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The Reception of Darwinism in the Nineteenth Century: A Three Part Story

For over a century, historians and other scholars have debated the impact of 'Darwinism' on late nineteenth century biological and social thought. The general view holds that Darwinism quickly became ascendant in science and has remained so ever since. Recent scholarship points toward a more nuanced view in large part because of a growing appreciation of how the term was then understood. To the extent that Darwinism simply meant evolutionary descent with modification, then the general view remains widely accepted by historians. Virtually every laboratory biologist and field naturalist accepted the concept by 1880 and continues to do so. During the late nineteenth century, however, Darwin's particular theory of evolution by natural selection, which was also commonly referred to as 'Darwinism', gradually lost ground to other scientific explanations for organic evolution. Further, despite Darwin's passionate defence of it, any direct evolutionary link between human and animal nature remained highly controversial throughout the nineteenth century.

Keywords: Darwinism, Neo-Lamarckism, orthogenesis, natural selection, evolution, biogeography, mutation theory, T. H. Huxley, Ernst Haeckel, Alfred Russel Wallace

Surveying the scientific scene in 1868, British naturalist and science leader Thomas Henry Huxley congratulated Charles Darwin, 'You will have the rare happiness to see your ideas triumphant in your lifetime.'[1] Precisely what Huxley meant by this comment is unclear because Huxley himself remained uncommitted to several key tenets of Darwin's epoch insight that new species evolve from old species through a survival-of-the-fittest process known as *natural selection*. Most likely, Huxley referred solely to the more basic concept also advanced by Darwin, but not originated by him, that organisms of one species evolve from those of another by some sort of process involving *descent with modification*. Largely due to Darwin's advocacy of it, by 1868, this latter concept was well on its way towards routing the doctrine of special creation within mainstream scientific thought.

At the time, the term 'Darwinism' could mean either natural selection in particular or descent with modification in general, with the two ideas viewed quite differently. Further, for non-scientists, Darwinism had become shorthand for these processes as applied specifically to humans. Darwin argued for both

1 T. H. Huxley to Charles Darwin, 12 September 1868, in Huxley, T. H. *Life and Letters of T. H. Huxley* I, New York: Appleton (1901), p. 319.

natural selection and descent with modification in his epoch-making 1859 book, *Origin of Species*, but never conflated them. 'Personally,' he noted in 1863, 'I care much about Natural Selection; but that seems to me utterly unimportant compared to the question of *Creation* or *Modification*.'[2] While *Origin of Species* did not exempt humans from these processes, for over a decade Darwin left the elaboration of that idea to others.

Reflecting his relative valuation of these issues, during the 1860s and 1870s, as scientists raised increasing doubts about the sufficiency of natural selection to account for evolution, Darwin revised *Origin of Species* to add ever larger doses of earlier Lamarckian concepts that characteristics acquired by individuals during their lifetime, rather than only modifications endowed at birth, supply the variations that fuel the evolutionary process. Indeed, though the term first applied only to the theories of German Darwinist August Weismann, in time, biologists who maintained that inborn variation and natural selection alone could cause the evolution of new species became known as neo-Darwinians to distinguish them from Darwin himself, who held less dogmatic views. Natural selection continued to lose ground in the final two decades of the nineteenth century – so much so that, by 1900, biologists were speaking of its eclipse or demise. The concept of evolution through descent with modification never faltered, though, and became ever more widely accepted by scientists.

To avoid confusion in chronicling these developments, this article uses the terms 'natural selection' or 'neo-Darwinism' to identify the specific theory that evolution proceeds though the natural selection of random, inborn variations and 'evolution' or 'evolutionism' to refer to the general concept of descent with modification, whether by natural selection or by other means. When dealing with the debate over animal origins for the human species, this article will refer to 'the theory of human evolution'. Following an introduction to the historical literature, the article will separately summarise the reception given to each of these three ideas in Europe and the United States during the late nineteenth century.

Introduction to the literature

No topic in the history of science attracts greater scholarly or popular interest than Darwin and Darwinism. Among historians of science, something resembling a publishing industry has developed around Darwin and his actual or supposed influence on modern thought. Virtually every aspect of his life and his impact has been or is being explored by one or more able historians. Any attempt to survey this literature, even as it pertains to Europe and North America in the late nineteenth century, is doomed to be incomplete. Still,

2 Charles Darwin to Asa Gray, 11 May 1863, in Burkhardt, F.H. et al.(eds.) *The Correspondence of Charles Darwin*, XI, Cambridge: Cambridge University Press, (1999), p. 403 (Darwin underlined 'Creation' and 'Modification' once and 'or' twice).

despite the wealth of historical scholarship, because he was an exceptional (and popular) writer as well as an enthusiastic (and candid) correspondent, the best place to begin any study of late nineteenth century responses to Darwinism is with the published and private writings of Darwin himself. Both *The Origin of Species* (1859) and *The Descent of Man* (1871) are literary and scientific masterpieces. Darwin's *The Expression of Emotions in Man and Animals* (1872) and his posthumously published *Autobiography* (1887; rev. edn. by Nora Barlow, 1958) also reveal much about both the author and responses to his work. Cambridge University's Darwin Correspondence Project is making available in multiple volumes and online with extraordinary notes the entire collection of Darwin's nearly 15,000 surviving letters, plus a vast number of letters written to Darwin. As Darwin remained the best defender of his own ideas, thousands of these letters deal with responses to Darwinism in all its forms. They can be read with profit and enjoyment.

Some of Darwin's many biographers have woven the late nineteenth century scientific and popular debates over evolution, natural selection and human origins into their biographies. In this respect, two biographies stand out: Janet Browne's *Charles Darwin: The Power of Place* (2002) and *Darwin* by Adrian Desmond and James Moore (1991). Both books present Darwin as a tormented celebrity who physically isolated himself in his country home in Down even as he threw himself into the promotion of his ideas. Browne's biography (the second in a two-volume set) begins with the publication of *Origin of Species* and is especially detailed in presenting the scientific and cultural responses to that book and *Descent of Man*. Her work is meticulous. Among the numerous biographies of Darwin's principal collaborators and defenders, Adrian J. Desmond's two-volume *Huxley* (1994 and 1997), *Alfred Russel Wallace: A Life* (2001) by Peter Raby; and A. Hunter Dupree's *Asa Gray, 1810-1888* (1959) provide insight into nineteenth century responses to Darwinism. Bernard Lightman explores T. H. Huxley's use of Darwinism in his battle for scientific naturalism in 'Victorian Sciences and Religions: Discordant Harmonies,' *Osiris*, 16 (2001), 343-366. Intellectual history is more often about winners rather than losers in the war of ideas but on the other side of this battle, Joe D. Burchfield's *Lord Kelvin and the Age of the Earth* (1975), *Richard Owen: Victorian Naturalist* (1975) by Nicolaas A. Rupke, and Edward Lurie's *Louis Agassiz: A Life in Science* (1960), relate the biography of three great scientists who resisted the Darwinian tide. These books show the immediate impact of *Origin of Species* transforming scientific thought in Britain and the United States. They do not always clearly differentiate between responses to evolutionism and natural selection, however.

Various books focus directly on the scientific or popular reception of Darwin's work in various places and contexts. As a general rule, in telling this story, these accounts do not differentiate sharply between evolution, natural selection and human origins. Two influential books originally written for the *Origin's* 100th anniversary, shortly after acceptance of the modern neo-Darwinian synthesis had re-established Darwin's place at the apex of biological thought, John C. Greene's *Death of Adam: Evolution and Its Impact on Western*

Thought (1959) and *Darwin's Century: Evolution and the Men Who Discovered It* (1958) by Loren Eiseley, set the contemporary framework for understanding the social and scientific impact of Darwinism generally.

The initial popular response in Britain to Darwin's ideas is recounted in Alvar Ellegard, *Darwin and the General Reader: The Reception of Darwin's Theory of Evolution in the British Periodical Press, 1859-1872* (1990). Ronald L. Numbers focuses on the American side of the story in *Darwinism Comes to America* (1998). The German story is told with a particular emphasis on the uses of evolutionary science to promote secularism, in Alfred Kelly, *The Descent of Darwin: The Popularization of Darwinism in Germany, 1860-1914* (1981). Giuliano Pancaldi's *Darwin in Italy: Science Across Cultural Frontiers* (1991) adds a Catholic, southern European dimension to the cultural history of Darwinism. *The Edge of Contingency: French Catholic Reaction to Scientific Change from Darwin to Duhem* (1979) by Harry W. Paul introduces another country into the mix. Two wide-ranging collections of essays dealing with the reception of evolutionism in various countries are Thomas F. Glick, ed., *The Comparative Reception of Darwinism* (1974) and Ronald L. Numbers and John Stenhouse, eds., *Disseminating Darwinism: The Role of Place, Race, Religion, and Gender* (1999).

David N. Livingstone explores the impact of local context on the reception of various scientific theories, including Darwinism, in *Putting Science in its Place: The Geography of Scientific Knowledge* (2003). The role of biogeography in late nineteenth century evolutionary thought is addressed in two delightful books, David Quammen, *The Song of the Dodo: Island Biogeography in an Age of Extinction* (1996) and Janet Browne, *The Secular Ark: Studies in the History of Biogeography* (1983). My book, *Evolution's Workshop: God and Science in the Galapagos Islands* (2001), explores the role played by Galapagos research in the debates over the theory of evolution during the late nineteenth century and beyond. Robert J. Richards provides a thesis-driven introduction to nineteenth century debates over evolutionary interpretations of the human nature in *Darwin and the Emergence of Evolutionary Theories of Mind and Behavior* (1987).

In a series of books and articles about late nineteenth century biology, Peter J. Bowler has explored the differing responses to various aspects of Darwin's work. On the one hand, in *Evolution: The History of an Idea* (2nd edn. 2003) and elsewhere, he has further documented the rapid, widespread and revolutionary acceptance in Europe and the United States of the evolutionary idea of descent with modification. On the other hand, in *The Eclipse of Darwinism: Anti-Darwinian Evolution Theories in the Decades around 1900* (1983) and *The Non-Darwinian Revolution: Reinterpreting a Historical Myth* (1988), he broke new ground in emphasising the persistent questions and growing doubts among European and American scientists of the sufficiency of natural selection and random, inborn variations to account for evolution.

The continuing resistance to the acceptance of modern scientific theories of evolution, natural selection and human origins by some Christians, Moslems

and Jews in North America, Africa and elsewhere has spurred historians to re-examine late nineteenth century religious responses to Darwinism. Three early works, James R. Moore, *The Post-Darwinian Controversies: A Study of the Protestant Struggle to Come to Terms with Darwin in Great Britain and America, 1870-1900* (1979), Frank M. Turner, *Between Science and Religion: The Reaction to Scientific Naturalism in Late Victorian England* (1974), and David N. Livingstone, *Darwin's Forgotten Defenders: The Encounter Between Evangelical Theology and Evolutionary Thought* (1987), explore how many late nineteenth century Christians in Britain and the United States – including some evangelical Protestants – became reconciled to evolutionism. The biblical concerns of American Protestants confronted with the challenge of evolutionary science are explored in *Darwinism and the Divine in America: Protestant Intellectuals and Organic Evolution, 1859-1900* (1988). Despite his limiting title, Peter J. Bowler includes some late nineteenth century material in *Reconciling Science and Religion: The Debate in Early Twentieth-Century Britain* (2001). The early chapters of various books on twentieth century American creationism look back to the late nineteenth century roots of anti-evolutionism among conservative Christians in the United States, including Ronald L. Numbers, *The Creationists: The Evolution of Scientific Creationism* (1992) and my *Trial and Error: The American Controversy over Creation and Evolution* (1985). In a series of overlapping books, philosopher of science Michael Ruse incorporates some historical study of late nineteenth century religious reactions to evolutionism in *The Evolution Wars: A Guide to the Debates* (2000), *Can a Darwinian be a Christian?* (2000) and *The Creation-Evolution Struggle* (2005). Drawing on these and other books, the ensuing article summarises the various and varying historical responses to Darwinism in four decades following the publication of *Origin of Species* in 1859.

The ascent of evolution

The doctrine of special creation had dominated Western biological thought for so long that few scientists could have predicted how quickly it would fall from grace. In the United States, for example, virtually no naturalist publicly endorsed the idea of organic evolution prior to the publication of *Origin of Species* in 1859, yet a dozen years later American paleontologist Edward Drinker Cope concluded that intervening developments had placed 'the hypothesis on the basis of ascertained fact'.[3] In his work, Darwin drew on the research of Harvard botanist Asa Gray, who returned the favour by arranging for the initial American publication of *Origin of Species* in 1860. A well-connected scientist known for his orthodox Christian faith, Gray gave Darwin's work an aura of respectability from the outset. Based on a study of naturalists within America's National Academy of Sciences, historian Ronald Numbers

3 Cope, E.D. 'Evolution and its consequences' *Penn Monthly* (1972) 3, 223.

concluded that, by the mid-1870s, nearly all of them had converted to evolutionism or died. 'Naturalists continued to argue about the adequacy of natural selection to account for evolution,' Numbers notes, 'but with few exceptions they, like Darwin, had forever turned their backs on the special creation of species.'[4]

The end result was much the same in Britain. There, Darwin, Huxley and their allies collaborated to win over the scientific establishment, with the goal of enthroning naturalism as the ideology of science and science as the mainspring of modern society. In the face of entrenched opposition from senior scientists wedded to the idea of special creation, they consciously sought to minimise open scientific debate over evolution while advancing the interests of biologists who utilised an evolutionary approach in their research. Working through a intimate group of like-minded intellectuals known as the X Club, Huxley and his friends secured leadership roles in many of Britain's leading scientific societies, placed supporters in prominent university and museum positions and influenced the editorial policies of scholarly journals.

By the 1870s, evolution had supplanted special creation in Britain as the accepted scientific explanation for the origin of species. 'So successful was this takeover of the British scientific community,' historian Peter Bowler says about the X-Club putsch, 'that by the 1880s its remaining opponents were claiming that Darwinism had become a blindly accepted dogma carefully shielded from any serious challenge.'[5] During this period, evolutionism also spread throughout the British Empire, taking root wherever an Anglo culture prevailed – particularly in the new scientific institutions of Australia, New Zealand and Canada.

Associated as it was with Darwin and clearly the product of Western thought, evolutionism spread more slowly outside the English speaking world than within it and hardly at all beyond the regions influenced by European science. For example, evolutionary thinking had little appreciable impact on nineteenth century science in the Roman Catholic domains of Southern Europe or Latin American. Further, the legacy of French naturalist Georges Cuvier, who had ridiculed and for a time routed the evolutionary hypothesis of his rival, the chevalier de Lamarck, during the early nineteenth century, kept evolutionism at bay in Francophone Europe for a generation. When it did re-enter French science, it did so with a distinctly Lamarckian flavour.

In the years immediately following the publication of *Origin of Species*, the key battleground for evolutionism outside Britain and the United States became Germany, which then stood out as the pre-eminent centre for the study

4 Numbers, R.L. *Darwinism Comes to America*, Cambridge, MA: Harvard University Press (1998), p. 24.
5 Bowler, P.J. *Evolution: The History of an Idea*, Berkeley: University of California Press, (1984), p. 184.

of morphology, physiology, cell theory and most other branches of laboratory biology. There, beginning in the 1860s, morphologist Ernst Haeckel used his own variant of natural selection as a battering ram against the entrenched metaphysical idealism of the sciences in his country. German idealism embraced stasis and preordained archetypes in nature as against Haeckel's vision of self-driven progress through natural processes. With a growing corps of disciples, Haeckel sought to understand living things according to evolutionary genealogies rather than archetypical patterns. Where Haeckel saw evolution proceeding through the accumulation of Lamarckian acquired characteristics selected for fitness in a Darwinian fashion, his contemporary August Weismann advanced a purer form of neo-Darwinism that relied exclusively on the natural selection of inherited variations, with those variations based in an individual's hereditary 'germ plasm'.

Everywhere that evolutionism took root during the late nineteenth century, it held a similar appeal for scientists. With a theory of evolution, laboratory biologists and field naturalists could begin trying to explain the origins of living things (and perhaps of life itself) in terms of regular, rational, repeatable natural processes rather than divine fiat. By that time, this was what scientists did: Find naturalistic causes for physical phenomena. Doing anything else represented an abrogation of their perceived responsibilities as modern scientists. For theists like Asa Gray, evolution might simply represent the immediate or secondary cause of new species; for materialists like Huxley and Haeckel, it surely served as the ultimate or final cause; for laboratory biologists and field naturalists in both camps, it increasingly became the only acceptable scientific answer to the origins question.

From the outset of their public campaign for the theory of evolution, Darwin and Huxley stressed that the opposing view of special creation simply was not scientific. This theme ran through *Origin of Species*, and Huxley echoed it in his laudatory reviews of the book. Gray made a similar point to American readers in his popular articles and books, summarised in his statement that the principle strength of evolution theory 'appears on comparing it with the rival hypothesis of immediate creation, which neither explains nor pretends to explain' anything in biology.[6] Gray's collaborator in devising a theory of theistic evolution, geologist George Frederick Wright, added that, in doing science, 'we are to press known secondary causes as far as they will go in explaining facts. We are not to resort to an unknown (i.e., supernatural) cause for explanation of phenomena till the power of known causes has been exhausted. If we cease to observe this rule there is an end to all science and all sound sense.'[7] Wright's defence of methodological naturalism in science is telling because he

6 Gray, A. *Natural Science and Religion: Two Lectures Delivered to the Theological School of Yale College*, New York: Scribner's (1880), pp. 61-62.
7 Wright, G.F. 'Recent works bearing on the relation of science to religion: No. II', *Bibliotheca Sacra*, (1876) 33, 480.

was an ordained minister and evangelical Christian college president.

Armed with a new paradigm, evolutionists began the task of reinterpreting nature in light of their theory of origins and pursuing the rich research agenda it offered. This inevitably appealed to the best young biologists, and they in turn uncovered additional evidence for evolution. In *Origin of Species*, for example, Darwin gave new meaning to rudimentary organs (such as the tail bone in humans) and homologous correspondences in comparative anatomy (like the five-fingered bone structure of mammalian hands, paddles and wings). Useless organs and less-than-optimal homologies made perfect sense as byproducts of evolutionary development but little at all as the artwork of an Intelligent Designer. Accordingly, Darwin used them as evidence for evolution, and his followers followed suit. During the late nineteenth century, comparative anatomists and evolutionary morphologists looked for and found an ever increasing number of such features throughout the animal kingdom, and then moved beyond Darwin by using them to investigate evolutionary relationships among species in a bold effort to diagram the so-called tree of life.

Interest in reconstructing the genealogic history of living things also focused attention on modern species that appear to connect fundamentally different kinds of plants or animals. Some evolutionists saw marine lancelets, which lack bony structures, as living links between invertebrates and vertebrates, for example, and lung fish, which can breathe air for short periods, as a bridge between fish and amphibians. Similarly, modern monotremes, including the egg-laying platypus and echidna, and marsupials, which bear underdeveloped young, seemed to tie reptiles to mammals. Some scientists and many within the general public saw living links as convincing evidence for evolution.

Even more than living links, fossils of extinct types offered the promise of disclosing the actual past history of organic life. Throughout the late nineteenth century, paleontologists culled the fossil record for evidence of evolutionary development. Among their many finds, two stood out as particularly persuasive: fossils linking reptiles to birds and a sequence of fossils leading to the modern horse. Huxley played a part in both discoveries, along with American paleontologist O. C. Marsh.

The links connecting reptiles to birds began turning up during the 1860s. At the time, some of the best-preserved fossils of the Jurassic Period came from limestone quarries near the Bavarian town of Solnhofen. There, in 1861, workers found the fossilised remains of the earliest known feathered animal. After examining the headless specimen, Huxley concluded that this Jurassic animal, called *Archaeopteryx*, was some sort of ancient bird, but noted its marked reptilian features and speculated that (like ancient reptiles but unlike modern birds) it had a mouth with teeth. In 1872, Marsh identified two quite different species of toothed birds, *Ichthyornis dispar* and *Hesperornis regalis*, from Cretaceous Period fossil beds in Kansas and, five years later, a second specimen of *Archeopteryx* turned up at Solnhofen, this one with a head *with a mouth and teeth*. Here were reptile-like birds from the age of dinosaurs apparently evolv-

ing into a multitude of forms. The Solnhofen quarries also produced a small dinosaur, *Compsognathus lognipas*, which apparently walked upright on bird-like hind legs and feet. In his 1868 paper, 'On the Animals Which Are Most Nearly Intermediate Between Birds and Reptiles', Huxley presented *Archaeopteryx* and *Compsognathus* as two links in a chain connecting the modern classes of birds and reptiles.[8]

Fossil evidence of ancestral horses surfaced at roughly the same time. From 1856 to 1860, French palaeontologist Albert Gaudry joined in excavating fossil-rich Miocene Age deposits at Pikermi, Greece, looking for mammalian species intermediate between those of the better known Eocene and Pleistocene Ages. Among his many such finds, Gaudry identified a three-toed genus of horse, *Hipparion*, which appeared much less specialised for running on the open plain than the *Equus* horse of the Pleistocene and today, with its broad hoofs derived from single toes. This immediately attracted the attention of evolutionists, who believed that the modern horse must have developed from normal, five-toed mammalian ancestors. During the late 1860s and early 1870s, Huxley in Britain and Vladimir Kovalensky in Russia fitted Gaudry's find into a sequence of fossilised European horses stretching back to the *Anchitherium*, a three-toed genus from the late Eocene Age.

Marsh found an even richer array of ancient horses in the fossil beds of the western United States, including four and five-toed types from the early Eocene. During his visit to America in 1876, Huxley hailed Marsh's sequence of horses as 'demonstrative evidence of evolution'.[9] Four years later, Darwin wrote to Marsh, 'Your work on… the many fossil animals of North America has afforded the best support to the theory of Evolution, which has appeared' since the publication of *Origin of Species*.[10] For his part, Marsh characterised his toothed birds and ancient horses as 'the stepping-stones by which the evolutionist of today leads the doubting brother across the shallow remnant of the gulf, once thought impassable'.[11]

Jurassic birds and Eocene horses simply represented the best publicised and most dramatic fossil finds of the period. Also during the 1870s, for example, Austrian paleontologist Melchior Neumayr arranged Tertiary Era non-marine molluscs into a virtually continuous evolutionary sequence and British naturalist C. J. A. Meyer did the same for sea urchins from successive layers of English chalk beds. Other researchers identified an ever increasing number of intermediate forms from the fossil record.

8 Huxley,T.H. 'On the animals which are most nearly intermediate between birds and reptiles', *Annals and Magazine of Natural History* (1868), 4th ser., 2, 70, 73.
9 Huxley, T.H. *American Addresses, with a Lecture on the Study of Biology*, London: Macmillan (1886), p. 90.
10 Charles Darwin to O. C. Marsh, 31 Aug. 1880, in Darwin, F.(ed.) *The Life and Letters of Charles Darwin* II, New York: Appleton (1897), p. 417.
11 Marsh, O.C. 'Introduction and succession of vertebrate life in America', *Nature* (1877) 16, 471.

While these finds satisfied nearly all paleontologists that species evolved over time, they shed little light on how the process operated. Indeed, the apparent spurts and stops of evolutionary development revealed in the fossil record, coupled with the seemingly ordered succession of fossilised forms, led many prominent paleontologists, especially in the United States, to favour Lamarckian or orthogenetic theories of evolution over Darwinian ones. Marsh, for example, believed an internal evolutionary force propelled brain growth across the generations. Speaking to scientists who held widely differing views on the mechanics of evolution, he could nevertheless open his 1877 plenary address to the American Association for the Advancement of Science by asserting, 'I need offer here no argument for evolution; since to doubt evolution today is to doubt science, and science is only another name for truth.'[12]

Although impressed with the new fossil finds, Darwin and Alfred Russel Wallace, the British evolutionist who discovered the theory of natural selection independently of Darwin and whose work spurred Darwin to publish, were first and foremost collectors of living species and their observations about the geographical distribution of native animals in South America and the South Pacific had inspired their thinking about evolution. Both of them relied heavily on such evidence to make their case for evolution.

Following the publication of *Origin of Species* in 1859, other naturalists pursued these lines of investigation. Using emerging data regarding the geographical distribution of land birds, for example, the influential British ornithologist Philip Lutly Sclater, had already divided the earth into six zoologically distinct regions – each with its own characteristic avian populations. As originally conceived in 1858, his scheme conformed to the notion of zoogeographic regions tied to the special creation of species in places suited for them, but it gained new meaning in light of evolution theory.

Sclater's regions perfectly fit Darwin's theory that the basic types of land animals evolved on the various large continental land masses, and then became modified to fit local conditions as they spread. Physical barriers to distribution (primarily oceans but also deserts and mountain ranges) coupled with past or present land bridges and island stepping stones produced the distinctive zoogeographic regions and accounted for the absence of land mammals on oceanic islands. During the 1860s, Sclater (then secretary of the Zoological Society of London and one of the best-connected scientists in the English speaking world) pressed his zoogeographic regions into the service of Darwinism. At the same time, evolutionary botanists Joseph Hooker at London's Kew Gardens and Asa Gray at Harvard University supplied evolutionary interpretations for the distribution patterns of plant species. This became some of the best scientific evidence for evolution.

For the half century from his return to Britain in 1862 to his death there in

12 *ibid.*, p. 448.

1913, no one was more associated in the public mind with questions of biogeography than Wallace. His engaging style and association with Darwin assured a market for his two-dozen books and scores of articles, all of which featured an evolutionary interpretation of biogeography. His 1869 *Malay Archipelago* discussed the dramatic line between South Asian and Australian species that splits the East Indies. The two large islands of Bali and Lombok are less than fifteen miles apart and yet, as Wallace noted, 'these islands differ far more from each other in their birds and quadrupeds than do England and Japan', both of which feature Eurasian types.[13] This barrier became known ever after as 'Wallace's line'. In his 1876 *Geographical Distribution of Animals*, Wallace extended Sclater's analysis of avian geography to animals in general, finding the same basic zoogeographic regions and reinforcing their evolutionary significance.

Wallace's 1880 book, *Island Life*, expanded on the significance of biogeography under an evolutionary view of life. 'So long as it was believed that the several species of animals and plants were "special creations" … their habitat was an ultimate fact which required no explanation', Wallace explained. 'But so soon as the theory of evolution came to be generally adopted … a real and important relation was established between an animal and its native country, and a new set of problems at once sprang into existence.' The distribution of the various species provided critical clues for deciphering the earth's geologic, geographic and climatological history, he asserted, as well as for charting the evolutionary genealogy of the species themselves.[14] Nevertheless, despite Wallace's personal tie to the theory of natural selection, his fieldwork could not resolve the question of how evolution operated.

The descent of natural selection

One objection pushing biologists away from natural selection involved the suspected age of the earth. Inspired as he was by Charles Lyell's uniformitarian theory in geology, Darwin originally assumed that natural selection had limitless time to grind out the present array of species. He did not know how long it would take, but envisioned the process as immensely slow. In 1866, the celebrated British physicist William Thomson (later Lord Kelvin), a traditionalist who found the very notion of natural selection morally and scientifically repugnant, used his recognised expertise in thermodynamics to estimate the earth's age at about one hundred million years – or far less than natural selection required. He derived this figure from the cooling time that it should take for a newly formed earth-sized mass of molten matter to reach current terrestrial temperatures. Darwin acknowledged the force of Kelvin's calculation, but

13 Wallace, A.R. *Island Life*, New York: Prometheus Books (1998 facs. rpt.), p. 4 (summarising findings from earlier works).
14 *ibid.*, pp. 12-13.

never fully accepted it. In response to it, however, many evolutionists looked for ways to accelerate the evolutionary process, such as by Lamarckian or theist factors. Not until the early twentieth century did physicists recognise that heat generated by the natural decay of radioactive elements greatly prolonged the earth's cooling process, and thus supplied added time for evolution. Kelvin's objections never stopped biologists from accepting an evolutionary view of life, but channeled them away from neo-Darwinism.

This channel was deepened by early attempts to solve the puzzle of inheritance. So long as species represented ideal, created forms, scientists could simply assume that those forms passed down through the generations, like begetting like, and dismiss individual variations as insignificant accidents of birth or development. Although breeders could propagate varieties through artificial selection, let nature take its course, and future generations would revert to the species norm through random breeding. In contrast, for evolution to operate, variation must be a real, naturally sustainable attribute of the individual – and species must be simply clusters of similar, reproductively fertile individuals. Yet without fixed forms, how could hereditary information pass down through the generations?

If, as Darwin initially assumed, offspring inherited a blend of their parents' traits, then even the most beneficial variation in any one individual would eventually disappear through generations of breeding with normal types. Under any theory of blended inheritance, individual variations are 'swamped' by the larger population. For evolution to work, a mechanism was required for fixing and propagating beneficial variations, and the most likely candidates smacked of Lamarckism.

In his massive 1868 *Variation of Animals and Plants Under Domestication*, Darwin offered pangenesis as his solution to the inheritance puzzle. Under this theory, each part of an organism supposedly generated tiny, unseen 'gemmules' that carried hereditary information about itself. Gemmules existed for eyes and ears, for example, not for an entire organism, and all individuals inherited them at conception. Every ovum, sperm and pollen grain contained 'gemmules thrown off from each different unit throughout the body', Darwin proposed.[15] In the process of reproduction, gemmules for all parts of both parents passed to their offspring, where they combined to produce a unique new individual. With each individual inheriting two gemmules for every trait, the possible combination were legion. Although Darwin continued to believe that parental traits often blended in their offspring, he suggested in *Variation of Animals* that one gemmule could dominate and its pair lie dormant, perhaps to express itself in a later generation. This would permit some beneficial variations to persist without swamping, and thus fuel the evolutionary process. Because gemmules

15 Darwin, C. *The Variation of Animals and Plants under Domestication*, II, London: Murray (1875), p. 373, quotation p. 397.

came from every part of living organisms, moreover, they provided a material basis for transmitting acquired characteristics. By this time, Darwin welcomed a bit of Lamarckism into his thinking as a way to speed the evolutionary process in response to Kelvin's estimate of the earth's age.

Although it anticipated some of the features of modern genetics that would later solve the problem of swamping, Darwin's crude theory of pangenesis did not win many converts and other nineteenth century solutions to the inheritance puzzle proved similarly unpersuasive. Many of them drew on Lamarckian or theistic forces because, so long as variations came from internal effort (as under Lamarckian evolution) or external direction (as under theistic evolution), then they could build within an entire population – and thus prevail. Random, individual variations were the most vulnerable to swamping – but they stood at the heart of neo-Darwinism. True to form, Weismann and Wallace clung to them in addressing the puzzle of inheritance.

As a young microscopist in Germany, before his eyesight failed, Weismann became one of the first biologists to see the rod-like chromosomes that exist in the nucleus of every cell. Beginning in the 1880s, he theorised that these chromosomes consisted of 'germ plasm', which purportedly carried hereditary information in a series of discrete germinal units. Like Darwin's gemmules, each germinal unit generated a particular body part, but unlike gemmules, germ plasm for the whole body existed in every cell. In sexual reproduction, Weismann believed, germ plasm from both parents combined to produce their offspring's unique heredity, which thereafter remained fixed.

Under Weismann's theory, inheritable variations in an individual's germ plasm occurred either at conception, when the parental germ plasm combined, or during a subsequent period of 'germinal selection', when the germinal units from both parents competed in a struggle to determine which of them survived to express themselves in the individual. Variations in the germ plasm would persist in future generations without swamping, Weismann argued, but traits acquired after birth would die with the individual. Indeed, to discredit the concept of acquired characteristics, the pugnacious German conducted a polemic experiment in which he cut off the tails of baby mice for generations – without any visible shorting in hereditary tail length. At the time, Lamarckians dismissed the experiment as irrelevant because it did not involve naturally acquired characteristics, but it became legendary after Lamarckism fell from favour. With germ plasm, Weismann found a mechanism of inheritance that fitted a neo-Darwinian model, except that selection occurred within an individual's germplasm before birth as well as among individuals after birth. Its highly speculative nature and Weismann's dogmatic style attracted only a small corps of very loyal followers, however.

Wallace did not go as far as Weismann in devising a neo-Darwinian theory of inheritance, but he did recognise that swamping should not pose an insurmountable barrier if evolutionists conceived of variation occurring within populations rather than in individuals. Variations do not come in only two options,

the field naturalist observed, but in a range of options centred over a hypothetical norm. If, in any group, more individuals survived at one end of the range than at the other, then the group's norm would shift – perhaps to form a new species. Population thinking required statistical analysis far beyond the capabilities of Wallace or Darwin, however, and only influenced evolutionary thought with the rise of biometrics around the turn of the twentieth century.

In addition to the age of the earth and the mechanisms of inheritance, other factors pointed evolutionists in non-Darwinian directions. The apparent persistence of gaps or discontinuities in the fossil record, for example, reinforced the position of Huxley and others that evolution proceeds in jumps rather than through the incremental processes associated with natural selection. Further, the continued absence of any known organic remains from pre-Cambrian strata bolstered the view that life did not appear gradually, but instead leaped on the scene. Perhaps most critically, many scientists continued to see a purposeful progression in organic history that seemed fundamentally at odds with the random directionlessness of inborn variations under a neo-Darwinian view evolution.

Many nineteenth century scientists simply could not imagine life without God. It became a matter of profound moral or spiritual significance to some. While granting that naturalistic processes may serve as the immediate cause of life's development, for example, renowned British astronomer John Herschel had nevertheless maintained that 'an intelligence, guided by a purpose, must be continually in action to bias the directions of the steps of change – to regulate their amount – to limit their divergence – and to continue them in a definite course'.[16] In saying so, he spoke for many. For their contributions to British science, Darwin and Herschel were buried near each other in the north transept of Westminister Abbey – far closer together than their positions in life. Lyell's body lies across the nave.

The general acceptance by European and American scientists of organic evolution coupled with persistent doubts about the sufficiency of natural selection to explain it left the field open for a flowering of alternative ideas. Among the alternative theories of evolution that cluttered the intellectual landscape by 1900, four basic approaches to the origin of species attracted the most attention from scientists: theistic evolution, Lamarckism, orthogenesis and saltation (or mutation theory). These flourished side-by-side with neo-Darwinism. Indeed, many scientists viewed the various approaches as complimentary (rather than conflicting), as Darwin apparently did in later editions of *Origin of Species* when he supplemented his selection-driven theory with Lamarckian notions of acquired characteristics. Further, multiple variants existed within each approach. Nevertheless, they represent the broad diversity of evolutionary thought that followed in Darwin's wake.

16 Herschel, J.F.W. *Physical Geography*, Edinburgh: Black (1861), p. 12.

In the United States during the late nineteenth century, Asa Gray virtually co-opted the name 'theistic evolution' for his theory that God guided the evolutionary process by supplying beneficial variations to species. Conceptually, Gray's theory left little to naturalism: if God had indeed supplied good variations, then natural selection should serve little purpose. This and other strong forms of theistic evolution that posit ongoing divine intervention in the evolutionary process encountered the objection that they reduced the divinity to a mere 'God of the Gaps' – an ephemeral deity invoked to account for physical phenomena that science could not yet explain but one doomed to retreat in the face of new scientific discoveries. In Britain, St George Jackson Mivart and the Duke of Argyll separately devised weak but less vulnerable versions of theistic evolution in which a foreknowing God imparted direction into the laws of development themselves, so that species evolved over time to fit changed conditions. By pushing God's intervention back to the beginning of time, Argyll hoped to leave room for play by naturalistic forces – but it was a limited playground in which naturalism simply worked out divinely preordained ends. Ultimately, theistic evolution failed the test of methodological naturalism that had come to define science. Although both strong and weak forms of theistic evolution continued to flourish among theologians, scientists and the general public, they increasingly disappeared from the formal scientific literature and survived as vehicles that gave meaning to and made sense of the natural world for religious believers.[17]

Weismann's tailed mice notwithstanding, the Lamarckian concept that characters acquired by use (or lost by disuse) could cause evolution retained a foothold within biology well into the twentieth century. By then, Lamarckism had spawned a related concept, known as 'orthogenesis', which held that developmental trends, once ingrained in a species, would continue by their own internal momentum regardless of their adaptive value. Indeed, some Lamarckians used this concept to explain the extinction of species deemed to have overdeveloped features, such as the Irish Elk, which supposedly had evolved antlers too large for its frame.

The German Lamarckian Theodor Eimer popularised orthogensis during the 1890s through his efforts to explain the extreme, seemingly non-adaptive colour variations of lizards and butterflies, but it found its largest following in

17 Ever since Darwin published his theory of evolution, scientists and theologians have written countless books and articles defending various strong and weak versions of theistic evolution. Two recent books of this type, both written for popular rather than a scientific audiences, illustrate the continuing appeal of theistic evolution. In *Finding Darwin's God: A Scientist's Search for Common Ground Between God and Evolution*, New York: Harper (1999), the respected Brown University biologist Kenneth R. Miller expounds his thoughts on God's role in designing the laws of nature that led to the development of life by Darwinian principles. In *The Language of God: A Scientist Presents Evidence for Belief*, New York: Free Press (2006), Francis S. Collins, the prominent American geneticist and leader of the Human Geonome Project, discusses God's role in designing not only nature's law but also human nature.

an American school of self-proclaimed 'neo-Lamarckians', which included such noted palaeontologists as Cope, Alpheus Hyatt, and Henry Fairfield Osborn. They freely invoked Lamarckian acquired characteristics and orthogenetic internal forces to explain the seemingly linear pattern of organic development that they detected in specimens from the rich fossil beds of the American West. These supposed evolutionary processes also gave a sense of purpose to nature, which appealed to optimistic, purposeful Americans. At theoretical and philosophical levels, Lamarckism and orthogensis solved too many problems to be dismissed out of hand – yet biologists could never reliably document them happening in nature or in the laboratory. Support for both concepts evaporated rapidly once a plausible alternative appeared on the scene early in the nineteenth century.

Saltation addressed many of the same problems as Lamarckism, but without the baggage of having to assume the unseen regarding the inheritance of acquired characteristics. Evolution by jumps perfectly fitted the available fossil evidence and explained the apparent speed of organic development. So long as enough individuals mutated to form a breeding population, it solved the swamping problem as well. Best of all, researchers claimed to have documented cases of decidedly different varieties, sub-species and even species appearing in a single generation, and thereafter breeding true to their new form.

Dutch botanist Hugo De Vries led the way during the 1890s with his study of the evening primrose, which seemed able to sprout new, differently coloured varieties at random. More than anyone else, De Vries transformed saltation into mutation theory, and in doing so pushed neo-Darwinism to the verge of extinction as a viable scientific theory. De Vries himself retained a role for natural selection to pick the winners among competing mutations, but other mutationists thought selection was superfluous in this respect. For many young biologists, including William Bateson in Britain, Wilhelm Johnannsen in Denmark, and Thomas Hunt Morgan in the United States, the mutation theory offered a fresh, new alternative to tired, old neo-Darwinian and Lamarckian dogma.

In 1903, the German botanist Eberhard Dennert proclaimed, 'We are now standing by the death-bed of Darwinism, and making ready to send the friends of the patient a little money to insure a decent burial of the remains.' Conceding Dennert's verdict on natural selection, Stanford University entomologist Vernon Kellogg added in 1907, 'it is also fair truth to say that no replacing hypothesis or theory of species-forming has been offered by the opponents of selection theory which has met with any general or even considered acceptance by naturalists. Mutations seem to be too few and far between; for orthogenesis we can discover no satisfactory mechanism; and the same is true for the Lamarckian theories of modification.' By this time, theistic evolution did not even merit a nod among scientists. For Kellogg, Dennert, or virtually any other biologist, however, doubts about natural selection and other mechanisms for forming species did not discredit the fact of evolution. 'While many reputable

biologists today strongly doubt the commonly reputed effectiveness of the Darwinian selection factors to explain descent,' Kellogg asserted, 'the descent of species is looked upon by biologists to be as proved a part of their science as gravitation is in the science of physics.'[18] The challenge for twentieth century biology became, how did evolution work?

The special case of human evolution

Even as scientific debates over the cause of evolution raged, the special case of human evolution bedeviled both scientists and the general public. 'I have read your book with more pain than pleasure,' Cambridge geologist Adam Sedgwick wrote sadly to Charles Darwin within a week of receiving a pre-publication copy of his former student's *On the Origin of Species* in 1859. 'Tis the crown & glory of organic science that it *does* thro' *final cause*, link material to moral… You have ignored this link; &, if I do not mistake your meaning, you have done your best in one or two pregnant cases to break it. Were it possible (which thank God it is not) to break it, humanity in my mind, would suffer a damage that might brutalise it.'[19] As a Christian, Sedgwick simply could not accept that heaven-bound humans descended from earth-bound apes.

Writing to Darwin after he received his advance copy of the book, Asa Gray also expressed concern about its theological implications. 'I had no intention to write atheistically,' Darwin replied to Gray. 'But I own that I cannot see as plainly as others do… evidence of design & beneficence on all sides of us. There seems to me too much misery in the world. I cannot persuade myself that a beneficent & omnipotent God would have designedly created the Ichneumonidae with the express intention of their feeding within the living bodies of Caterpillars.' Alluding to the then famous analogy by British natural theologian William Paley between an intelligently designed mechanical pocket-watch and the even more intricately devised human eye, Darwin then noted, 'Not believing this, I see no necessity in the belief that the eye was expressly designed.' Even human nature and mental ability might result from natural processes, he added.[20]

The sequence in Darwin's letter to Gray is telling. It passed quickly from observations of what seemed bad in nature (such as cruel animal behaviour) to their implications for what seemed good in it (such as the human eye), and then moved on to ponder the origin of what seemed best of all, human morality and mentality. In *Origin of Species*, Darwin avoided making comments about human evolution, fearing that they would prejudice readers against his general theory, but his private notes, essays and letters reveal his longstand-

18 Kellogg, V.L. *Darwinism Today*, New York: Holt (1907), pp. 3, 5, 6 (includes Dennert quotation).
19 Adam Sedgwick to Charles Darwin, 24 Nov. 1859, in Burkhardt, *Correspondence of Darwin*, VII, pp. 396-397.
20 Charles Darwin to Asa Gray, 22 May 1860, in *ibid.*, VIII, p. 224.

ing fascination with the issue. Indeed, his earliest private notebooks on evolution are peppered with comparisons between the native peoples of Tierra de Fuego, whom he met during his *Beagle* voyage and considered the lowest form of humanity, and primates in the London zoo. 'Compare, the Fuegian & Orang-utan, & dare to say difference so great,' Darwin wrote in a typical entry. As for the vaunted 'mind of man,' Darwin privately added, it 'is no more perfect, than instincts of animals'. Human thought itself (like animal instincts) he attributed to brain structure, chiding himself 'oh you Materialist!' for thinking so.[21]

While Darwin avoided commenting publicly on human evolution, Huxley took up the cause and made it his own. In 1863 he packaged the pieces of his various arguments on the topic into a single popular study, *Evidence as to Man's Place in Nature*. 'Whatever system of organs be studied,' Huxley concluded, 'the structural differences that separate Man from the Gorilla and the Chimpanzee are not so great as those which separate the Gorilla from the lower apes.'[22]

The most vexing questions raised by the theory of human evolution concerned the origins of mental and moral attributes, particularly altruistic behaviour. Could these distinguishing human characteristics have evolved by a naturalistic process, Victorian evolutionists asked, or did God implant them in an evolved human body? Traditionally, Christian theologians had attributed these attributes to an indwelling soul, the existence of which lifted humans above other animals. Scientists generally segregated humans from other animals on this basis as well, from Aristotle's theory of the rational soul found only in humans, through the Cartesian dualism splitting physical matter from the human and divine soul, to Cuvier's division of humans and primates into separate taxonomic orders. Then Huxley, in *Man's Place in Nature*, put humans in the same order with other primates and boldly asked, 'Is the philanthropist or the saint to give up his endeavours to lead a noble life, because the simplest study of man's nature reveals, at its foundations, all the selfish passions and fierce appetites of the merest quadruped? Is mother-love vile because a hen shows it, or fidelity base because dogs possess it?'[23] These were the new questions of the Darwinian age.

After steering clear of the intense public debate over human evolution for over a decade, Darwin finally articulated his thinking on the subject in his 1871 *Descent of Man*. 'The sole object of this work', he wrote, 'is to consider, firstly, whether man, like every other species, is descended from some pre-existing form; secondly, the manner of his development; and thirdly, the value of the differences between the so-called races of man.'[24] In it, Darwin raised the

21 For these and similar quotations, see Barrett, P.H. et al., (eds.) *Charles Darwin's Notebooks*, 1836-1844, Ithaca: Cornell Univ. Press (1987), pp. 264, 291, 542, 549, 558, 567, 574.
22 Huxley, T.H. *Man's Place in Nature*, New York: Modern Library (2001 repr.), p.106.
23 *ibid.*, pp.112-113.
24 Darwin, C. *The Descent of Man and Selection in Relation to Sex* I, New York: Appleton (1871), p. 3.

key issues that would thereafter occupy researchers in the field.

Darwin's basic case for human evolution consisted of two main parts. First, he presented the, by then, well-known evidence for the evolution of the human body. In anatomic structure and embryonic development, people resemble other animals, he noted, and the persistence of monkey-like rudimentary features (such as the tail bone) reinforces the conclusion that the human body evolved from lower forms. Relying primarily on structural similarities, Darwin traced human ancestry from 'the most ancient progenitors in the kingdom of the Vertebrata', through ancient fishes and amphibians, early marsupials and placental animals, to 'the New World and Old World monkeys; and from the latter, at a remote period, [to] Man, the wonder and glory of the Universe'.[25]

The body's evolution, even if accepted, did not settle the matter because many believed that humans stood apart from animals due to their minds and emotions, not their bodies. Darwin thus extended his naturalistic analysis to include those mental and moral attributes that supposedly uplifted humanity, such as higher reasoning, self-consciousness, religious devotion and the ability to love. The mental powers and moral feelings of humans differed in degree (rather than in kind) from those of other animals, he asserted, with a progressive gradient linking the lowest beasts to the highest humans. Darwin stressed the human-like qualities of higher animals (particularly pet dogs and wild monkeys) and the animal-like qualities of the 'lowest' savages. 'Can we feel sure that an old dog with an excellent memory… never reflects on his past pleasures in the chase? and this be a form of self-consciousness,' he wrote in a typical passage. 'On the other hand … how little can the hard-working wife of a degraded Australian savage… reflect on the nature of her own existence!' Similarly, Darwin doubted whether Fuegians felt religious devotion yet saw 'some distinct approach to this state of mind in the deep love of a dog for his master'.[26]

Darwin attributed the evolution of even the most ennobling of human traits to gradual, survival-of-the-fittest processes. Long ago in Africa, he suggested, some anthropoidal apes descended from the trees, started walking erect in the open spaces, began using their hands to hold or to hunt, and developed their brains – all in incremental steps that helped to preserve the individual or its group. As in *Origin of Species*, the variations themselves were either inborn or acquired, with beneficial ones propagated through natural selection.

Descent of Man offered the first comprehensive naturalistic theory of human evolution, but it did not change many minds. Europeans and Americans had

25 *ibid.*, pp. 203-204.
26 *ibid.*, pp. 55, 60. For an excellent discussion of Darwin's views on the religious attributes of canines and Fuegians, see Day, M. 'Godless savages and superstitious dogs: Charles Darwin, imperial ethnography, and the problem of human uniqueness', *Journal of the History of Ideas* (2008), 69, 49-70.

hotly debated the proposition that humans evolved from beasts ever since the publication of *Origin of Species* in 1859, but most continued to reject the idea long after the appearance of *Descent of Man* in 1871, including many evolutionists within Darwin's inner circle. Even Alfred Russel Wallace became persuaded that an 'Overruling Intelligence' created the first humans by ennobling anthropoidal apes with enlightened minds. 'Natural selection could only have endowed the savage with a brain a little superior to that of an ape,' he wrote in 1869 and maintained ever after, 'whereas he actually possesses one but very little inferior to that of the average members of our learned societies.'[27] Darwin's mentor and friend, the geologist Charles Lyell, endorsed Wallace's position, much to Darwin's dismay. For his part, Asa Gray steadfastly maintained that God supervised the beneficial variations that produced humankind.

Outside the world of science, the theory of human evolution fared even worse. Late in his life, for example, Wallace could claim (with some hyperbole) that 'all of the greatest writers and thinkers' agreed 'that the higher mental and spiritual nature of man is not the mere animal nature advanced through survival of the fittest'.[28] Novelist Leo Tolstoy proclaimed this viewpoint in Russia, for example, and prominent liberal minister Henry Ward Beecher did so in the United States. Both embraced evolutionism to a point, but maintained that only God could make a soul. Roman Catholic Church doctrine fitfully gravitated toward accepting a similar position. During the late 1800s, British Prime Minister William Gladstone made a point of endorsing the divine creation of humankind. Whether expressed in scientific or popular articles, the basic sentiment was similar: most people simply refused to believe that their highly developed minds, morals, or emotions evolved from those of beasts. The gap appeared too great. They felt themselves superior to other animals.

Just as some people instinctively rejected the idea of human evolution, others embraced it for reasons that had little to do with science. Materialists, atheists and radical secularists had long displayed a certain fondness for evolutionary theories of origins, such as Lamarckism – anything to dispense with a designing God. Even though Darwin held strictly conventional political and economic views, his theory attracted the usual crowd. Huxley and Haeckel initially embraced evolutionism in part because it supported their anticlerical agendas for science and society. In America, feminist leader Elizabeth Cady Stanton welcomed evolutionism as a means to undermine what she saw as biblically based arguments for the subordination of women. 'The real difficulty in woman's case is that the whole foundation of the Christian religion rests on her temptation and man's fall,' she wrote in *The Woman's Bible*. 'If, however, we accept the Darwinian theory, that the race has been a gradual growth from the lower to a higher form of life, and the story of the fall is a myth, we can exon-

27 Wallace, A.R. 'Sir Charles Lyell on geological climates and the origin of species', *Quarterly Review* [American Edition] (1869), 126, 204-205.
28 Wallace, A.R. 'Evolution and Character', *Fortnightly Review* (1908), 83 ns, 22.

erate the snake, emancipate the woman, and reconstruct a more rational religion for the nineteenth century.'[29]

From the conservative end of the political spectrum, the enormously influential social philosopher Herbert Spencer freely worked the theory of human evolution into his progressivist philosophy of social development. As social theorists, Spencer and Darwin became inexorably linked in the public mind during the late nineteenth century. Spencer's many followers, whose numbers comprised a virtual social register of the Anglo-American financial elite, typically embraced a selectionist theory of human evolution as well. In his *Autobiography*, industrialist Andrew Carnegie recalled the day in the1870s that his reading of Darwin's *Descent of Man* and various books by Spencer transformed his life. 'I remember that light came as in a flood and all was clear. Not only had I got rid of theology and the supernatural, but I had found the truth of evolution', he wrote. 'Man was not created with an instinct for his own degradation, but from the lower he had risen to the higher forms.'[30]

For people like Carnegie, Darwinism became a religion, or an alternative to religion. Pictorially, this sentiment appeared in a popular 1883 poster, attributed to London secularist George Holyoake, which purported to illustrate the fragmentation of the established British 'National Church' into various factions ranging from High Church and Roman Catholicism to dissent and rationalism. In the upper left corner, under the banner of 'Darwinism', an ape leads Spencer, Huxley, and other 'agnostics' away from the central, umbrella-like dome of London's St Paul's Cathedral toward a distant cloud of 'Protoplasm'. A bust of Darwin rises above the cloud.[31] With his great white beard, Darwin could as readily appear Godlike as apish – and during the late nineteenth century, illustrators pictured him both ways. It had less to do with science than with society.

Conclusion

During the nineteenth century, the term 'Darwinism' acquired many meanings. To the extent that his name was equated with the concept of descent with modification, or organic evolution, the place of Darwin in the pantheon of science appeared secure. Virtually every laboratory biologist and field naturalist accepted it. By 1900, however, his particular theory of evolution by natural selection, which was also commonly called Darwinism, was in eclipse and would remain so until the second quarter of the twentieth century. Further, despite Darwin's passionate defence of it, any direct evolutionary link between human and animal nature remained highly controversial amongst the general

29 Stanton, E.C. *The Woman's Bible* 2, Boston: Northeastern Univ. Press (1993 repr.), p. 214.
30 Carnegie, A. *Autobiography*, Boston: Haughton Mifflin (1920), p. 339.
31 The poster titled 'Our National Church' is reprinted as the end pages of Smith, W.S. *The London Heretics:1870-1914*, New York: Dodd (1968).

public well into the twentieth century. Two hundred years after his birth in 1809, and 150 years after publication of *Origin of Species* in 1859, the profound import of Darwin's work is only now becoming fully recognised and accepted, particularly in the understanding of human behaviour.

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