

Lyell's views on organic progression, evolution and extinction

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Abstract: Following Cuvier, Lyell was readily prepared to accept a succession of species extinctions in the past but he rejected Cuvier's ideas on episodes of catastrophic mass extinction. In the *Principles of Geology* he argued against organic progression in the fossil record, believing instead that organic traces had been substantially removed from older rocks by metamorphism and other factors, and that groups such as land mammals should not be expected, except very rarely, in the marine strata of the Palaeozoic and Mesozoic. He did, however, accept that the human species was of modern origin, but emphasized that the most significant feature of humanity emergence was in the moral rather than the physical sphere. Lamarck's theory of evolution involving species transmutation was vehemently rejected; like Cuvier, Lyell believed in the stability of species. As evidence continued to accumulate in favour of some kind of organic progression in the stratigraphic record, Lyell's resistance eventually crumbled, but he continued to believe in the extreme imperfection of the fossil record. Like Darwin, he could find no direct evidence from it for evolution. In the 1860s he eventually came to accept some form of evolution, while adhering to the rest of his uniformitarianism, but continued to reject Darwin's theory of natural selection.

The first written record of Lyell's opinions on the subject of this article comes in his review (1827) of Scrope's monograph on the geology and geomorphology of central France (Scrope 1827). Lyell had read at least the English translation of Cuvier's celebrated *Discours sur les révolutions de la surface du globe* (Cuvier 1813), based primarily on his researches on the Tertiary strata of the Paris Basin. Cuvier was the first to establish clearly that strata contained the remains of fossil species that had subsequently gone extinct, and Lyell had no trouble in accepting this. He soon recognized that the succession of species through Tertiary strata, marking a series of extinctions and replacements, could be used as a natural chronometer for Tertiary time. He was, however, firmly opposed to Cuvier's postulation of a succession of catastrophic mass extinctions separated by longer interludes of comparative quiescence.

In his review, Lyell pointed out that the Massif Central had not experienced any Tertiary marine incursions, unlike the Paris Basin. Between Cuvier's Tertiary faunas and those of the present, Lyell suggested, was a period in the history of life 'over which the greatest obscurity still hangs' (Lyell 1827, p. 452). However the fauna had changed during this period, it could not have been by Cuvier-type revolutions: central France had evidently remained free from whatever physical changes had occurred in the lower-lying Paris

Basin. Lyell foresaw a piecemeal replacement of species as they went extinct, due no doubt to environmental causes. His extended visit to Sicily in 1828 confirmed for him that both biological and geological changes in the past could have occurred by processes as gradual in their action as those still in operation (Rudwick 1972).

Lyell's *Principles of Geology*

In establishing his uniformitarian doctrine Lyell (1830–1833) faced a potentially serious problem. Sufficient fossils had been collected to suggest to many a kind of organic progression through time, from simple plants and invertebrates to progressively more complicated or biologically sophisticated vertebrates, culminating in our own species. Chapter 9 of his first volume is devoted to an attempted refutation of this 'objection urged against assumption of uniformity in the order of nature' (1830–1833, vol. 1, p. 144).

Lyell argued that in the older rocks of what was subsequently called the Palaeozoic there must have been many agents – including metamorphism, tectonic deformation and solution of fossil material by the 'percolation of acidulous waters' (p. 147) – that would have acted either separately or in concert to obliterate to a greater or lesser degree the traces of organic remains. Thus it was hardly surprising that so few vertebrates had yet been

found in rocks of 'Palaeozoic' age. Nevertheless, fish were known from some of the oldest strata, which 'entirely destroys the theory of precedence of the simplest forms of animals' (p. 148). Furthermore, land mammals could not be expected in the marine strata of the Carboniferous and 'Mesozoic' of the well explored rocks of Great Britain. Vertebrates are abundant in the marine Mesozoic but consist almost entirely of fish and reptiles. Lyell noted, however, that mammalian jaws related to opossums (determined by Cuvier as belonging to the genus *Didelphis*) had been found in the Middle Jurassic Stonesfield Slate of the southern English Midlands. The Tertiary strata of the Paris Basin were partly of nonmarine origin and contained many land mammals, but fossils of this group were extremely rare in marine deposits of the same age. The London Clay, for example, contains only marine fish and reptiles, notably turtles and crocodiles. In contrast, the Jurassic Stonesfield Slate contains mammals, indicating a reversal in the presumed order of progression.

Lyell was prepared to accept that the human species is of modern origin. Was it then the culmination of organic progression? His reply to this query is that 'the superiority of man depends not on those faculties and attributes which he shares in common with the inferior animals, but on his reason by which he is distinguished from them' (p. 155). Indeed, 'the animal nature of man, even considered apart from the intellectual, is of higher dignity than that of any other species'.

We may easily conceive that there was a considerable departure from the succession of phenomena previously exhibited in the organic world, when so new and extraordinary a circumstance arose, as the union, for the first time, of moral and intellectual faculties capable of indefinite improvement, with the animal nature. (p. 155)

In biological comparisons – for example, in competition for food and space, predation, and vulnerability to such natural phenomena as earthquakes and volcanoes – humans are indistinct from other animals. There remains, however, a crucial difference:

But he would soon perceive that no one of the fixed laws of the animate or inanimate world was subverted by human agency, and that the modifications produced were on the occurrence of new and extraordinary circumstances, and those not of a *physical*, but a *moral* nature. (p. 164).

Thus did Lyell attempt to preserve the dignity of *Homo sapiens*, prior to Darwin. His uniformitarian views with regard to what he considered to be a very incomplete fossil record are perhaps

best epitomized by the following well known passage:

Then might those genera of animals return, of which the memorials are preserved in the ancient rocks of our continents. The huge iguanodon might reappear in the woods, and the ichthyosaur in the sea, while the pterodactyl might flit again through the umbrageous groves of tree ferns.

This passage provoked a cartoon by his colleague Henry de la Beche (see Rudwick this volume, p.11), portraying the future Professor Ichthyosaurus, lecturing to fellow reptilian students on the skull of a strange (human) creature of the last creation.

Lyell's first encounter with evolutionary theory concerned the transmutational ideas of Lamarck, whose *Zoological Philosophy* had just been reissued following Geoffroy de St Hilaire's revival of the subject. Volume 2 of the *Principles* contained an extensive critique of Lamarck's ideas. To have admitted that species were unreal and that organisms were in a state of constant flux would have undermined the validity of his natural chronometer. Lyell shared Cuvier's belief in the stability of species. A continually changing physical environment would lead to shifting patterns of ecological conditions, which could lead to species extinctions. The 'creation' of new species remained an unsolved puzzle, both to Cuvier and to Lyell. Neither invoked divine intervention.

The firm establishment of organic progression

Lyell's dismissal of the fossil evidence for 'progression' failed to convince most of his contemporaries, and almost all other publications on the subject, whether specialist or popular, emphasized that the fossil record was indeed broadly progressive. This became increasingly apparent as a result of further collecting, most notably in the undeformed Palaeozoic strata of cratonic regions of eastern Europe and North America. Enough nonmarine Palaeozoic and Mesozoic rocks were examined to rule out with confidence Lyell's supposition that 'higher' vertebrates arose much earlier in geological history than indicated by the pioneer studies of Cuvier and Brongniart. By the mid 1840s the major outlines of the fossil record were firmly established on lines that have survived with only minor modifications into the twentieth century.

Rudwick (1972) has emphasized the important role of the German palaeontologist Heinrich-Georg Bronn in establishing with authority what might be termed the consensus view of informed opinion in

the middle of the nineteenth century. Earlier in his career, Bronn attempted to use numerical techniques to assess degrees of affinity between faunas of different formations. All his later compilative works illustrate the same belief that organic change is gradual, with the piecemeal extinction of old species and production of new ones. However, he never made Lyell's mistake of assuming that uniformity of gradual change necessarily entailed a steady-state picture of the history of life. The nature of the creative force for producing new species was emphatically a *natural* agency, albeit mysterious. (This was indeed a common view, with divine intervention never being seriously invoked; Darwin (1859) was unduly polemical in putting up such a straw man.)

Bronn saw evidence of a continual replacement of extinct species by more diverse and 'higher' forms of life, while there was maintained at all times a well balanced ecological assemblage. The organic world had come gradually to approximate more and more its present state, with no periods of massive extinction or of wholesale production of new species. Increased taxonomic diversity was related to the progressive physical diversification of the Earth's surface and the increased complexity of ecological relations between organisms. A true 'progressive' trend towards more complex forms of life could also be discerned within each of the major groups.

Bronn and Lyell were sharply divided about the *degree* of imperfection of the fossil record. Because Lyell clung desperately to his original belief in the steady-state history of the organic world, he was obliged to maintain with equal tenacity his view that the fossil record was extremely imperfect, such that any appearance of 'progress' was an illusion. In support, however, of Lyell, and opposed to Lamarck's evolutionary theory, there was no fossil evidence of species changing gradually into others when traced through successive strata, nor of major groups, with distinctive anatomy, being traceable to a common ancestor.

Lyell's changing position from mid-century

Lyell's last defence of non-progression was his Anniversary Address to the Geological Society of London in 1851 (Lyell 1851). As has been elucidated from study of his private journals, compiled between 1855 and 1861 (Wilson 1970), he subsequently began to waver and eventually surrendered with as good a grace as he could muster. The tenth edition of *Principles*, published in 1868, was the first to announce his retreat. The eleventh edition, appearing in 1872, just three years before his death, contained only minor revisions; Chapter 9 of this

edition assents to 'progressive development of organic life'.

Lyell's relationship with Darwin during these two decades is a subject of critical importance to historians of science. From the time of the *Beagle* voyage, Darwin was an ardent disciple of Lyell's uniformitarian doctrine, with its emphasis on gradualism (Desmond & Moore 1991). Following Lyell, Darwin believed that discontinuities in the fossil record were the result of its imperfections. His view in the *Origin of Species* (Darwin 1859) was that dramatic faunal turnovers in the stratigraphic record reflected major stratigraphic hiatuses. 'The old notion [i.e. Cuvier's] of all the inhabitants of the earth having been swept away by catastrophes at successive periods is very generally given up.'

Lyell encouraged Darwin to publish his revolutionary theory of evolution, recommending his own publisher, John Murray, and arranging with Hooker the famous joint presentation of the papers of Darwin and Wallace at the Linnean Society's meeting rooms in London in 1858 (Desmond & Moore 1991). It is widely believed that Darwin was instrumental in provoking Lyell's assent to evolution. Gould (1987) considers that examination of Lyell's journals (Wilson 1970) forces us to reverse this conventional argument towards a new interpretation.

The journals record that Darwin first broached his theory to Lyell during his visit to Darwin's home in 1856, and reveal that Lyell was already obsessed with doubt about non-progressionism. Before Darwin's revelation, he had already come to the conclusion that he would probably have to abandon this anchor of his central vision. Gould argues that Lyell did not accept evolution because Darwin persuaded him. In particular, he never accepted natural selection, much to Darwin's disappointment.

If we take the three attributes of the deity of the Hindoo Triad, the Creator, Brahma, the preserver or sustainer, Vishnu, and the destroyer, Siva, Natural Selection will be a combination of the two last but without the first, or the creative power, we cannot conceive the others having any function. (Quoted in Wilson 1970, p. 369)

The journals reveal Lyell's great reluctance to place human origins into nature's ordinary course.

There is but little difference between the out and out progressionist and Lamarck, for in the one case some unknown *modus operandi* called creation is introduced and admitted to be governed by a law causing progressive development and by the other an extension of multiplication of the variety-making power is adopted of

the unknown process called Creation. It is the theory of a regular series of progressively improved beings ending with Man as part of the same, which is the truly startling conclusion destined, if established, to overturn and subvert received theological dogmas and philosophical reveries quite as much as Transmutation. ... There seems less to choose between the rival hypotheses [evolution and progressionism] than is usually imagined. (Quoted in Wilson 1970, p. 222).

Gould (1987) regards this statement as the key to Lyell's conversion. He does not accept evolution because the facts proclaim it, since he finds little to choose between evolution and progressionism. Why then should one prefer evolution? Lyell's answer seems clear in the journals. Evolution is the fallback position of minimal retreat from the rest of uniformity. He could continue to hold firmly to uniformity of rate, uniformity of law, and actualism. Thus he could retain as much of his uniformitarianism as possible, when the facts of the fossil record finally compelled his reluctant allegiance to organic progression.

Lyell's first public statement of his altered views was in his semi-popular book the *Antiquity of Man* (1863). While he was able to sketch out an evolutionary history of the human species, he could not present any positive evidence of its origin, but nevertheless suggested, with some reluctance, that evolutionary theory might ultimately be applicable to human beings. The key issue at stake, as much earlier in his life, was the status of mind and consciousness, and he refers to 'new and powerful causes to explain the spiritual part of human nature'. To Darwin's evident disappointment (Desmond & Moore 1991), he could not accept humanity's place 'among the brutes'.

Lyell found himself in the curious position of believing so strongly that, because of the imperfection of the fossil record, palaeontology could not provide direct evidence for evolution, that he failed even to consider what fragmentary evidence could show. A good example of this is his failure to recognise the evolutionary significance of the

discovery in 1861 of the first specimens of *Archaeopteryx* as a kind of 'missing link' between birds and reptiles. Huxley made no such mistake (Rudwick 1972).

It would be wrong, however, to be unduly critical of Lyell's somewhat reluctant and lukewarm conversion to evolution. As an old man he could hardly be expected to embrace with enthusiasm a new doctrine which appeared to challenge in such a fundamental way his lifelong beliefs, especially about the place of humankind in nature. In the event he made a noble effort to make the best of a bad job.

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