate of departure from an ur-language as a means of estimating the age of man—similar to modern use of DNA mutation rates to find the most recent common ancestor.

Darwin's letter written to Henslow from St Helena reported 'There are many pleasant people at the Cape. Mr Maclear, the astronomer, was most kind & hospitable'. Maclear himself was not keeping a diary at this time, but his wife, Mary, recorded several visits to the observatory by FitzRoy, for most of which Darwin was elsewhere, but 'Friday 10th [June] Disappointed to find the H[erschel]s were previously engaged – also of Dr Smith's company – disappointed only Mr Darwin & Capt. F. here'.⁵¹

The third component of influence on Darwin's thought, beyond those of Herschel and Lyell, was his discovery in October 1838 of the reasoning in Thomas Malthus's book.⁵² As an economist Malthus was interested in the competition for resources within the human population, but Darwin realised its relevance to Nature in general; in particular, not just to competition between species but also to the struggle for survival between individuals of the same species. This was the component missing from previous theories of evolution of species. It is perhaps slightly surprising that Darwin overlooked Malthus until 1838—in his *Preliminary Discourse* Herschel quotes admiringly from another of Malthus's books, the *Principles of Political Economy*.⁵³

Darwin and Herschel had only one later joint involvement. In 1848, the Navy persuaded Herschel to produce a handbook, a *Manual of Scientific Enquiry*, for seafarers, which would help them to record observations of use to science. Herschel distributed the task among experts, selecting *Meteorology* for himself (he expanded this in the 8th edition of the *Encyclopedia Britannica* in 1857, later published separately⁵⁴), and choosing Darwin rather than Lyell to provide Section VI, on *Geology*, probably reasoning that, unlike Lyell, Darwin had himself been a seafarer. Darwin's magisterial essay contained much advice, based on his *Beagle* experiences, and right at the outset states that although a traveller may not witness geological changes 'he is admirably

situated for studying the still active causes of those changes, which, accumulated during long-continued ages, is the object of geology to record and explain'.⁵⁵ In connection with this article he wrote to Herschel, apparently forgetting where he first learnt to think in such a fashion, and probably causing Herschel to form an analogy with grandmothers and their evacuation of eggs:

'You may possibly be surprised at my having expressed myself rather strongly, that the mere collecting rock-specimens is hardly of any use to Geology. I have for some years come deliberately to this opinion, in which some other geologists, with whom I have discussed the point, concur with me. I could specify several large collections lately brought home, which no one person would take the trouble even of looking at. This is very mortifying to the collector & prevents him afterwards turning his attention to some other branch of Nat[ural] Hist[ory], in which mere collecting would be of service'.⁵⁶

That Darwin really had taken such matters to heart is seen in a letter he wrote to Asa Gray in America in 1857: 'It ought never to be forgotten that the observer can generalise his own observations incomparably better than any one else. How many astronomers have laboured their whole lives on observations, and have not drawn a single conclusion; I think it is Herschel who has remarked how much better it would be if they had paused in their devoted work and seen what they could have deduced from their work'.⁵⁷

In a letter to J.D. Hooker, Darwin saw the value of the *Manual* to current and future scientists like themselves: 'This work, which is edited by Sir J. Herschel, is a very good job, in as much as, the Captains of Men of War, will now see the Admiralty care for science & so will favour naturalists on board'.⁵⁸

By the time of the *Manual* Darwin had established himself by publishing his first few books, two reporting his discoveries on the voyage of the *Beagle*, but one conforming more completely to Herschel's expectations of a scientist—his work on coral reefs.⁵⁹ In his autobiography Darwin says of this book 'No other work of mine was begun in so deductive a spirit as this, for the whole theory was thought out on the west coast of South America, before I had seen a true coral reef. I had therefore only to verify and extend my views by a careful examination of living reefs'.⁶⁰ But later in life, in the autobiography, he noted that 'My mind seems to have become a kind of *machine for grinding general laws* out of large collections of facts', which is closer to the Baconian concept of research.

When Darwin produced the *Origin*, his *opus magnum*, in 1859, he naturally was anxious to hear his hero's opinion and so sent Herschel an advance copy:⁶¹ 'I have taken the liberty of directing Murray to send you a copy of my book on the Origin of species, with the hope that you may still retain some interest on this question.— I know that I ought to apologise for troubling you with the volume & with this note (which requires no acknowledgment) but I cannot resist the temptation of showing in this feeble manner my respect, & the deep obligation, which I owe to your Introduction to Natural Philosophy. Scarcely anything in my life made so deep an impression on me: it made me wish to try to add my mite to the accumulated store of natural knowledge'.⁶²

To some extent, Darwin's *Origin* follows Herschel's *Preliminary Discourse* in that both assembled an enormous number of examples that a theory, or theories, could connect together in explanation. That had become the emphasis—science is not a mere accumulation of facts, it provides *understanding*, from which prediction and verification should be possible. Furthermore, Darwin's process of arriving at the principle underlying trans-

mutation had incidentally satisfied Herschel's wish that 'the true idea ... present itself almost spontaneously': Darwin says in his autobiography that 'I can remember the very spot in the road, whilst in my carriage, when to my joy the solution occurred to me'.⁶³

The influence of Herschel and Whewell on Darwin's philosophy of science has been examined in depth by Ruse.⁶⁴ He remarks that 'Darwin, working in the light of the Herschel-Whewell philosophy, felt able to regard selection as a possible evolutionary mechanism' and emphasises that, to Darwin, his selection mechanism was the 'biological equivalent of Newtonian astronomy'. But this was not admitted by Herschel: he did not publish a review of *Origin*, but rumours of his attitude towards it spread: 'I have heard by round about channel that Herschel says my Book 'is the law of higgledy-pigglety'. What this exactly means I do not know, but it is evidently very contemptuous. If true this is a great blow & discouragement.'⁶⁵

In fact, Herschel had failed to accept the essence of Darwin's proposed mechanism—that genetic variations produce changes that may be advantageous or disadvantageous, and, in a competitive world, the former can lead to steady departure from the original type. Thomas Huxley's reaction when he read this in his own advance copy of *Origin* was 'How extremely stupid not to have thought of that!'⁶⁶ But Herschel believed that *directed* variations were necessary: 'Favourable variations must 'occur' if anything is to be 'effected' is what he noted in his copy of the *Origin*. But we may respect that he was also still influenced by his earlier stated principle that 'so long as no progress can be seen to go on ... the utmost that we can admit is, that such a formative nisus may have once existed', which is correct in intention but ultra-conservative and effectively denies the possibility of arriving at a solution by inductive reasoning.

Herschel's rejection of straightforward natural selection might be thought to be the result of his advancing years but probably was also partly due to the influence of his wife, who was the daughter of a Presbyterian minister. He also resisted acceptance of the law of conservation of energy a few years later,⁶⁷ based on the sensible argument that not all forms of energy were yet known and therefore the sum over them may be incomplete and its postulated constancy therefore not testable. In retrospect this was correct—the existence of 'sub-atomic' energy was unsuspected, and was the cause of Thomson calculating an incorrect age for the Sun, and hence his conflict with Lyell's (and Herschel's) much greater geological age of the Earth. As with many who had been educated in that era,⁶⁸ he persisted in believing that the species *Homo sapiens* is at the top of the tree of life, so even if evolved from lower animals there had to be a built-in bias to natural selection in order to ensure the 'right' outcome. He, and those with vested interests, ignored the reality that in 1543, when Nicholas Copernicus moved the Earth from the centre of the universe, *Homo sapiens* went with it.

Just prior to publication of the *Origin*, Herschel had contributed a major article on geography to the eighth edition of the *Encyclopaedia Britannica* in which he is explicit in his belief that 'in each of those successive submersions and reconstructions of the continents, fresh corresponding races of animals, and a new and different clothing of vegetation have been introduced ... which, however, has not operated, either by a gradual progressive variation of species, nor by a sudden and total abolition of one race, and introduction of another entirely new, but by a series of overlappings, leaving the last portion of each in coexistence with the earlier members of the new series.'

When Herschel republished this article as a book, *Physical Geography*,⁶⁹ two years later, he emphasised '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 definite course... ', but added a footnote: 'This was written previous to the publication of Mr. Darwin's work on the Origin of Species, a work which, whatever its merit or ingenuity, we cannot, however, consider as having *disproved* the view taken in the text'. He goes on to affirm that random variations will only produce slow departure in a literally random direction from the average, and uses the analogy of constructing Newton's *Principia* or the works of Shakespeare by 'Laputan' means (see Swift's *Gulliver's Travels*)! Nevertheless, he softens the blow by ending his comment '...with some demur as to the genesis of man [author's emphasis], we are far from disposed to repudiate the view taken of this mysterious subject in Mr. Darwin's work'.

This gave Darwin the opportunity in a letter to Herschel, to be, initially, grateful:

'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, & shall prize this Book with your autograph. I am pleased with your note on my book 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; & has been ably discussed by 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 with all living productions & man without believing that all 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 in the tail of the rock-pigeon to vary in a highly peculiar manner in order that man might select such variations & make a Fan-tail; & 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 apologise for thus troubling you'.

Finally, losing patience, and out of character, Darwin the mature and successful scientist, insults his revered senior:

'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 partially 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, simple geology & palaeontology. Forgive me boasting, if you can; I do so because I should value your partial acquiescence in my views, more than that of almost any other human being.'⁷⁰

And that is how it was left. One of Darwin's contemporary young supporters was Alfred Russell Wallace, who had independently arrived at identical conclusions; and later discoveries in genetics and molecular biology revealed the mechanisms by which natural selection works, variously at molecular and species level. A modern assessment of Darwin's contribution can be found in Stamar's book.⁷¹

In his autobiography,²⁶ Darwin counters Herschel by stating that 'astronomers do not state that God directs the course of each comet and planet. The view that each variation has been providently arranged seems to me to make Natural Selection entirely superfluous, and indeed takes the whole case of the appearance of new species out of the range of Science'.

Darwin and Herschel did not converge in their views, but ultimately they did in their corporeal remains—they are buried in neighbouring graves at the northeast corner of the nave in Westminster Abbey, next to the tomb of Isaac Newton.

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