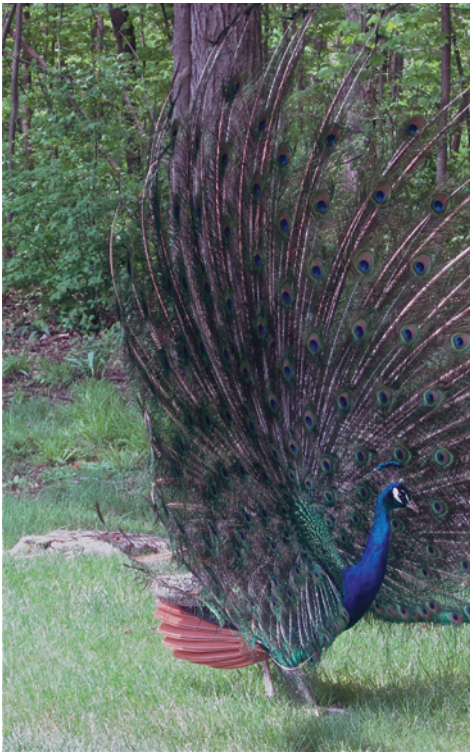
# Peter Dear

## *Laminates of Time: Darwin, Classification, and Selection*



THE HANS RAUSING LECTURE 2013
UPPSALA UNIVERSITY

SALVIA SMÅSKRIFTER

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# *Laminates of Time: Darwin, Classification, and Selection*

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UPPSALA
UNIVERSITET

SALVIA SMÅSKRIFTER, NO. 15

Tryck Wikströms, Uppsala 2014
ISBN: 978-91-506-2383-3

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## *Writing about Darwin*

Most of my work in the history of science has focused on early-modern Europe, and on epistemological issues primarily related to mathematical and physical, rather than life, sciences. So I owe you an explanation of why I propose to talk today about Darwin. I'll leave aside the most important autobiographical aspects, which relate to undergraduate courses that I've taught, and roadblocks that I'd found in the work I'd been doing on seventeenth-century issues, and focus instead on the less consequential intellectual aspects, which I hope at least have some interest of their own.

Historiographically, there seems these days to be a considerable gulf between approaches to the early-modern period in the history of science and approaches to Darwin and his work. For many decades, it's been fairly easy to investigate the more baroque byways of the Scientific Revolution without offending more than a handful of people who are still invested in celebrating the accomplishments of luminaries like Galileo and Newton; the idea that Newton's alchemy or Galileo's casting of horoscopes are not subjects fit for public viewing has largely (though not entirely) passed. But Darwin is another matter. Because his remains a name to conjure with among evolutionary biologists, almost as if he were a contemporary or, better, a transcendent guiding spirit, historical treatments often retain a slightly reverential tone, lest the essential rightness of his scientific ideas be lost from sight.

Adrian Desmond and Jim Moore have in their various writings striven mightily to avoid this historiographical pitfall, although even they cannot entirely avoid the sheer overwhelming stature of their subject. Meanwhile, the principal thread of modern Darwin scholarship takes an approach to Darwin and his scientific world that's rooted in social and cultural history: a world of scientific societies and correspondence networks—and such an approach tends to leave the intellectual content of his work unsullied.

One of the consequences of the reverence, or at least grudging respect, accorded to Darwin by his historians is an unintentional modernizing of his work and thought: he tends often to appear in historical treatments as a modern biologist, or perhaps modern naturalist, albeit dressed in slightly quaint clothes. This is fine for present-day scientists, of course, who understand their own work in part through a sense of an historical tradition in which they're participating just as their predecessors had done.[1] But historians of science still have our own work to do, and although it's not currently in vogue to say this, not all history of science need attempt to speak immediately to wider audiences: sometimes there are important things to say within a more specialized research community, at least to begin with. That happened with Newton; I have the sense that more of it can be done with Darwin too.

So I want to talk about what happens when an early-modernist looks at Charles Darwin. I want to see what Darwin had to say about his own science rather than how Darwin's work can be related to themes found in later biology; I want to look at things—ideas—that were novelties in his own work regardless of whether scientists of later times found them useful. And of course I've no interest in representing Darwin as a moral paragon whose science must be kept free of the taint of political interest or questionable purposes--I'm thinking here of Barnes and Shapin's essay of

[1] On modern scientific traditions, see Peter Dear, "The History of Science and the History of the Sciences: Sarton, *Isis*, and the Two Cultures," *Isis 100* (2009), pp. 89-93.

thirty-five years ago, in which they examined the rhetorical and conceptual tricks used by many Darwin scholars as means of cleansing Darwin's ideas of Malthusianism and eugenics, which would have undermined their perceived scientific purity.[2] It's notable even today, with the significant exception of Desmond and Moore's book *Darwin's Sacred Cause,*[3] how comparatively little attention is generally given to *The Descent of Man*, or the *Expression of the Emotions,* both of which contain ideas, assumptions, and arguments about human beings that intersect only glancingly with the concerns of modern evolutionary biology and which sometimes, despite Darwin's monogenist, anti-slavery position, betray conventional ethnic and other prejudices that sit badly with a hagiographic portrayal of the Great Man.

All of this is a shame, not least because Darwin is so remarkably interesting in his own right. Early-modernist historians of science still study closely detailed aspects of Isaac Newton's thought and belief, as well as the intellectual projects of many other such prominent figures, but Darwin (and I exaggerate a little here) seems mostly to have received such treatment only in selected areas of generally recognized theoretical significance—artificial versus natural selection, the principle of divergence, adaptation. The one obvious exception that springs to mind is Darwin's theory of pangenesis, which has received some attention, but the scholarship on which still disproportionately relies on Gerry Geison's still-standard article from 1969.[4] Bob Richards' work deserves mention as an example of historical engagement with Darwin that dares to challenge received understandings of Darwin's importance among evolutionary biologists: Richards has established very clearly

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[2] Steven Shapin and Barry Barnes, "Darwin and Social Darwinism: Purity and History," in Barnes and Shapin (eds.), *Natural Order: Historical Studies of Scientific Culture* (London/Beverly Hills: Sage, 1979), pp. 125-142.

[3] Adrian Desmond and James Moore, *Darwin's Sacred Cause: Race, Slavery and the Quest for Human Origins* (London: Allen Lane, 2009).

[4] Gerald L. Geison, "Darwin and Heredity: The Evolution of His Hypothesis of Pangenesis," *Journal of the History of Medicine 24* (1969), pp. 375-411.

that Darwin thought of evolution as qualitatively progressive, with Man as its pinnacle, and there are a good many other such scholars, of course, such as Staffan Müller-Wille and Stephen G. Alter.[5] It's that kind of work that I find the most engaging, in amongst the overwhelming volume of scholarship on Darwin's intellectual work. It's also, potentially, a way of placing Darwin in his appropriate historical frame, so as to elaborate approaches that attempt to grasp Darwin's social world.

My own interest in Darwin focuses on his assumptions and practices in making arguments. I'm struck by the practical approaches he takes to accomplishing the task of persuasion: not so much a rhetorical analysis of Darwin's work as an archeology investigating how it's put together. My first attempt at this is a piece examining how Darwin managed one of his central problems in the *Origin of Species:* his use of arguments relating to taxonomy, to the classification of organic beings. His fellow naturalists had produced the hierarchical system of classification that Darwin now wanted to use to show something that almost all of them believed to be untrue: the mutability of species.

Darwin clearly recognized his reliance on the work of other, non-transformist taxonomists, and he needed in effect to explain how their work could have produced just such groupings as his own theory explained through descent with modification. Since he used these groupings in many cases as evidence for his theory, they could scarcely be accepted on the basis of that theory. Darwin wanted only to reinterpret the meaning of those groupings, not to undermine the notion of an already-achieved natural classification; he wanted to use accepted taxa as data for his theory when only

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[5] Robert J. Richards, *The Meaning of Evolution: The Morphological Construction and Ideological Reconstruction of Darwin's Theory* (Chicago: University of Chicago Press, 1992); idem, "Darwin's Theory of Natural Selection and Its Moral Purpose," in Michael Ruse and Robert J. Richards (eds.), *The Cambridge Companion to the "Origin of Species"* (Cambridge University Press, 2009), pp. 47-66; Staffan Müller-Wille, "The Dark Side of Evolution: Caprice, Deceit, Redundancy," *History and Philosophy of the Life Sciences 31* (2009), pp. 183-200; Stephen G. Alter, *Darwinism and the Linguistic Image: Language, Race, and Natural Theology in the Nineteenth Century* (Baltimore: Johns Hopkins University Press, 2002).

his theory (he thought) could justify them. How could that be, without argumentative circularity? Clearly, some other means of acknowledging the legitimacy of the naturalist's groupings was needed.

Hence the well-known passage towards the end of the *Origin of Species* in which Darwin concludes:

> ...that the characters which naturalists consider as showing true affinity between any two or more species, are those which have been inherited from a common parent, and, in so far, all true classification is genealogical; that community of descent is the hidden bond which naturalists have been unconsciously seeking....[6]

Like Arthur Koestler's sleepwalkers, in the famous book of that title, Darwin's fellow naturalists (those unenlightened by the doctrine of descent with modification) were on the right track without knowing it, and had often used correct procedures in going about their work of classification without knowing why they were correct. Darwin can now tell them what they had been doing all along: they had been speaking the prose of transformism. This left him with the task of dealing with the potential circularity that I've mentioned, and that's what my essay on classification deals with. I want to know how in practice Darwin managed such matters; I don't myself believe in sleepwalkers who miraculously "got it right"; I'm interested in people who helped to *persuade* us that they got it right.

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[6] Charles Darwin, *On the Origin of Species by Means of Natural Selection* (London: Murray, 1859; facs. rpt., Cambridge MA: Harvard U.P., 1964), p. 420.

## *Temporal Metaphysics and Aids to Reason*

I want to address a related but distinct issue. This one is a little easier to handle than issues of classification, where the considerable risk remains that I can be misunderstood to be asking how Darwin sorted out "correctly" what should have been an intractable conceptual difficulty. Instead, I want to consider the way in which Darwin employed a metaphysics of time that enabled the articulation of (*inter alia*) his view of classification and its taxonomic meaning.

It's usual to stress the importance of immense periods of geological time for Darwin, and that's clearly correct; but in practice he configured time in ways tailored to particular tasks. One of those tasks was to short-circuit problems of conceivability: if you couldn't imagine something as actually occurring, like the production through natural selection of the mammalian eye, he asked you to pause and take into account something even more unimaginable, namely immense periods of time beyond comprehension—time that, as he wrote in the *Origin,* the "mind cannot possibly grasp."[7] In this way, the one inconceivability inoculated you against the other inconceivability, and all was well again. But even more fundamentally (I want to suggest), these immense periods of time possessed properties that were qualitatively distinct from those of time as it was actually experienced by human beings. This was the real value, to Darwin, of "deep time."

Martin Rudwick uses this evocative term "deep time" in his illustrated book *Scenes from Deep Time,*[8] and he notes its influential use in 1981 by the writer John McPhee. McPhee used the term

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[7] *Origin,* p. 481.

[8] Martin J. S. Rudwick, *Scenes From Deep Time: Early Pictorial Representations of the Prehistoric World* (Chicago: University of Chicago Press, 1992).

as the geologist's equivalent of the astronomer's "deep space."[9] Nineteenth-century geology dealt in deep time as part of its vast extension of the temporal framework within which understanding of geological processes was to be established; the work of Charles Lyell was definitive of the form that it was to adopt, and Charles Darwin's use of deep time borrowed from Lyell's perspective to make sense of *organic diversity*.

Lyell's uniformitarian, or actualist, conception of the Earth's past had led him to propose, in his *Principles of Geology* in the early 1830s, an essentially unchanging Earth in which all processes of change had always been of the same kind and magnitude as those witnessed at the present day. As a consequence, qualitative change, including developmental or directional change, had no place in Lyell's world. Details differed at different periods as regions of the surface rose and fell relative to each other, but the overall character of the Earth remained constant. For organic beings too, the picture was essentially static—there had always been mammals, always birds, always reptiles, always trees, always cotyledons, even if not the self-same species as we now see.[10] Geologically, Darwin's world was in many ways Lyellian, as has long been recognized; what has not been recognized is the temporal character of its modified Lyellian conception of living beings. Natural selection was for Darwin an actualistic process, of course, as were his other modes of gradual transmutation of species: attributed causes of organic transmutation in the past had always to be ones found operative in the present.

But the "deep time" required for such processes was not, for Darwin himself, simply an enormously extended period commensurable with everyday, shallow time. His conception of

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[9] Rudwick, *Scenes,* p. 255 (n. 1 to "Introduction"), referencing John McPhee, *Basin and Range* (New York: Farrar, Straus and Giroux, 1981); also Rudwick, *Bursting the Limits of Time: The Reconstruction of Geohistory in the Age of Revolution* (Chicago: University of Chicago Press, 2007), p. 3.

[10] Charles Lyell, *Principles of Geology,* 3 vols. (London: Murray, 1830-1833; facs. rpt., Chicago: University of Chicago Press, 1990-1991).

*geological* time, following Lyell, tended to run shallow and deep time together: the demand for a known *vera causa* to explain particular phenomena enabled an easy move from (for example) small elevations of land during earthquakes to the enormous elevations of the Andes, given long enough.

But in the case of *organic transmutation*, by contrast, Darwin built a world around an implied metaphysics of time that treated deep time as something qualitatively different from ordinary, experienced time. He did not simply require a vast amount of time within which his primary evolutionary mechanism of natural selection could operate; in practice, he required a deep time that functioned according to different rules from those of ordinary, "shallow" time. The experience of the naturalist occupied shallow time, but it was from that experience that Darwin necessarily had to build his arguments concerning transformism and the deep time within which it took place.

The novelty of Darwin's use of time becomes clearest on comparing it with the dominant alternatives found in the work of his predecessors in natural history. Georges Cuvier's classification system for zoology, like other contemporary taxonomic schemes in natural history, treated time as a static dimension. Cuvier's classification arranged organisms in a hierarchical structure that corresponded broadly to Linnaean categories, and was similarly static. Cuvier established extinctions as parts of the natural order, but he still classified extinct organisms within exactly the same classificatory grid as he used to order living organisms: the temporal differences between them had no reflection in the classificatory scheme.[11] The same holds for Charles Lyell's less systematic understanding of organic nature, although in his case

[11] William A. Coleman, *Georges Cuvier, Zoologist: A Study in the History of Evolution Theory* (Cambridge, MA: Harvard University Press, 1964); Martin J. S. Rudwick, *Georges Cuvier, Fossil Bones, and Geological Catastrophes: New Translations and Interpretations of the Primary Texts* (Chicago: University of Chicago Press, 1997).

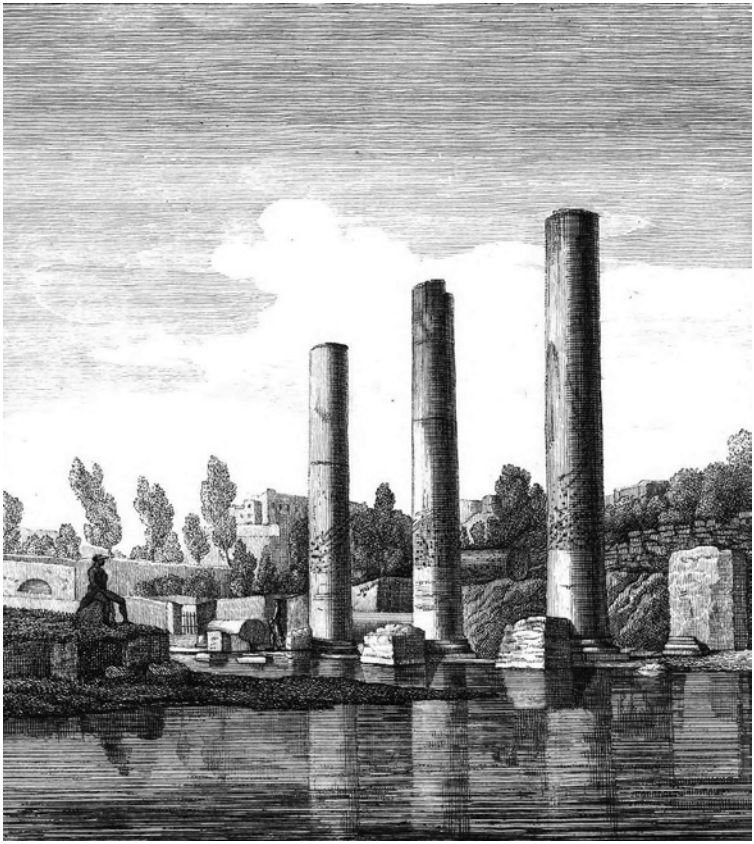

Figure 1: Temple of Serapis, frontispiece to Charles Lyell, *Principles of Geology* (London, 1830), famously illustrating, through the water marks on the columns, its variation in level since Antiquity. These changes, unlike Darwin's transmutatory changes, had occurred in shallow, not deep, time.

the uniformity of nature already implied that temporal distance had no qualitative significance: everything could be arranged on a single plane.

Matters were quite different for Darwin. The very taxonomic categories themselves were generated, contingently, over the course of long ages. Nonetheless, the placement of organisms within these categories still looked, as a practice, continuous with previous classificatory work: the creation of the categories by the coming-into-being of the kinds of organisms that instantiated them was always something that Darwin regarded, conceptually, as having occurred *before* the taxonomic placement of an organism took place. This is in part because, as Richards has clearly shown, evolution for Darwin was directional or progressive, despite subsequent views to the contrary in later biological thought.[12] The taxonomic categories applicable to living organisms were generally more capacious than their earlier versions (because of the temporal direction of divergence and diversification), so that they necessarily subsumed those earlier versions and the organic forms placed within them; but even evolutionary dead-ends, which had not effloresced into broader and more capacious versions, also retained a consistency with the overall classificatory scheme, by virtue of simple addition: Darwin's genealogical picture of classification allowed such extinguished lines to be slotted into the big picture whenever needed, without at all disrupting the other lines (the successions of branching taxonomic boxes)—and hence without disrupting the continuity that led to the present.

But while the practicalities of classification remained only slightly disrupted by the acceptance of Darwin's work, the meaning of earth history was radically altered. Each natural-historical cross-section through time—each successive synchronic laminar slice of the "contemporary"—had its own integrity. To speak anachronistically: each temporal layer had its own *ecological* integrity, with interconnections occurring across space and within shallow time, but with the linkages through deep time being irrelevant to making sense of it. Darwin himself, by setting up such

[12] See n. 5, above.

a laminar structure, rendered shallow time incommensurable with deep time. His particular idiom for doing so stressed a qualitative distinction between reason and imagination, and was expressed when he spoke of transmutation effected (typically) by natural selection. Thus, in Darwin's famous discussion in *the Origin* of the gradual development of an eagle's eye, he notes that someone who grasps his entire theory should accept "that a structure even as perfect as the eye of an eagle might be formed by natural selection, although in this case he does not know any of the transitional grades."[13] Darwin acknowledges that such an acceptance would not in practice be easy, but in principle it can be done. Of his ideal reader, Darwin says: "His reason ought to conquer his imagination; though I have felt the difficulty far too keenly to be surprised at any degree of hesitation in extending the principle of natural selection to such startling lengths."[14]

## *Incommensurability of Deep and Shallow Time*

That the inference may be "startling" is simply a psychological "Idol of the Tribe," to use Francis Bacon's term. In any case, reason comes to the rescue. But reason, while conquering imagination, is not simply opposed to it; Darwin often allows the imagination to serve as a vehicle to convey reason from one way-station to another:

> If we must compare the eye to an optical instrument, we ought in imagination to take a thick layer of transparent tissue, with a nerve sensitive to light beneath, and then suppose every part of this layer to be continually changing slowly in density, so as to separate into layers of different densities and thicknesses, placed at different distances

[13] *Origin,* p. 188.

[14] Ibid.

> from each other, and with the surfaces of each layer slowly changing in form. Further we must suppose that there is a power always intently watching each slight accidental alteration in the transparent layers; and carefully selecting each alteration which, under varied circumstances, may in any way, or in any degree, tend to produce a distincter image.[15]

Darwin then connects his way-stations together by invoking inconceivably, imprecisely large numbers:

> We must suppose each new state of the instrument to be multiplied by the million; and each to be preserved till a better be produced, and then the old ones to be destroyed. In living bodies, variation will *cause* the slight alterations, generation will multiply them almost infinitely, and natural selection will pick out with unerring skill each improvement. Let this process go on for millions on millions of years; and during each year on millions of individuals of many kinds; and may we not believe that a living optical instrument might thus be formed as superior to one of glass, as the works of the Creator are to those of man?[16]

So here is where Darwin addresses, as much as he ever did, the production of deep time from discrete episodes of shallow time. Uncounted millions of years, individuals, and modifications paper over the passages from one state to another. Deep time allowed the transition from one world of shallow time to the next, but it could only be constituted by imprecise, ungraspable magnitude. As Darwin's son George was to write to his fellow physicist William Thomson (later Lord Kelvin) in 1878, if Charles had been obliged,

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[15] Ibid., pp. 188-189.

[16] Ibid., p. 189.

when he wrote the *Origin*, to assign an age to the Earth, "he w[oul] d have written a 1 at the beginning of the line & filled the rest up with 0's. Now I believe that he cannot quite bring himself down to the period assigned by you, but does not pretend to say how long may be required."[17]

Indeed, it was strategically important that Darwin not specify particular durations, as Thomson's notorious age-of-the-earth intervention had shown—the significance of the latter lay in its own establishment of fairly precise limits to the history of the earth. Darwin was always happiest not just with indefinite vagueness, but with an unfathomable temporality that provided enough time for *anything*, as it were orthogonal to quotidian events.[18]

The effective incommensurability of shallow and deep time for Darwin appears in remarks such as his confession in the *Origin*, regarding the painfully slow but inexorable effects of erosion, that "[t]he consideration of these facts impresses my mind almost in the same manner as does the vain endeavor to grapple with the idea of eternity."[19] Darwin sometimes represented this virtual incommensurability of shallow and deep time as resulting from human perceptual and cognitive incapacity. Of the imperceptible shading of varieties into distinct species, he remarked that, if anything, it should be surprising that we did not see more examples of what he called "occasional blending by intermedial forms"; he blamed the usual lack of surprise at this fact on "our restricted notions of the lapse of time."[20] Above all, what Darwin's in-

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[17] Quoted in Crosbie Smith and M. Norton Wise, *Energy and Empire: A Biographical Study of Lord Kelvin* (Cambridge: Cambridge University Press, 1989), p. 579. Cf. Peter Dear, *The Intelligibility of Nature: How Science Makes Sense of the World* (Chicago: University of Chicago Press, 2006), chap. 4 on these passages; also Joe D. Burchfield, *Lord Kelvin and the Age of the Earth* (New York: Science History Publications, 1975).

[18] On Darwin's conceptions of geological time (immense) and species change (creepingly slow), see Sandra Herbert, *Charles Darwin, Geologist* (Ithaca: Cornell University Press, 2005), pp. 346-354.

[19] *Origin,* p. 285.

[20] R. C. Stauffer (ed.), *Charles Darwin's Natural Selection, being the second part of his Big Species Book written from 1856 to 1858* (Cambridge: Cambridge University Press, 1975), p. 103. Cf. *Origin,* p. 174, explaining the apparently troublesome lack of "closely-linking intermediate varieties," and ibid., p. 292.

practice argumentative distinction between shallow and deep time reveals is the peculiar character of his processes of transmutation. Natural selection did not, of course, concern the production of changes in particular material things themselves—changes in an individual organism, for example. Instead, it was a process designed to generate gradual changes in genealogical lineages. Each generation of such lineages consisted of individuals that possessed particular characteristics, even including developmental characteristics. But transmutation concerned changes between the individuals of successive generations, and those themselves only in the aggregate.[21]

Change itself was therefore stochastic and discrete even without Mendelian genetic mechanisms. Darwin had no conception of, or proposed means of detecting, gradual and continuous evolutionary change: Cuvier's famous blow against transformism, which pointed to the unchanged anatomy of modern animals as compared to mummified ancient Egyptian exemplars, received no challenge from Darwin, because practically discernible shallow time would never be capable of tracing out and revealing any changes occurring in historically accessible human history.[22] As Sandra Herbert has noted, "Evolution occurring in nature on so short a time scale as to be susceptible to human measurement lay outside even Darwin's imagination."[23]

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[21] Perhaps less the case for use/disuse processes.

[22] Rudwick, *Georges Cuvier,* p. 229.

[23] Herbert, *Charles Darwin*, p. 347.

## *Uses of Dual Temporalities*

Darwin's analogy between artificial and natural selection shows clearly the role of these two distinct temporal frames. Artificial selection displayed itself in shallow time, natural selection in deep time. This is perhaps the most profound sense in which Darwin's drawing of parallels between the two was truly only analogical. It was never the case that artificial selection, including unconscious selection, was a special case of natural selection: the two processes operated in distinct temporalities. The physiologist W. B. Carpenter, a sympathetic early reviewer of the *Origin*, put the point clearly when he noted that artificially produced forms, such as Darwin's show pigeons, would on the usual classificatory criteria used by ornithologists certainly count as members of distinct genera, due to the large differences among their beaks and skulls. He therefore distinguished between what he called "Naturalists' species" and "Nature's Species," and thereby captured a nicety that Darwin had rather glossed over in the *Origin* when attempting to stress the character and stability of variations as they were picked on by selective agents.[24] Alfred Russel Wallace never accepted the legitimacy of the parallel between artificial and natural selection, maintaining that the kinds of variation selected by human breeders amounted to abnormalities rather than regular slight variants.[25] Darwin himself acknowledged the far greater subtlety of natural selection. For Darwin, artificial selection was always useful as an expository device that emphasized the existence of variations among organisms, but it was never a shallow-time equivalent of natural selection.

Much of Darwin's reconstruction of what took place in deep time relied on inferences drawn from taxonomic classification, and

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[24] W. B. Carpenter "Darwin on the Origin of Species," *National Review 10* (1860), pp. 188-214, on p. 197.

[25] See his discussion of this point in Alfred Russel Wallace, "On the Tendency of Varieties to Depart Indefinitely from the Original Type," *Journal of the Proceedings of the Linnean Society of London, Zoology 3* (August 1858), on pp. 59-61.

those inferences, as I mentioned earlier, depended to a large degree (particularly prior to the publication of the *Origin of Species*) on conclusions that had been reached through the already-established practices of his fellow naturalists—almost all of them non-transformists. By advancing his transformist arguments in part using the classificatory judgments of non-transformists, Darwin attempted to convince his fellow naturalists of the truth of his theory. But his explanation of how changes of organic form had occurred required the invocation of natural selection and other subsidiary means of gradual alteration, including most notably (besides use and disuse) sexual selection. Darwin invoked sexual selection in many cases where natural selection seemed not to explain salient features of organisms as they were found in the naturalist's usual, shallow-time experience: for Darwin, the two principal instances concerned sexual dimorphism and human racial differences.[26]

The effects of both natural and sexual selection manifested themselves in deep time. While Darwin argued for the working of the processes themselves in shallow time, their transformist consequences could only be traced out in deep time: the evidence for those divergent consequences was located in both contemporary and geologically remote layers of shallow time. Darwin needed, in effect, to sum each successive $\Delta t$ of shallow time to create the needed, but unexperienced, deep time. The non-transformist idea of "independent creation," one of Darwin's main targets in the *Origin*, had obviated any need for deep time by making the appearance of new forms instantaneous; by contrast, Darwin's deep time emerged from a summing of infinitesimals, each of which was a lamina of shallow time.

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[26] Stephen G. Alter, "Separated at Birth: The Interlinked Origins of Darwin's Unconscious Selection Concept and the Application of Sexual Selection to Race," *Journal of the History of Biology 40* (2007), pp. 231-258; also Nancy Stepan, *The Idea of Race in Science: Great Britain, 1800-1960* (Hamden, CT: Archon Books, 1982), esp. pp. 83-139.

One of the virtues that Darwin saw in transformism generally and natural selection in particular was their capacity to explain the empirical generalizations of the naturalist, in ways that the assumption of "independent creation" could not.[27] In some respects this tactic was his most powerful, in that it stood firm even when other arguments seemed weak: at the end of the *Origin's* chapter six, "Difficulties on Theory," Darwin remarks that many of those difficulties were "very grave." Nonetheless, he goes on, "I think that in the discussion light has been thrown on several facts, which on the theory of independent acts of creation are utterly obscure."[28] Or in the book's concluding chapter, referring to his discussions of crosses among plants species, he says: "these would be strange facts if species have been independently created, and varieties have been produced by secondary laws," as many believed.[29] Over and over, Darwin stresses that creation yields "no apparent reason" for certain facts,[30] which without natural selection would remain, he claims repeatedly, "inexplicable."[31] More positively, but with the same stress on intelligibility as his principal criterion, he writes that "all the other great leading facts in palæontology [besides those of missing transitional links and the apparent absence of pre-Silurian fossils] seem to me simply to follow on the theory of descent with modification through natural selection."[32]

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[27] See Charles Darwin, *The Descent of Man, and Selection in Relation to Sex* (London: Murray, 1871; facs. rpt. Princeton: Princeton University Press, 1981), vol. 1, pp. 152-153.

[28] *Origin,* p. 203.

[29] Ibid., p. 475.

[30] Ibid., p. 55.

[31] E.g. ibid., pp. 59, 333, 372, 478. These speak to the Whewellian theme of consilience; see Michael Ruse, *The Darwinian Revolution: Science Red in Tooth and Claw* (Chicago: University of Chicago Press, 1979), chap. 3.

[32] *Origin,* p. 343.

## *Sexual Selection and the Dualities of Human Prehistory*

The idea that nature reveals its own intelligibility recurs often in Darwin's writings: "Nature may be said to have taken pains to reveal, by rudimentary organs and by homologous structures, her scheme of modification, which it seems that we willfully will not understand."[33] Later, in *Descent of Man*, Darwin applied the same criterion to evaluating the role of sexual selection in forming racial distinctions in man: "Nor do I pretend that the effects of sexual selection can be indicated with scientific precision; but it can be shewn that it would be an inexplicable fact if man had not been modified by this agency."[34] Nonetheless, inexplicability remained a difficulty for sexual selection itself. A curious aspect of Darwin's view of sexual selection is that, while sexual selection was intended to explain sexual dimorphism, sexual selection as a supposed phenomenon or process in nature itself remained ungrounded in explanatory terms.

While natural selection rested on ideas of adaptation and Malthusian population pressure, sexual selection, of the kind that depended on female choice, failed to account for the female predilections that drove it—neither accounting for why females had initially come to prefer the things they supposedly did, nor for why these predilections were sustained over the generations. No positive selective pressure seemed to establish or sustain them; Darwin simply accepted them as empirically verifiable, and then used them to explain those characteristics of organisms which natural selection seemed unable to produce.[35] Not only did Darwin refuse to provide a functional rationale for female choice, as more

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[33] Ibid., p. 480.

[34] *Descent,* vol. 1, p. 249. My emphasis.

[35] Mary M. Bartley, "Conflicts in Human Progress: Sexual Selection and the Fisherian 'Runaway'," *British Journal for the History of Science 27 (*1994), pp. 177-196, discusses R. A. Fisher's attempt to correlate preferred features with overall fitness.

Figure 2: An attractive peacock. Photo credit: Carin Berkowitz.

recent evolutionary biologists have done by associating the preferred characters with overall selective advantages such as general health and strength; instead, Darwin openly acknowledged that sexual selection sometimes favoured otherwise disadvantageous variants. Of human relative hairlessness, explained through sexual selection, he wrote in *Descent of Man:* "Nor is it surprising that a character

in a slight degree injurious should have been thus acquired; for we know that this is the case with the plumes of some birds…."[36] In such cases, different forms of selection competed with one another for dominance, leaving sexual selection by female choice simply unexplained. Female choice could not explain why peahens prefer elaborately decorated peacocks: they just do.

For Darwin, it was an argument against "independent creation" that it could not make sense of the fact that indigenous mammals (apart from bats) are not found on oceanic islands.[37] And yet he did not use the similar unintelligibility of animal aesthetic judgments to undermine the value of sexual selection. Sexual selection through female choice served a function for him, even though it failed to provide an explanation. And like natural selection, the process of sexual selection occurred day-to-day in shallow time, with its long-term modifications revealed only in deep time.

Deep time exposed its character most clearly when Darwin's expositions invoked comparable distribution across space. Towards the end of the *Origin*, he notes Edward Forbes' analogizing of the relationships of species across geological time with the relationships of existing species across space.[38] This analogy also resembled Wallace's observation of the origin of new species in just those geographical regions that already possessed forms closely related to the newcomers. But this kind of spatial distribution presented only an *imperfect* analogy, in that the absence of a gradation of intermediate forms between neighbouring similar species seemed more stark than the temporal equivalent of just a few individuals having formed the link between earlier and later successful species: the latter case could be portrayed in terms of the relative numbers of links and species, where the links typically left no trace in the fossil record, whereas the former, spatial case

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[36] *Descent*, vol. 2, p. 377.

[37] *Origin,* pp. 393, 409 on mammals; *Descent,* vol. 2, pp. 135-141 on peacocks.

[38] *Origin,* p. 409.

very seldom presented discrete intermediates between contiguous regions containing related species.[39] Such separation was most clearly instantiated by the separate islands of an archipelago, whether very large (as with the Malay archipelago), or much more compact (as with the Galápagos): each island had its own characteristic forms, but sometimes only slightly different from its neighbours.[40] Nonetheless, Darwin insists, "whether we look to the forms of life which have changed during successive ages within the same quarter of the world, or to those which have changed after having migrated into distant quarters, in both cases the forms within each class have been connected by the same bond of ordinary generation."[41] The analogy only really works when we see that broad geographical distribution for Darwin was the equivalent of deep time, displaying, along with the accidents of migration, the obscure passage of uncounted generations across vast areas; shallow time by contrast corresponded only to those restricted geographical regions in which distinguishable varieties of relevant forms existed, with their intermediates always having been already exterminated according to the principle of divergence. And in a more direct sense, the relationship between the development of the embryo and its distant taxonomic filiations—what came later to be called the recapitulation of phylogeny by ontogeny—portrays an analogy between the shallow time of an individual organism's growth and the deep time of its ancestral lineage: related, but categorically distinct, temporalities.[42]

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[39] Stauffer, *Natural Selection*, pp. 262-274; cf. also *Origin*, pp. 302-303, 461-464.

[40] Stauffer, *Natural Selection*, p. 115; *Origin*, e.g. pp. 399-401.

[41] *Origin*, p. 410.

[42] *Origin,* pp. 448-450. Darwin later complained in his autobiography of not receiving adequate credit for the idea: Charles Darwin, *The Autobiography of Charles Darwin, ed. Nora Barlow* (London: Collins, 1958), p. 125.

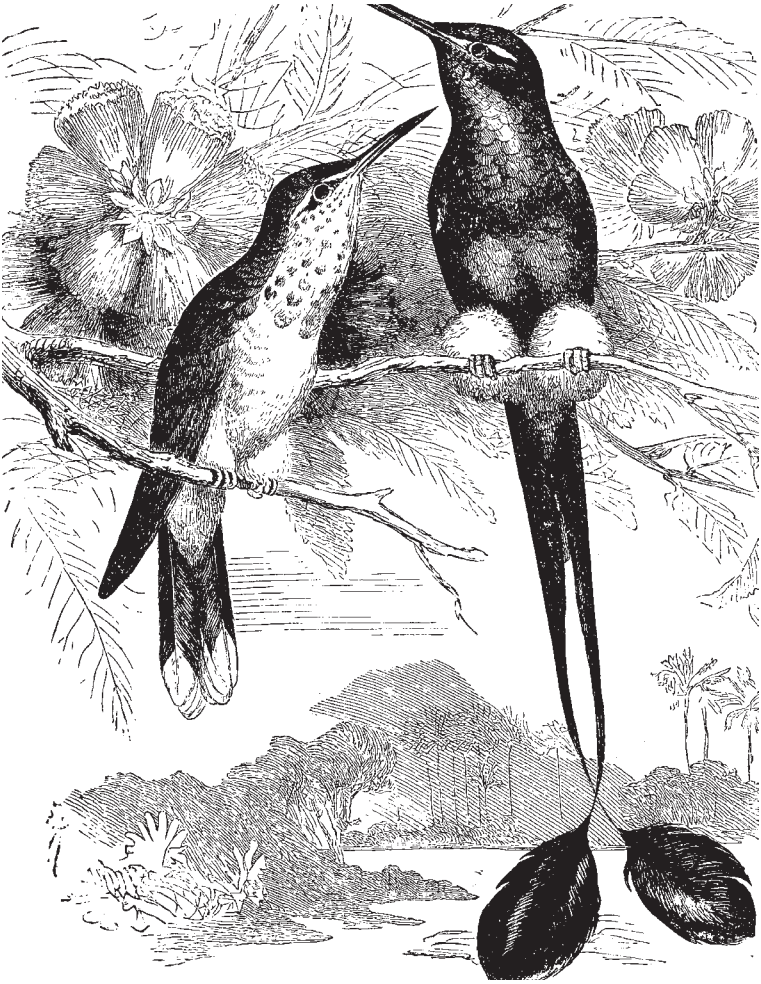

Figure 3: Humming birds, showing the results of sexual selection through female choice. Darwin, *Descent of Man*, 2nd. edn. (London, 1874), p. 388.

Nineteenth-century notions of human prehistory capture (and reflect) some of Darwin's sensibilities. The prehistoric represented a gulf of time only terminologically related to the historic, characterized by written records of human activity. Victorian conceptions of the prehistoric were necessarily conjectural, and structural rather than contingent; as George Stocking showed in detail, British anthropology of the 1860s, plentifully drawn upon by Darwin in *Descent of Man*, represented human sociocultural development as proceeding through stages, such that the same sequence was potentially followed by all societies. On this view, the most accomplished of all was, of course, the European, at the pinnacle of advancement; the preceding steps in European sociocultural development thus represented the ladder up which other human societies were themselves laboriously climbing—many no doubt by now stalled. Knowledge of the earlier stages wasn't regarded as wholly conjectural; there were useful heuristic markers to be found in the comparative anthropology of more primitive races around the world. Writers such as Darwin's protégé John Lubbock, often cited in the *Descent of Man*, combined reports of the characteristic behaviours of "savages" with conjectural accounts of social development to yield pictures of human sociocultural "evolution." But these vignettes of life among the savages did not represent that life as dynamic; instead, each vignette stood in for a snapshot of characteristic human behavior at a particular developmental point. Darwin himself had, long before the *Descent of Man*, treated his Fuegians, encountered during the Beagle voyage, in just this way.[43]

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[43] George W. Stocking, Jr., *Victorian Anthropology* (New York: Free Press, 1987), chap.5, esp. pp. 153-156; Fuegian remarks in Charles Darwin, *Journal of Researches into the Natural History and Geology of the Countries Visited during the Voyage of H.M.S. Beagle,* 2d ed. (London, 1845), chap. 10, and in *Descent,* vol.1, e.g. pp. 34, 232, and vol. 2, p. 404; also ibid., vol. 1, pp. 180-184, 234, for more on human progenitors and savages. See also, on Darwin and Fuegians, Cannon Schmitt, *Darwin and the Memory of the Human: Evolution, Savages, and South America* (Cambridge: Cambridge University Press, 2009), chap. 1.

Darwin's conception of human sociocultural development in turn rested on a particular laminar assumption about the deep time of human prehistory. Darwin adopted it directly from Wallace, quoting him approvingly in the *Descent of Man*:

> Mr. Wallace, in an admirable paper…, argues that man after he had partially acquired those intellectual and moral faculties which distinguish him from the lower animals, would have been but little liable to have had his bodily structure modified through natural selection or any other means.[44]

Even racial differentiations, according to Darwin, were themselves physical features that predated the period during which sociocultural development had occurred. Human physical evolution had effectively ceased before the ascent along the ladder of civilization had begun. The laminar structure of human evolutionary time was therefore a composite one: no effective physical evolutionary change since modern man had first appeared, complete with his racial typology; then a series of static sociocultural levels, vestiges of which were preserved in various groups of modern savages. Once again, Darwin seems to have had no way of incorporating developmental change into a passage of shallow time; only deep time could witness such change, as the summation of discrete differences.

One of the great themes of Victorian naturalism, as Robert Young showed us, was that of the uniformity of nature.[45] It was a means of removing God from an understanding of the natural world by making that world both self-sufficient and temporally invariant: things have always worked in the same way. When Darwin applied

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[44] *Descent,* vol. 1, p. 158, citing an 1864 paper by Wallace in the *Anthropological Review*.

[45] Robert M. Young, "Darwin's Metaphor: Does Nature Select?" *Monist 55* (1971), pp. 442-503; idem, "Malthus and the Evolutionists: The Common Context of Biological and Social Theory," *Past and Present* (1969), #43, pp. 109-145, both reprinted in Young, *Darwin's Metaphor: Nature's Place in Victorian Culture* (Cambridge: Cambridge University Press, 1985).

the actualist world-view of Lyellian geology to the organic realm, a vast expanse of *time* to incorporate inconceivably slow processes of change, he found that its articulation required two distinct idioms, one of them that of deep time, in which evolution took place, and another of shallow time, in which the processes themselves operated insensibly. Shallow time never formed deep time by mere *addition*, but by imaginative *integration*. In the eighteenth century, Isaac Newton's follower Samuel Clarke wrote that infinites are composed of finites as finites are composed of infinitesimals.[46] For Darwin, deep time was composed of slices of shallow time in the same way: his was a world of multiple self-contained uniformities, jammed together into a laminate whole.

[46] H. G. Alexander (ed.), *The Leibniz-Clarke Correspondence* (Manchester University Press, 1956), p. 48.

## *Author's biographical sketch*

Peter Dear is professor of history and of science and technology studies at Cornell University. He is the author of, among other books, *Discipline and Experience: The Mathematical Way in the Scientific Revolution* (1995), which was awarded the Ludwik Fleck prize from the Society for Social Studies of Science in 1998, and *The Intelligibility of Nature: How Science Makes Sense of the World* (2006), which discusses episodes stretching from the seventeenth to the twentieth centuries. A specialist in early-modern Europe, his interests also extend to aspects of science as a cultural product in various periods, including most recently work on Charles Darwin and ideas of the uniformity of nature.

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In 2002 the Hans Rausing Professor of History and Science Tore Frängsmyr took the initiative to inaugurate a publication series *Salvia Småskrifter* with the aim to publish lectures arranged by the Office for History of Science at Uppsala University. The coinage *Salvia* is meant in memoriam of Sweden's first scientific book printer *Lars Salvius* (1706–1773) as well as that it refers to a wild growing Swedish plant, *Salvia pratensis*.

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