Genome time: Post-Darwinism then and now

One model of time: an infinite matryoshka doll of painted moments, each ‘shell’ (the present) encased inside a nest of ‘shells’ (previous presents).

– David Mitchell, Cloud Atlas

As a gifted young composer prepares to commit suicide, he contemplates the possibility of reincarnation, the return not only of the individual but of historical epochs. The year is 1931, and he has just finished his signature piece, ‘Cloud Atlas Sextet’, a work for overlapping soloists, six musicians interrupted one after another by the next solo, only to resume their parts in reverse order as the composition moves to a close. The piece aspires to capture the cyclical nature of time, history’s Eternal Return played on ‘Nietzsche’s gramophone record’, as the young man observes near the end of a letter to the man he loves. ‘Rome’ll decline and fall again, Cortés’ll lay Tenochtitlán to waste again, and later . . . you and I’ll sleep under Corsican stars again, I’ll come to Bruges again, fall in and out of love with Eva again, you’ll read this letter again, the sun’ll grow cold again’ (CA 393) The sextet, with its melancholy echoes of other artists but also its startling originality, mirrors the structure of the novel in which it appears, David Mitchell’s contemporary masterpiece, Cloud Atlas (2004).

Time haunts Mitchell’s novel. Cloud Atlas opens in the Victorian age with the journal of Adam Ewing, a ship-wrecked traveller searching for passage home from a South Sea island while being slowly poisoned by a doctor posing as his friend. The journal breaks off in mid sentence, and the next chapter picks up the story of a different character, the young composer in 1931. Each subsequent chapter shifts to the story of a new character decades in the future until the novel reaches its pinnacle in a distant, post-apocalyptic world, only to reverse course back down time’s ladder, completing the stories in reverse order. The Victorian section introduces one of the novel’s central themes: Will human history be ruled by survival of the fittest? In each of the six linked stories characters who believe that ‘humanity may transcend tooth & claw’ (CA 508), as Adam does, contend with the will to power of characters like his supposed friend who believe ‘the weak are meat the strong do eat’ (CA 489). This Darwinian theme is everywhere evident: in the extermination of a peaceful island tribe by conquering Maori, in the extinction of seals
by overhunting, in the looming environmental damage from an unscrupulous nuclear power corporation, in the cloning of human slaves in the near future, and in the radioactive deadlands that cover most of the planet in the far future. ‘Our will to power, our science, and those very faculties that elevated us from apes, to savages, to modern man’, one character declares, ‘are the same faculties that’ll snuff out Homo sapiens before this century is out!’ (CA 444–5).

The novel’s portrait of natural selection reflects the transformation in our culture’s conception of time that began in the nineteenth century. Darwin’s contemporaries experienced a vertiginous sense that time had expanded. Nineteenth-century geologists pushed back the age of the earth, while astronomers and physicists calculated the death of the sun and the cooling of the planet. But evolution, more than anything else, altered our relation to time. It linked the individual not just to familial ancestors but to generations back before the dawn of history, to the animal kingdom, and before that, to the protozoa. The future was changed as well. Posterity came to signify not merely lineal descendants, not even a sacred eternity, but an impersonal futurity, a time beyond the individual, a time beyond even the species, a time that entailed the prospect of extinction. The result was a temporal vista as vast and bleak as it was linear – a worthy complement to the philosophy of survival of the fittest.

In counterpoint with this Victorian perspective, Mitchell adds another, cyclical model of time. Nietzsche’s Eternal Return, nested Russian dolls, variations on a musical theme, reincarnation – these are only a few of the motifs that evoke time’s cycle. Events repeat one another; characters share the same birthmark and remember things that happened centuries past or future; genres and media recapitulate the history of forms – journal, epistolary narrative, novel, film, hologram – then back to the earliest form of all, oral narrative. The paradoxical combination of linear and cyclical perspectives on time reflects contemporary genomics more than nineteenth-century attitudes toward evolution. Or rather, the paradox captures the way in which our culture’s understanding of time has developed in tandem with biology’s exploration of evolution. The result today is a dual temporal consciousness that might be called ‘genome time’.2

Genome time fuses the personal timescale of everyday life with the immense impersonal timescale of the species. On the one hand, your genetic code is unique, a personal inheritance from your parents that defines key aspects of your identity and influences your singular destiny. From this perspective genetic inheritance occurs in linear time. Your genetic code is the species’ parole, a speech act that can never be repeated. On the other hand, the genome has a synchronic dimension. It
is a four-letter *langue* that runs through and beyond the individual, reaching back to the first primordial cell and forward to whatever future humanity may encounter. As a self-contained sign system, the relationship between past, present, and future seems arbitrary, a game of chance and necessity that challenges ordinary notions of time. Although actual variations occur in linear time, the set of possible evolutionary variations are always already ‘there’, in potentia. The past and future appear inscribed as theoretical possibilities within the virtual space of the code.

I first became aware of this distinctive time sense in the 1990s, when I noticed the similar temporality infusing two powerful representations of the new genetics: Richard Powers’s novel *The Gold Bug Variations* (1992), and the dystopian film *Gattaca* (1997). Both created a dual temporality in their plot and structure, and offered this double perspective as a metaphor for the temporality of the gene. Versions of this dual temporal consciousness are common in contemporary genome discourse. We see it in the public pronouncements of genome scientists and biotech firms, in journalism about genetic medicine, in transhumanist web sites, in movies about cloning, in science fiction about genetic engineering, and in a number of impressive novels published in recent decades. Barry Barnes and John Dupré conceptualise this distinctive relation to time in terms of genomics’ new emphasis on the ‘life cycle’ rather than ‘inheritance’. Whereas inheritance traced descent through linear time, the life-cycle approach looks at the differential activation of propensities that were always already present in the genome. In words that could easily be applied to *Cloud Atlas*, Barnes and Dupré write: ‘A series of life cycles may be addressed as a single changing object, rather than as a series of different objects between which something has to be transmitted in order to account for the resemblance between later members of the series and those that come before’. From this perspective, Mitchell’s interest in reincarnation and the eternal return may not signify spiritual or philosophical commitments – or not merely so – but a profound response to changes in our relation to time wrought by twenty-first-century genomics.

This article plucks three moments out of the history of genome time, rough points which will help sketch a historical arc describing the way British culture has attempted to come to terms with the disorienting changes in temporal scale brought about by Darwin. Three dates – 1870s–1890s, 1930s, and 2000s – are chosen for their heuristic value rather than any claim that they constitute an unbroken line of development. But these snapshots do reveal shared configurations among those novelists and scientists who confronted the implications of evolution in each period. In the 1870s, little more than a decade after the
publication of the *Origin of Species*, writers began to resurrect the ideas of Lamarck as a way to make sense of what evolution implied about the nature of time. This trend continued and intensified through the remainder of the century, often combined with an interest in eugenics as a way to shape the future of the species. In the 1930s, as the modern synthesis of evolution and genetics was first worked out, biologists reconceptualised the impersonal time of natural selection in mathematical and statistical terms. An influential circle of novelists and scientists responded to the same conundrum about time by aestheticising the new insights disclosed by the modern synthesis. In the twenty-first century David Mitchell’s celebration of time’s duality typifies a prominent contemporary way of coming to terms with what genomics suggests about time. Hence it is fortuitous but unsurprising that Mitchell picks roughly the same three moments – the nineteenth century, the 1930s, and the early twenty-first century – for three of the six temporal points in *Cloud Atlas*.

**Deep time**

*birthed by a god o’ Smart named Darwin*

– *Cloud Atlas*, p. 277

According to Stephen Jay Gould, the recognition that the world was older than six thousand years exacerbated a crisis that had been building throughout the nineteenth century. In *Time’s Arrow, Time’s Cycle*, Gould traces the discovery of what he calls ‘deep time’ to the late-eighteenth century, identifying James Hutton and Charles Lyell, who was an important influence on Darwin, as the heroes of deep time in geology, and he nominates Darwin for the same honour in natural history. Together, these figures helped change the earth’s timescale from a genealogy of Adam’s descendants to the scarcely comprehensible aeons of geologic strata. The concept of deep time opened an unsettling vista to the Victorians, a sense of time far beyond human comprehension, stretching back to the dim origins of the planet and forward to the cold embers of the sun. According to Gould, ‘Deep time is so alien that we can really only comprehend it as metaphor’. Hence the usefulness of literature and other cultural forms for mediating the impact of evolutionary time.

Victorian unease about deep time is an early episode in our culture’s struggle to come to terms with a disenchanted conception of eternity. Religious or ritual conceptions of time, which frame eternity in cyclical terms, seem to have always existed. Gould invokes Mircea Eliade’s well-known discussion in *The Myth of the Eternal Return* to describe this perennial metaphor, but he does not acknowledge how wedded cyclical
visions are to religious world views. Instead Gould posits ‘time’s cycle’ as one pole of a neutral dichotomy that takes linear time – ‘time’s arrow’ – as its other extreme. This is a powerful formulation, but the attempt to describe the two poles as logical (and recurrent) alternatives leads Gould to underplay the Victorian context. The choice was anything but neutral. For most of Darwin’s contemporaries, what was disturbing about deep time was that it presented a secular alternative to the dominant Christian scheme – the old circular vision of humanity’s fall from grace and redemption at the world’s end.

With few exceptions it was not until the twentieth century that our culture found ways to describe time’s cycle without religious overtones. Genome time is one such metaphor. At the conclusion of his book, Gould proposes another model for thinking about cyclical time without resorting to religious metaphors, but his account conflates Victorian deep time with his own modern scientific understanding: ‘The metaphor of time’s cycle captures those aspects of nature that are either stable or else cycle in simple repeating (or oscillating) series because they are direct products of nature’s timeless laws, not the contingent moments of complex historical pathways.’ Most Victorians would not have been comfortable with such a disenchanted vision of time’s cycle as a direct product of ‘nature’s timeless laws’. For the Victorians, deep time felt brutal and inexorable. Take, for example, the ending of H. G. Wells’s *The Time Machine* (1895). The Time Traveller stands on a desolate shore beneath a dying, red sun. His journey has taken him more than thirty million years into the future when the only signs of life are lichen and a monstrous sea slug. Nothing remains of humans or their works. Extinction has taken all except for these last denizens at the edge of a dead sea. The planet itself has ceased to rotate and grown cold. His heart sickens at the death-pangs of his world. To Wells’s Time Traveller, as to many of the author’s compatriots, this end was implicit in the universe Darwin had revealed. The incomprehensible sweep of time that brought humans onto the scene would one day take them off to extinction.

*The Time Machine* was only one of many late-Victorian novels that explored this unsettling scenario. The science fiction and utopias that became popular near the end of the century brought readers face to face with a secular vision of deep time. Here the public confronted vivid representations of the immensity of time without the solace of religious metaphors. In the process, however, this fiction helped readers cope with what was disturbing in the vision. Stark as they were, they tempered the brute materialism of natural selection with a more comforting vision, compounded out of hope for the progressive improvement of the species through the inheritance of acquired traits, or in Wells’s case, through the power of eugenics? Collectively,
late-Victorian genre fiction made the endless aeons tolerable by giving them teleology and a method. Perfection of the human species was the teleology, and eugenics the method. Restoring a goal to evolution helped cushion its impact, even if the goal was secular rather than sacred, and identifying a supposedly ‘scientific’ method for reaching that goal – eugenics – mitigated the sense of insignificance in the face of a meaningless eternity.

Contrast Wells’s didactic handling of evolution with the more circumspect approach found in some of the realistic novels of the Victorian period. As we know from Gillian Beer, George Levine, and others, the realistic novel had a sophisticated response to Darwin – and vice versa. George Eliot and Thomas Hardy, to take just two important realists, dealt with evolutionary ideas in formal terms as much as explicit themes. The reciprocal influence of Darwin and Victorian realism can be seen in the shared emphasis on gradual almost imperceptible change over time, the ‘entangled bank’ or continuum of life, the interconnectedness of all beings, and the role of chance in shaping our destinies. But popular late-Victorian genres – science fiction, mystery novels, imperialist adventure stories, and, in a different fashion, sensation fiction, New Woman novels, and utopia – responded to evolution in more explicit and polemical ways. These less-canonical works revel in topical concerns – eugenics, acquired characteristics, the mutability of species, degeneration, and extinction – in ways that most of the canonical texts of realism do not. These plot-driven genres were better suited for dramatising multi-generational eugenics narratives or stories of human species change.8 Certainly, the social message of utopia and New Woman fiction enabled authors to treat directly evolutionary themes that remained implicit in most realistic novels.

During the last three decades of the century, the question of whether acquired characteristics could be inherited increasingly preoccupied popular novelists, from Edward Bulwer-Lytton and Samuel Butler in the 1870s to Grant Allen and Walter Besant in the 1890s. Many scientists also returned to Lamarck to explain what they saw as the inability of natural selection to explain the dramatic changes required by Darwinian evolution. The evidence appeared to be mounting from all sides that the gradual accumulation of small changes could not account for the diversity of life, especially after Lord Kelvin’s calculations of the age of the earth seemed to demonstrate that there had been insufficient time for natural selection alone to have produced such abundant varieties of life. Lamarck’s model of inheritance offered an alternative explanation to scientists like Herbert Spencer, who were convinced of the truth of evolution but had come to believe that natural selection played only a secondary role in shaping descent. Rival conceptions of biological
inheritance were fought out between circles of true-believers in evolution: neo-Lamarckian novelists and scientists, on the one hand, and Darwinians, on the other. By 1885, the year the term ‘neo-Lamarckism’ was coined, the anti-Darwinian party had become so strong that the historian Peter J. Bowler describes this period as ‘the eclipse of Darwinism’.  

‘Neo-Lamarckism’ was the name of a loose confederation of evolutionists who argued for the central role of the inheritance of acquired traits in shaping the descent of plants, animals, and humans. Little known today, it constituted a serious challenge to Darwin from within the ranks of naturalists, morphologists, physiologists, and eugenicists. Although named after Lamarck, the movement actually elevated only one aspect of his thinking into a guiding principle – the notion that characteristics that one learned during one’s lifetime could be passed on to one’s descendants. This idea applied equally to physical features and learned behaviours. Other aspects of Lamarck’s thinking, such as the directed nature of evolution, its progressive character, use or disuse of an organ as a cause of species change, and the willed nature of some evolutionary changes, were largely subsumed under the banner of the heritability of acquired characters. Samuel Butler established a powerful analogy for this process by arguing that the ‘unconscious memory’ of the species directed evolution toward a purposeful goal.  

Like the infinite matryoshka doll Mitchell invokes in *Cloud Atlas*, every individual contained the collected wisdom of the race as its birthright, an inherited record of successful adaptive strategies.  

The cultural influence of neo-Lamarckism pre-dates the coining of the term. In 1871 and 1872 three British publications gave a powerful boost to the ideas that would become a polemical movement in the mid eighties, St George Jackson Mivart’s theistic account of evolution, *On the Genesis of Species* (1871), Edward Bulwer-Lytton’s utopian novel *The Coming Race* (1871), and Samuel Butler’s *Erewhon* (1872). Mivart’s work was one of the leading sources for arguments against natural selection; his vivid depiction of evolution as taking place by large, discontinuous leaps helped associate scepticism about Darwin’s gradualism with the argument by design. Bulwer-Lytton’s and Butler’s novels, though, set the mould for later neo-Lamarckian works in the popular vein. Neither novelist at that time was an opponent of Darwin. Bulwer-Lytton saw his utopian fable as a strong plea for evolution by natural selection, just as Butler did the following year, when he published *Erewhon*. Like Spencer, both novelists believed that the struggle for existence was a motive force for evolutionary change. Here is how Bulwer-Lytton puts it: ‘since in the competition a vast number must perish, nature selects for preservation
only the strongest specimens’. But the progressive direction of natural selection is shaped by the inheritance of acquired characteristics: ‘We are all formed by custom – even the difference of our race from the savage is but the transmitted continuance of custom, which becomes, through hereditary descent, part and parcel of our nature’ (CR 94).

The Coming Race was enormously popular in its day, which is hard to comprehend. Most readers today find it dull, although the satire on war, religion, capitalism, and democracy amuses some and the vision of a future in which women are more powerful than men contradicts stereotypes of the Victorian age. Still, like many utopias, its static discursive chapters on linguistics and social customs can be heavy-going. Whether one finds the work entertaining or not, this bizarre Darwin-haunted fable illuminates much about how evolution was assimilated by late nineteenth-century literary culture. Bulwer-Lytton’s novel tells the story of a mining engineer who stumbles across an underground civilisation vastly more advanced than his own nineteenth-century world. The subterranean people have abandoned industrial and technological progress and rely entirely upon an all-pervasive energy in the universe that they call ‘Vril’ – something like the Force that Jedi knights channel in the Star Wars movies. The people have developed the ability to harness this power over thousands of years of directed evolution. Their greatly elongated thumbs, the outward sign of this adaptation, have been cultivated by thousands of years of ‘continuous exercise, of the vril power’ by people who ‘devote[d] themselves to that paramount science’, and it could be ‘slowly developed in the course of generations’ by the ‘higher beings of the [human] race’ (CR 58). The notion that the willed use of a trait could strengthen its powers and result in heritable characters became a pillar of neo-Lamarckism at the end of the century. Vril is the source of the strange race’s many abilities: telepathy, winged flight, control over matter, and the power to blast entire cities into atoms with a single ray. The evolution of such powers has led them to abandon war and all forms of aggression as useless, since any individual could destroy all others with a wave of his Vril-stick – a Victorian version of the doctrine of Mutual Assured Destruction. (It was a widely shared fantasy of late-Victorian science fiction that technological advances in weaponry would render war so senseless that all nations would become pacifist, a fantasy put to rest by World War I). The people of the Vril are unabashed eugenicists, who strengthen their stock by exogamous marriages with distant communities and exterminate all weaker races. As a result of this stringent programme of social hygiene, an entirely new species of post-humans has evolved, the ‘coming race’ of the title. Here is how the narrator describes them:
I arrived at the conviction that this people – though originally not only of our human race, but, as seems to me clear by the roots of their language, descended from the same ancestors as the great Aryan family, from which in varied streams has flowed the dominant civilisation of the world... had yet now developed into a distinct species with which it was impossible that any community in the upper world could amalgamate. (CR 119)

Other examples could be multiplied from utopias ranging from Samuel Butler’s *Erewhon*, published the next year; to W. H. Hudson’s *A Crystal Age* (1887), with its ‘later race’, which possessed the ‘passionless, everlasting calm of beings who had for ever outlived, and left [emotion] as immeasurably far behind as the instincts of the wolf and ape’;¹³ to Grant Allen’s *The British Barbarians* (1895), with its traveller from the future who tells of a human race that has evolved beyond ‘war, bloodshed, superstition, fetish-worship, religious rites, castes, class distinctions, sex taboos, [and] restrictions on freedom’¹⁴; to H. G. Wells’s *A Modern Utopia* (1905), with its vision of a Samurai elite, a scientifically trained ruling class, who will guide the evolutionary course of the species by the ‘only sane and logical thing to be done with a really inferior race’, which was to ‘exterminate it’.¹⁵

The utopias that looked forward in time had a counterpart during this period among imperial adventure stories that portrayed lost civilisations from the distant past: H. Rider Haggard’s *She* (1887), for example, or Arthur Conan Doyle’s *The Lost World* (1912). In *She*, reincarnation consoles the African princess Ayesha during the endless centuries she waits for the return of her dead lover: ‘we shall awake, and live again and again shall sleep, and so on and on, through periods, spaces, and times, from eon unto eon, till the world is dead, and the worlds beyond the world are dead, and naught liveth save the Spirit that is Life’.¹⁶ Sensation fiction such as Wilkie Collins’s *The Legacy of Cain* (1889) and Walter Besant’s *The Fourth Generation* (1899) and New Women novels such as Grant Allen’s *The Woman Who Did* (1895) and Sarah Grand’s *The Beth Book* (1897) brought a progressive view of evolution into their plots through the emphasis on a neo-Lamarckian conception of the inheritance of acquired traits. Thus Besant’s novel informs us that ‘children may inherit the disease of crime just as they may inherit the disease of consumption or gout’, a pure instance of neo-Lamarckism, but one day, those who succumb to their inherited tendency will be forbidden to breed so that the tendency itself will die away and leave humanity in a higher state, an obvious instance of eugenics.¹⁷

Near the end of *Cloud Atlas* Adam Ewing composes an image of deep time as a ‘stream grinding boulders into pebbles through an unhurried eternity’ (CA 507). The earth’s unhurried ages have provided Adam with more examples of nature working ‘red in tooth and claw’ than he cares
to contemplate, and he has heard too many men justify violence and rapaciousness, the enslavement or outright extermination of darker races, as part of Nature’s plan. Mitchell is writing in the twenty-first century, however, and his Victorian character does not take solace in the belief that ‘Nature’s Law and Progress move as one’ (CA 488). Adam rejects this interpretation of deep time, averring instead that ‘for the human species, selfishness is extinction’ (CA 508).

Around 1931

The library refused many downloads, but I succeeded with two Optimists translated from the Late English, Orwell and Huxley... – Cloud Atlas, p. 211

The dystopian chapters of Cloud Atlas, set in a near-future corpocracy that manufactures clones for slave labour, pay homage to Brave New World (1932) in a number of places, not least the grimly comic epigraph above. Brave New World is one of the most influential depictions of genetics in all of literature. As Aldous Huxley was hard at work on this book, his longtime friend J. B. S. Haldane published a foundational work of the modern synthesis, The Causes of Evolution (1931). The modern synthesis – sometimes called the neo-Darwinian synthesis – brought together Darwin’s theory of evolution with the new science of genetics. Haldane, along with R. A. Fisher and Sewall Wright, used mathematical models to demonstrate that Darwin was correct to assert that natural selection was the primary cause of evolution. Their research did more to restore Darwin to scientific respectability than any other development in the early twentieth century.

The reputation of Darwin was at a low ebb as the century began, for the neo-Lamarckian assault on Darwin had only been strengthened by the rediscovery of Mendel’s work in 1900. Early Mendelians doubted that natural selection alone could account for the clear-cut differences among Mendelian factors that their model described. Additionally, some Mendelians like William Bateson were saltationists and thought that large mutations, not the small continuous variations Darwin postulated, better explained species change. Evolution was seen as an account of inheritance – of how characteristics were transmitted across time. Genetics, by contrast, was a science of difference: it explained how individuals varied from one another. As Haldane put it, ‘Genetics can give us an explanation of why two fairly similar organisms, say a black and a white cat, are different. It can give us much less information as to why they are alike’. So pervasive was the impression that Darwin’s ideas had been exploded that another early exponent of the modern
synthesis, Julian Huxley, prefaced his magnum opus, *Evolution: The Modern Synthesis* (1942), with a version of Mark Twain’s quip: reports of ‘the death of Darwinism’ seem ‘to have been greatly exaggerated’.\textsuperscript{20} By the time Julian Huxley wrote his overview of the modern synthesis, though, the revolution had swept the field, and he could state with confidence: ‘Mendelism is now seen as an essential part of the theory of evolution’.\textsuperscript{21}

Julian Huxley was the older brother of Aldous Huxley and an early collaborator with Haldane. The ferment around the discovery of the modern synthesis shaped Aldous Huxley’s understanding of genetics and can be discerned in the novel’s account of eugenics, pre-implantation genetic screening, in vitro fertilisation, embryo sorting, selective sterilisation, cloning, ectogenesis, and x-ray bombardment of chromosomes. Scholars of *Brave New World* have long pointed to the influence on the novel of Haldane’s youthful essay *Daedalus, or, Science and the Future* (1923). Few have noted the importance of the larger circle of scientists and fellow novelists who wrote about the cultural impact of genetics during this period. Haldane, Julian Huxley, and Aldous Huxley were only three of the writers who speculated on how the modern synthesis would affect their culture. Charlotte Haldane, wife of J. B. S. Haldane, anticipated *Brave New World* with her own novel about the future of genetics, *Man’s World* (1926); Naomi Mitchison, Haldane’s sister and a childhood playmate of the two Huxley brothers, wrote a play about a genetically enhanced species; and Bertrand Russell’s *The Scientific Outlook* (1931) tracked many of the same themes that appeared in J. B. S. Haldane’s essays ‘The Future of Biology’ and ‘The Last Judgment’, both published in *Possible Worlds* (1927). (This was the second book by Russell to engage with Haldane; Russell’s earlier *Icarus, or, The Future of Science*, 1924, was inspired by *Daedalus*.) In the scientific futures variously envisioned by these five writers, there will be no war, poverty, or disease; the working class will be conditioned to be docile, while a scientific elite will be groomed for leadership positions; most citizens will be sterilised to facilitate unlimited casual sex; romantic love will be seen as antisocial or deviant; and constant entertainment will keep the population pacified (Haldane remarks on these shared traits in his volume of essays *The Inequality of Man*, 1931).\textsuperscript{22}

One of the unifying features of this circle’s writings about genetics was opposition to neo-Lamarckism and other metaphysical ideas such as Bergson’s concept of *élán vital* or ‘creative evolution’. The Huxley–Haldane circle was adamant in resisting any philosophical attempt to sugar-coat the materialist foundation of the modern synthesis. Haldane’s demonstration that the natural selection of purely random mutations was the basis of all evolution, human and otherwise, made no
compromise with mystical or idealist notions that postulated a guiding purpose to evolution. Haldane could not be more blunt: he declares the mind to be a ‘by-product or epiphenomenon of certain material systems’ (CE 87); the process of evolution ‘does not suggest the work of an intelligent designer, still less of an almighty one’ (CE 85); and natural selection leads to no goal. These attitudes mark a decisive break with the utopias and science fictions of the prior century.

Aldous Huxley writes against neo-Lamarckism as frequently as Haldane or his brother Julian Huxley. Throughout Huxley’s early novels, one finds interesting satires on the misguided views about evolution that were widespread among his contemporaries. In his second novel, Antic Hay (1923), Huxley burlesques an earnest young biologist telling his mentor that he has ‘found a way of making acquired characteristics . . . heritable’. Everything in the scene, from the description of the young man’s ‘dark protruding eyes, and staring, doggy nostrils’ and his ‘very eager, lively and loud’ manner to the preposterousness of the experiment that involved injecting pulped eyes of a dead rabbit into a pregnant rabbit, underlines how bogus Huxley finds such pseudo-science. In Brave New World the necessity to genetically re-engineer every generation and to reinforce behavioural modifications through lifelong psychological conditioning dramatises that none of the artificially acquired traits were heritable.

To underline the cultural ramifications of the modern synthesis, Haldane, Julian Huxley, Bertrand Russell, and Aldous Huxley all explicitly attack the writings of Samuel Butler and George Bernard Shaw. As I have already mentioned, Butler’s Life and Habit (1878) and Unconscious Memory (1880) were touchstones for the neo-Lamarckian cause. Shaw’s Preface to Back to Methuselah (1921) became even more widely known during the 1920s for its championing of neo-Lamarckism. Shaw maintained that humans were capable of developing new traits by willing them into existence. Evolution by ‘senseless accident’ seemed impossible to the playwright. Instead, he maintained (with no evidence whatsoever) that ‘the will to do anything can and does, at a certain pitch of intensity set up by conviction of its necessity, create and organise new tissue to do it with’. The power of what he called ‘creative evolution’ would be capable of extending the human lifespan to 3,000 years once we marshalled sufficient will to stimulate this organic change. Echoing a long line of neo-Lamarckian polemicists, Shaw asserted: ‘If you like eating the tender tops of trees enough to make you concentrate all your energies on the stretching of your neck, you will finally get a long neck, like the giraffe’. But he was frank in admitting that he did not have a clue as to why. ‘Nobody knows how: nobody knows why: all we know is that the thing actually takes place’. Hence the disdainful tone of
Haldane’s reply is hardly surprising: ‘[Shaw] admits that Darwinism cannot be disproved, but goes on to state that no decent-minded person can believe in it. This is the attitude of mind of the persecutor rather than the discoverer’ (CE 88).

The more interesting question was why serious scientists like Haldane, Julian Huxley, and Russell felt that Shaw and Butler needed rebutting decades after they wrote. The answer lay in the cultural impact such neo-Lamarckian theories had long after their scientific credibility had been destroyed. Haldane’s comments sometimes have the fervour of a biologist today warring against theorists of Intelligent Design. But the relevant feature to this discussion is the role evolutionary time plays in his objections to neo-Lamarckism. Far from viewing human evolution in terms of progress, Haldane ironically considers whether the change from monkey to human might not have been a change for the worse – a human being is not only ‘an extremely primitive and imperfect type of rational being. He is a worse animal than the monkey’ (CE 83). Like Wells (and indeed Mitchell), Haldane situates the unprogressive character of evolution in the context of the species’s eventual extinction: ‘Most lines of descent end in extinction, and commonly the end is reached by a number of different lines evolving in parallel. This does not suggest the work of an intelligent designer, still less of an almighty one’ (CE 85). Further, Haldane sees the deplorable condition of the human species as a sign that the idea of directed evolution – whether by a creator or by the willed exertion of our faculties and the inheritance of acquired traits – is a sham. ‘If evolution, guided by mind for a thousand million years, had only got as far as man, the outlook for the future would not be very bright’ (CE 88).

Despite his polemical vigour against the remnants of nineteenth-century attitudes toward evolutionary time, Haldane puts forward his own characteristic way of reconciling our finite lives with the vast expanse of geological time. He confronts the insignificance of the human timescale with an unblinking gaze, but like many of the poets and artists of his era, he recuperates the experience in aesthetic terms. Where Victorian genre fiction recuperates Deep Time through teleology and eugenics, Haldane substitutes a self-sufficing beauty:

If I were compelled to give my own appreciation of the evolutionary process . . . I would say this: In the first place, it is very beautiful. In that beauty there is an element of tragedy. On the human time-scale the life of a plant or animal species appears as the endless repetition of an almost identical theme. On the time-scale of geology we recapture that element of uniqueness . . . which makes the transitoriness of human life into a tragedy. In an evolutionary line rising from simplicity to complexity, then often falling back to an apparently primitive condition before its end, we
perceive an artistic unity similar to that of a fugue, or the life work of a painter of great and versatile genius like Picasso . . . Possibly such artistic work gives us a good insight into the nature of the reality around us as any other human activity. To me at least the beauty of evolution is far more striking than its purpose. (CE 90)

Once again, we see the division of history into human and geological time-scales. The transitoriness of the former lends life a tragic element, but the unity of the latter is consoling in the way a fugue or the work of a great painter can be. To value the beauty of evolution more than its purpose is to join Darwin (rather than neo-Lamarckians) in rejecting teleology. What unites this pioneer of the modern synthesis with a pioneer of modern art like Picasso is an appreciation of form as much as content. That is why Haldane suggests that an artistic work might give us as much insight into reality as science, or indeed any human activity.

In Aldous Huxley’s *Those Barren Leaves* (1925), a novel of ideas set in an Italian palazzo where a group of British writers, artists, and intellectuals are gathered together for little more, apparently, than to give Huxley an opportunity to satirise the foibles of his day, characters speculate about the past, future, and distant end times in ways that made me think of *Cloud Atlas*. One character laments the passing of the late 1850s when he was born ‘almost a twin to *The Origin of Species*’, while another prophesises a future society which ‘has contrived to make slavery, for the first time, really scientific and efficient’ and an even more distant time when there is not ‘going to be a future at all, at any rate for human beings’. There is no reason to suppose that Mitchell needed these oblique hints from Huxley to conceive *Cloud Atlas*’s nineteenth-century past, near-future slave society, and far-future apocalypse. But my point is the reverse: these sorts of reflections on time represent a common response among artists and scientists who meditate on the implications of evolution for humanity.

**Three moments**

> She grasps for the ends of this elastic moment, but they disappear into the past and the future.

– *Cloud Atlas*, p. 430

With the release of the 2012 film of *Cloud Atlas*, science journalists leapt at the chance to instruct us about the imminence of the genetic technologies depicted in the near-future dystopia. The bioethicist Kevin Smith, for example, drew on his earlier scholarly contribution to the *Archives of Medical Research* to comment that the benefits of cloning seemed likely to outweigh the harms and that ‘a nightmarish “Cloud
Atlas” future would not flow inexorably from the deployment of human germline genetic modification.30 The novel’s ‘fabricants’ are genetically modified clones, created to serve as slaves in the Corpocracy that has replaced present-day South Korea. Fabricants are fictional descendants of the Deltas and Epsilons in Huxley’s Brave New World, but the fabricant Sonmi-451 reflects Mitchell’s thoughtful depiction of cloning when she asserts that ‘even same-stem fabricants cultured in the same wombtank are as singular as snowflakes’ (CA 187). This claim seems likely to be borne out if society ever creates human clones because even identical genotypes are altered by epigenetic factors and environmental variables. After all, homozygous twins with identical genomes have distinct identities. That is why Mitchell’s fabricants must be fed a daily ration of drugs, like the Soma in Brave New World, to keep them from developing into independent autonomous beings, and why they must be euthanised at the end of their service life, again as in Huxley’s novel.

The movie version makes numerous changes to the plot and structure of the novel.31 The consensus of most reviewers, even those who found the film less than successful, was that the changes represented interesting approaches to adapting the work for a new medium. For example, the movie continuously cross-cuts all six time periods instead of progressing forward, then moving backward, through time. This cinematic strategy effectively leverages the power of montage to re-imagine the novel’s experimental structure. One recurrent transition shot features a character opening a door in one time period and a different character resuming the story in another. The effect is of narrative simultaneity within a context of difference. Each story is visibly a variation on a theme – or, to use a genetic metaphor, each character is a variant of a single genotype. From this perspective the comet-shaped birthmark shared by numerous characters becomes the marker of a common genetic makeup, expressed differently in different historical niches. In the novel the birthmark tended to signify reincarnation, a motif that runs through several of Mitchell’s novels. But the movie allegorises this motif in more ambiguous ways. The viewer encounters the birthmark as a symbol of continuity within a pattern of difference, not of spiritual (or literal) reincarnation. Thus the movie, unlike the novel, allows the birthmark to manifest on villains – such as the murderous doctor in the nineteenth century – as well as on idealistic figures, such as the crusading female journalist in the twentieth century.

In their different ways, however, both film and novel capture what is distinctive about genome time. Both view the present as an elastic point, incorporating past and future. The present is potentially all times at once – everything that has led up to it and all possible outcomes. This is a fundamentally synchronous approach to evolutionary time. Humans
live and die in linear time, of course. Diachrony rules all life in this sublunary sphere. But the concept of the genome allows us to grasp a synchronic conception of evolution in ways that were not plausible in earlier eras. Naturally, genomics alone has not wrought this change. One could argue that the digital computer contributed as decisively as genomics to such reflections. The idea of the genome, however, frames the temporal insight in biological terms. It uncovers the synchrony within biology, which had hitherto been hidden by the inexorable march of time.

This article has focused on three moments – the late nineteenth century, the early twentieth, and our own time – which delineate three prominent relationships to evolutionary time. The nineteenth-century conception of deep time enormously expanded the culture’s sense of the past and opened vistas onto an endless set of tomorrows. I have argued that much of the popular fiction of that era compensated for these unfathomable gulfs by providing evolutionary time with teleology – species change – and a method of reaching that goal, eugenics. But the Victorians had no sense that this past and future could be conceptualised as a synchronic system in the present. Without an understanding of the mechanism of heredity, the gene, the double logic of genome time was ruled out.

The authors of the modern synthesis were unafraid of the abyss, but they looked for consolation in the aesthetic beauty of synthesis itself. The union of evolution and genetics revealed what Haldane called ‘the austerely beautiful outline of reality’ (CE 90). For all the writers in the Haldane–Huxley circle, the only honest attitude is a ‘truly passionate attachment to reality as such, whether it be bright or dark, mysterious or intelligible’ (CE 91).

Today genomics has changed our relation to time as radically as the two previous moments. As we saw earlier, Barry Barnes and John Dupré phrase the change in terms of genomics’s emphasis on ‘life cycle’ rather than ‘inheritance and inherited differences’. This shift, they maintain, has important consequences for how we conceptualise the object of biology and its continuity over time. ‘From a life cycle perspective, the different organisms that we identify as the ancestors of a given individual over successive generations are recurrent patterns in a continuing cycle of changes, and what part of the cycle will count as “the organism” should be considered no more than an arbitrary decision’. Such a perspective suggests new ways that readers, and viewers, of Cloud Atlas might interpret Mitchell’s ‘infinite matryoshka doll’ of the present (CA 392). The series of ‘previous presents’ encasing the moment in which we live ‘may be addressed as a single changing object’, to quote Barnes and Dupré again, ‘rather than as a series of different objects
between which something has to be transmitted in order to account for
the resemblance between later members of the series and those that
come before.\textsuperscript{35} Eternal recurrence, variations on a musical theme,
reincarnation, nested dolls, genome time – \textit{Cloud Atlas} offers a powerful
set of metaphors for what has happened to time since the nineteenth
century.

Notes

I would like to thank my research assistant, Donald T. Rodrigues, for his help
with this article and Regenia Gagnier for her advice and support.

further references to this work will be cited in the text as \textit{CA}.
2 The term ‘genome time’ comes from my chapter of that name in Jay Clayton,
\textit{Charles Dickens in Cyberspace: The Afterlife of the Nineteenth Century in
Postmodern Culture} (Oxford: Oxford University Press, 2003). Several
sentences in the next paragraph are adapted from that earlier work.
3 See ibid., 166–89.
4 Barry Barnes and John Dupré, \textit{Genomes and What to Make of Them} (Chicago:
University of Chicago Press, 2008), 49.
5 Stephen Jay Gould, \textit{Time’s Arrow, Time’s Cycle: Myth and Metaphor in the
Discovery of Geological Time} (Cambridge MA: Harvard University Press,
1987), 3.
6 Ibid., 196.
7 After reading August Weismann, Wells turned away from Lamarckism, but
his growing interest in eugenics gave him a reason to believe that society
could take control of evolution and direct it toward a desired end.
8 I owe this insight to Jessica Staley’s comment following my paper
‘Evolutionary Circles: Rivalry and the Eclipse of Darwinism’ at the North
American Victorian Studies Association (Madison, 28 September 2012).
9 Peter J. Bowler, \textit{The Eclipse of Darwinism: Anti-Darwinian Evolution Theories in
the Decades around 1900} (Baltimore: Johns Hopkins University Press, 1983).
10 See Samuel Butler, \textit{Life and Habit} (London: Trübner, 1878) and \textit{Unconscious
Memory} (London: D. Bogue, 1880).
11 Bowler, \textit{The Eclipse of Darwinism}, 49.
12 Edward Bulwer-Lytton, \textit{The Coming Race} (1871; Santa Barbara CA:
Woodbridge Press, 1979), 52. All further references to this work will be cited
in the text as \textit{CR}.
16 H. Rider Haggard, \textit{She and King Solomon’s Mines} (1887; New York: Modern
Library, 1957), 216.
17 Walter Besant, \textit{The Fourth Generation} (New York: Frederick A. Stokes, 1900),
247; for the eugenics passage, see 324–5.
Of course neither did many thoughtful late-Victorian evolutionists, ranging from Thomas H. Huxley to Weismann. But during the last decades of the nineteenth century, they were in the minority among both novelists and scientists.

J. B. S. Haldane, *The Causes of Evolution* (1932; Princeton: Princeton University Press, 1990), 34. All further references to this work will be cited in the text as *CE*.


Ibid., 26.


Ibid.


Ibid., xvi.

Ibid., xxi.

Ibid., xxiii.


Tom Stoppard makes that point in his play *Arcadia* when he has a mathematician muse that calculating iterated algorithms would have been insane prior to the invention of the computer.


Ibid., 49.

Ibid., 49.
Then over time, the underlying science radically changed. We learned about DNA and the genetic code and protein machinery and more—but there was intellectual inertia. People said, "No, Darwin's still got this covered." And Darwinism does that, too. If there's any advantage in getting rid of something, then natural selection and random mutation will get rid of it without a moment's thought, because they can't think. What's an example of that in biology? Now we do, because the entire genomes of the grizzly and polar bears have been sequenced. It turns out, of the 17 most important changes, about three-quarters of them are degraded genes in the ancestor, the brown bear. One gene involved in making pigment in the brown bear's coat was broken, so the polar bear has a white coat. Darwinism is a mess. It makes all kinds of wild assumptions that are seldom even brought to conscious awareness, and those defending Darwinism often play games with definitions and the meanings of words. So instead of tackling Darwinism head-on, let's first consider it in the context of another theory that Darwinism sought to replace and that has made a comeback in recent decades: Intelligent Design ("ID"). The design argument is very old indeed: if we look at life on our planet, including human life, our intuition tells us that all this beauty, complexity, symmetry, specialization, systems, e Darwin, Then and Now is a chronicle of who Darwin was, how he developed his theory, what he said, and what scientists have discovered since the publication of The Origin of Species in 1859. The book details the rise and fall of evolution as a scientific theory. With over 1,000 references from Darwin and scientists, Darwin Then and Now retraces how this once popular theory is now recognized as only a philosophy; not a valid scientific theory. Get Connected. Website Search. Darwinism is a term that is generally considered synonymous with the theory of natural selection. This theory, which was developed by Charles Darwin, holds that natural selection is the directive or creative force of evolution. The term "Darwinism" also has been applied to the evolutionary theories of Charles Darwin in general, rather than just the theory of natural selection. It may also refer specifically to the role of Charles Darwin as opposed to others in the history of evolutionary thought.
We then explore how differences in mutation rates have flow-through effects to the rate at which populations acquire substitutions, which in turn influences the speed at which populations become reproductively isolated from each other due to the acquisition of genomic incompatibilities. Since diversification rate is commonly measured from phylogenetic analyses, we propose a conceptual approach for relating events of reproductive isolation to bifurcations on molecular phylogenies. As we examine each of these relationships, we consider... Darwin, Then and Now is a chronicle of who Darwin was, how he developed his theory, what he said, and what scientists have discovered since the publication of The Origin of Species in 1859. The book details the rise and fall of evolution as a scientific theory. With over 1,000 references from Darwin and scientists, Darwin Then and Now retraces how this once popular theory is now recognized as only a philosophy; not a valid scientific theory. Get Connected. Website Search. 2013, Genome Time: Post-Darwinism, Then and Now, Critical Quarterly. 2012, Touching the Telectroscope: Haptic Communications, Journal of Victorian Culture. 2012, The Dickens Tape: Affect and Sound Reproduction in The Chimes, Essays and Studies. 2012, The Future of Victorian Literature, Cambridge History of Victorian Literature. 2009, Literature and Science Policy: A New Project for the Humanities, PMLA. 2007, Victorian Chimeras, or, What Literature Can Contribute to Genetics Policy Today, New Literary History. 2003, Frankenstein's Futurity, The Cambridge Companion to Mary Shelley. 2002, Convergence of the Two Cultures: A Geek™'s Guide to Contemporary Literature, American Literature. 2002, Genome Time, Time and the Literary. Darwinism: Then and Now. by Terry Melanson Â– February 4, 2014. by Erik G. Magro ©, Aug. 16th, 2005. The Victorian Age in England was a time of dramatic changes, new inventions, the Industrial Revolution, and an introduction to new ideologies, all of which would transform the way significant portions of society lived and thought of life forever. The overwhelming external changes in daily life during this period would match in intensity the nature of changes happening in the internal lives of the public.