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CHARLES LYELL AND CHARLES DARWIN[1)]

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ABSTRACT

Lyell's main work, *The principles of geology* (1830-1833), left a deep impression on Darwin. This is not only evident from the three geological books Darwin published after his return from the voyage of the *Beagle*, but also from his main work, *The origin of species* (1859). The latter can be considered as an application of Lyell's principle of uniformitarianism to the history of the living world. Lyell on the other hand never became a fully convinced Darwinian. It is suggested that this was mainly due to a fundamental difference between Lyell's steady-state model of the Earth's history, and Darwin's view of the history of life as a progressive process. Increased knowledge of the Earth's early Cryptozoic history shows that progressive changes also occurred in the history of the Earth. This, however, does not invalidate the general applicability of the principle of uniformitarianism throughout the whole of geological time.

LYELL'S INFLUENCE ON DARWIN

A copy of the first volume of Charles Lyell's *Principles of geology* (L y e l l, 1830-1833) accompanied Charles Darwin when he sailed from Devonport on board the *Beagle* on December 27, 1831. It took the small ship two months to reach South America. Apart from some incidental observations at sea, and visits to some of the Atlantic islands where the *Beagle* harboured, there was not much to do for Darwin. He read the *Principles*, mastered its contents, and became deeply impressed by the way Lyell looked at the changes of the inorganic world. This approach was quite different to that of Jameson whose lectures Darwin had attended when he was an unsuccessful medical student in Edinburgh. The experience made him decide never to occupy himself with geology anymore.

Darwin has expressed his appreciation for Lyell's work in several ways. The impression the work made on his mind, is most evident from the three books he wrote during the ten years following his return in 1836: *The structure and distribution of coral reefs*, *Geological observations on the volcanic islands...*, and *Geological observations on South America* (D a r w i n, 1842, 1844, 1846). Even when writing on coral reefs Darwin approaches the subject as a geologist. Moreover, this volume as well as the two other volumes, reflects a typically Lyellian way of thinking. One of the main conclusions regarding coral reefs is that the several types of reef can only be understood by assuming a subsidence of their foundations. Again, in the volume on South America, Darwin is largely concerned with the many features of elevation visible along both the east and the west coast of the continent. Obviously Darwin is looking for Lyell's "causes now in operation". There can be no doubt that his mind had been profoundly affected by his reading the *Principles*, and this conclusion is further supported when it is remembered that neither during his years in Edingburgh nor in Cambridge, had his interest in natural history been particularly orientated towards geology. In those days he had been a keen beetle collector, but the five volumes on the zoological results of the voyage of the *Beagle* were written by several specialists, Darwin's only contribution being a geological introduction to Richard Owen's volume on fossil mammals. Darwin was well aware of what he owed to Charles Lyell, to whom the second edition of his narrative of the voyage is "dedicated with grateful pleasure, as an acknowledgment that the chief part of whatever scientific merit this journal and the other works of the author may possess, has been derived from studying the well-known and admirable Principles of geology" (D a r w i n, 1845).

During these same ten years Darwin started to work on what twenty years later would appear to be his main work. During the voyage of the *Beagle* he had been deeply impressed by three observations:

(1) the discovery of great fossil animals in the Pampean formation of South America,

(2) the manner in which closely allied animals replace each other form north to south over the same continent, and

(3) the slight faunal difference between the individual islands of the Galapagos archipelago within their general South American character.

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Forty years later he wrote (Fr. D a r w i n, 1887, vol. 1, p. 82):

It was evident that such facts as these, as well as many others, could only be explained on the supposition that species gradually become modified; and the subject haunted me.

Darwin opened his first notebook in July 1837. Initially he collected facts "especially with respect to domesticated production, by printed enquiries, by conversation with skilful breeders and gardeners..." (Fr. D a r w i n, 1887, Certainly not less important are the differences between their authors, although here Here again Darwin was looking for the "causes now in operation". Lyell's influence, so evident in Darwin's geological works, did not lose its strength when he turned his attention to the organic side of the history of nature.

THE MAIN WORKS AND THE AUTHORS

Lyell's *Principles* (L y e l l, 1830-1833) and Darwin's *Origin* (D a r w i n, 1859) treat two different aspects of the history of nature: the changes of the Earth itself, and the changes of its living inhabitants. In their most essential features both books rest on the same fundamental principle of uniformity.

Lyell as well as Darwin sought to explain former changes by subscribing them to the same causes that before their own eyes lead to minor changes from year to year, and from generation to generation. In this respect it is of interest to remember that they held opinions about the length of geological time that were markedly different from prevailing opinion in their days. Nothwithstanding a close correspondence in the underlying principle, the two books show interesting differences, particularly in the way that they were developed. Certainly not less important are the differences between their authors, although here too remarkable similarities exist.

Neither Lyell nor Darwin received any formal education in the fields where they later were to make their brilliant contribution during a long life's work, but both developed a more than superficial interest in these fields at an early age. Lyell went to Exeter College, Oxford, in 1816, and took his B.A. with second class honours in 1819. Soon afterwards he was entered at Lincoln's Inn, London, to study law. Darwin spent two years at Edingburgh (1825-1827) as a medical student before moving to Cambridge when it was decided that he would become a clergyman in the Church of England. He took his B.A. in 1831. Whatever hopes there may have been to serve the church – the prospect of being a country clergyman was not entirely unattractive to him – they ended completely, however, when he left England as a naturalist with the *Beagle* in December of the same year. The turning point in Lyell's life is less well defined. After having been admitted to the bar in 1822 he joined the "western circuit", a kind of travelling court of justice. However, he was not much attracted by the work, and moreover he soon discovered that his earnings were insufficient to cover his expenses en route. During this time Lyell contributed a number of reviews to the *Quarterly Review.* His first original paper, dealing with recent freshwater limestones in Forfarshire, was published in 1826. His position in geology is probably better illustrated by his serving on the council of the Geological Society of London, from 1823 till 1825, than by his election into the Royal Society in 1826, an honour that was in those days not primarily based on scientific merit. As a beginning barrister Lyell devoted more and more of his time to the study of geology. The idea of devoting his life to geology entirely seems to have crept into his mind gradually. Perhaps the year 1827 should be considered as the turning point in his career. In a letter to his father, dated April 10, 1827, he wrote (M r s. L y e l l, 1881, vol. I, p. 170):

> But if I wrote anything, I would wait longer (unless I was in want of cash), and certainly a work even elementary, which would gain one reputation, would neither be done in a few months nor easily. I have my doubts as to leaving sessions on the score of economy. I found the additional time of which I am master, in consequence of ostensibly following a profession, is very great, and perhaps the 30 *l.* that sessions cost me, might be annually returned by an additional article, which I might be thereby enabled to write.

The idea of writing a general book on geology also developed only gradually. In 1827 he planned to contribute a long paper reviewing the state of the science of geology, to the *Quaterly Review*, but before he had started on it he received a copy of Poulett Scrope's work on the volcanoes of Auvergne (S c r o p e, 1827). Feeling that Scrope's earlier book on volcanoes (S c r o p e, 1825) had been unjustly treated by M a c c u l l o c h (1826), Lyell decided to review Scrope's new book first. He seems to have had doubts as to whether or not a general review of the state of geology could be fitted within the pages of a magazine, and to have thought that a book would be a more appropriate form. This motion was probably strengthened by his previous experience that hammer and pen could earn him a living rather than the codes of law.

In May 1828 Lyell started on his long trip to the continent, together with the Murchisons. The latter returned home from northern Italy in September, when Lyell continued his journey alone to southern Italy. By February 1829 he was back in London. Although different in scope and length of time, perhaps less so in hardships, Lyell's journey in France and Italy was of comparable significance to him as the voyage of the *Beagle* was to Darwin. The experiences left a distinct stamp on the main works of Lyell and Darwin. The *Principles* as well as the *Origin* was largely developed in the years after their authors' travel experience when impressions of fascinating observations were still fresh. Neither the *Principles* nor the *Origin* would have looked as they do, without

the impressive experience left on Lyell by his ten months' journey on the continent, or on Darwin by the five years' voyage of the *Beagle*.

Lyell left Britain in 1828 with a vague concept of the book already in mind. From Naples he wrote to Murchison in a letter dated January 15, 1829 (Mrs. L y e l l, 1881, vol. I, p. 234):

> My work is in part written, and all planned. It will not pretend to give even an abstract of all that is known in geology, but it will endeavour to establish the *principles of reasoning* in the science; and all my geology will come in as illustration of my views of those principles, and as evidence strengthening the system necessarily arising out of the admission of such principles, which, as you know, are neither more nor less than *no causes whatever* have from the earliest time to which we can look back to the present, ever acted, but those *now acting*;...

How much of the book actually was written by that time, is uncertain, but in view of Lyell's absence from London since May 1828, and the very few references to the book before that date, one is inclined to think that it cannot have been much. Nevertheless, the first volume was published in the summer of 1830, followed by the second volume in 1832 and the third volume in 1833 (L y e l l, 1830-33). Lyell completed the whole work in an amazingly short time.

Darwin on the other hand laboured on the *Origin* for over twenty years, and what finally appeared in November 1859 was considered by Darwin as a mere abstract of his "big book"[3]. Its hasty publication was only due to A.R. Wallace who when travelling in the Malayan archipelago had independently developed a theory remarkably similar to that of Darwin. Darwin received Wallace's manuscript on June 18, 1858, with a letter asking him to forward it to Lyell. Darwin did so the same day. There is no need to retell the events between June 18, and July 1st, the day of the special general meeting of the Linnean Society where Lyell and Hooker presented the papers by Darwin and by Wallace. In view of the sometimes small-minded behavior of scientists one cannot fail to note what a sublime chapter in the history of science these weeks represent.

One can hardly escape the conclusion that the different prehistories of the two books reflect different physical and probably psychical constitutions of their authors. Evidently Lyell easily formulated his thoughts. It is known that he dictated large parts of the *Principles* to a secretary, whose roll was taken over by Mrs. Lyell on Sundays! Lyell moreover seems to have enjoyed a vigorous health during most of his life, whereas Darwin after his return from the voyage of the *Beagle* suffered from an illness the real nature of which has never been established with certainty. Ill-health, however, did not prevent him from producing an impressive scientific output (P i c k e r i n g, 1974). Besides smaller papers he wrote twenty volumes of books and large monographs, apart from several later editions and manuscripts that appeared in print only after his death.

It should be borne in mind, however, that the different prehistories of the books may be in part due to the different intention their authors originally had in mind. From the onset Darwin was well aware that his book would cause a shock to many of his comtempories, as indeed it did. The events during the famous Oxford meeting of the British Association early in 1860 are a sufficient illustration. Lyell on the other hand mainly wanted to summarize the existing geological knowledge. No doubt an overall view of the science was needed as rapid progress had been made after the publication of James Hutton's *Theory of the Earth*... (1788)[4], and A.G. Werner's *Classification und Beschreibung der verschiedenen Gebirgsarten* (1787). The way in which Lyell accomplished the task he had set himself, gave geology for the first time a sound scientific foundation. Up to the present day Lyell's *Principles* and Darwin's *Origin* have had a lasting effect on the study of the history of nature.

In this respect it is of interest to note that Kuhn refers to these two epoch-making books in a quite different way. Not surprisingly the *Origin* is considered as a classical example of a work bringing new ideas that caused a revolution in science (K u h, 1970, p. 171-2). Geologists must feel disappointed to see that Lyell's *Principles* is just referred to in one breath with some other early nineteenth century books reputed as useful reviews of existing knowledge, but without new ideas that caused a breakthrough in their field (K u h n, 1970, p. 10). Kuhn evidently completely failed to note the fundamental significance of the *Principles*. This seems hardly understandable with an author, writing well over a century after the publication of the *Principles*, and particularly concerned with scientific revolutions. W i l s o n (1972) gave the first volume of his new biography of Charles Lyell the subtitle: *The years to 1841: the revolution in geology*. Indeed the publication of the *Principles* was not less than that.

LYELL, DARWIN, AND THE HISTORY OF NATURE

Darwin not only became profoundly affected by Lyell's work, but there can be not the slightest doubt that he wholeheartedly accepted the fundamental ideas set forth in the *Principles*. On the other hand Lyell until the end of his life hesitated to become a fully convinced Darwinian. He was not fundamentally opposed, as Richard Owen, and neither a champion, as Th.H. Huxley. In this respect it is of some

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[3] Much of the material collected, however, Darwin later used in *The variation of animals and plants under domestication* (Darwin, 1868). What remained appeared in print only recently (Stauffer, 1975).

[4] The paper was read in March and April 1785, and an abstract in pamphlet form was published the same year. The work in two large volumes appeared ten years later. Its influence was greatly enhanced by Playfair (1802).

interest to remember that notwithstanding the common root of Lyell's and Darwin's concepts one fundamental difference remained. What Lyell offered was a steady-state model of the Earth, as contrasted with Darwin's progressive evolution of life. A certain schism is apparent in Lyell's opinions with regard to the former changes of the Earth itself, and those occurring in past floras and faunas. It is the more interesting because Lyell included both in his definition of the science of geology. The frequent appearance of new species of plants and animals in the history of the Earth, a phenomenon with which he was well familiar as a result of his long journey through France and Italy, posed a serious problem to Lyell. He saw no parallel in the present-day world, and doubted whether the principle of uniformity could be applied to the history of the living world. The notebooks on the species question, kept from 1855 until the end of 1861, show how much his mind was occupied with this problem (W i l s o n, 1970). It was left to Darwin to prove that the principle of uniformity holds true for the changes of the organic world as well. The "causes now in operation" came clearly to light when Darwin ploughed through volumes and volumes of journals in which plant growers and animal breeders had described their results. But even then Lyell remained doubt ful. He could not detect any evidence in favour of progressive development in the history of the Earth.

Lyell later returned to the problem in his *Antiquity of man*, published in 1863, four years after the publication of the *Origin* (L y e l l, 1863). Lyell seems to have been prompted in writing his *Antiquity of man* by a desire to approach the much debated question of man's origin from a geological point of view. Darwin had carefully left out this question when writing the *Origin*, but his readers not surprisingly had continued one step further. It was exactly this problem that had lead to the clash between Huxley and Wilberforce during the Oxford meeting in 1860. When Darwin took up the subject again in *The descent of man, and selection in relation to sex* (D a r w i n, 1871), it no longer aroused an emotional outburst. Lyell's book of 1863, and Huxley's *Evidence as to man's place in nature* (1863), published in the same year, had paved the way. Ten years after the publication of the *Origin* man was able to look more quietly at his own place in the long history of the animal kingdom. What is of interest, however, is the difference between Huxley's small book, a fervent defence of Darwin's ideas applied to human evolution, and the careful wording in the last five chapters devoted to this still controversial problem in Lyell's book. One wonders in how far Lyell felt troubled by a fundamental difference between his own cyclic nature of the Earth's former changes, and Darwin's changes of the organic world as a progressive process.

In this respect one final remark should be made. Although for well over a century geologists have adhered to Lyell's princinple of uniformity, some doubt has been cast recently on its validity to the early history of the Earth. Increased knowledge of early Cryptozoic crustal structures, dated prior to ca. 2500 million years, have shown these to differ from comparable younger structures. In other words the inorganic history of the Earth seems to include, apart from the well known recurrent cyclic phenomena, certain elements reflecting a progressive evolution as well. This has tempted some authors (S u t t o n, 1973, p. 316; R e a d & W a t s o n, 1975, p. 171-191) to put a question mark at the general applicability of a uniformitarian principle throughout Earth history. As early as 1962 R u t t e n referred to a pre-actualistic stage for the long interval when no free oxygen was present in the atmosphere.

In doing so these authors seem to neglect the difference between geological agents, the "causes in operation", and the results eventually produced. The latter depend on the material conditions under which the agents operate. Crustal structures produced by orogenic forces certainly depend on the state of the crust, and one can well imagine that an appreciably thinner crust, as a consequence of a much larger heat production from radioactive processes in the early Cryptozoic history, behaved differently from a gradually thickening crust in later history. Similarly changes in the composition of the atmosphere or of the hydrosphere cannot be considered non-uniformitarian. The introduction of shells and skeletons in the Metazoa with the beginning of Cambrian times, reflect changing environmental conditions rather than a non-uniformitarian behavior of these animal groups.

The main conclusion that stems from recently increased knowledge regarding the Earth's early history, is that the former changes of the Earth not only reflect recurrent processes corresponding to a steady-state model, but at the same time include a number of progressively changing elements. In other words there is no fundamental difference between the inorganic and the organic history of nature, as had seemed the case for a long time after Lyell and Darwin had made their fundamental contribution to the understanding of the history of the Earth and its inhabitants.

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