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Introduction: Evolution and historical explanation

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> Wind back the tape of life to the early days of the Burgess Shale; let it play again from an identical starting point, and the chance becomes vanishingly small that anything like human intelligence would grace the replay.
>
> Stephen Jay Gould (1990, 14)

> Evolutionary biology, in contrast with physics and chemistry, is a historical science—the evolutionist attempts to explain events and processes that have already taken place.
>
> Ernst Mayr (2000, 80)

We routinely regard evolution as one of the natural sciences. But it is easy to forget that it is also a *historical* science. This means that although it has undoubted affinities with more exact sciences like physics and chemistry, it also shares some of the characteristics of history. Both evolutionary biology and history are concerned with past events that are not repeatable. Neither discipline is strong on prediction, and while we encounter rules and laws in biology, they are not comparable to the deterministic laws that characterize physics. The business of explanation in biology, then, has more in common with explanation in history than we have often thought. As the distinguished Harvard biologist Ernst Mayr has written of the events and processes that make up the subject matter of biology: 'Laws and experiments are inappropriate techniques for the explication of such events and processes. Instead one constructs a historical narrative, consisting of a tentative reconstruction of the particular scenario that led to the events one is trying to explain' (2000, 80). The historical character of evolutionary biology, often unacknowledged, brings with it a number of challenges and at times has fueled intense debates. These challenges and their broader implications form the subject of this collection.

The special issue deals with four closely overlapping sets of concerns. First are those issues that are internal to the discipline of biology. While the evolutionary synthesis of the twentieth century brought with it a general agreement about the various mechanisms of evolution, there was considerable room for differences about their relative importance. This left a number of key questions remained unresolved: Why are some branches of the evolutionary tree rich and diverse, while others are quite sparse? Does evolutionary history unfold in a steady way, or are there moments of rapid and intense evolutionary change? Is it possible to speak of trends, directions, or even progress in evolution, and what mechanisms would give rise to such trends? In what ways do developmental considerations constrain evolutionary change, and how important are such considerations in relation to other evolutionary mechanisms such as natural selection and genetic drift? More recent discussions have also pointed to the importance of the role played by hitherto unsuspected agents of evolutionary change: plasticity—how the environment shapes the traits of organisms; niche construction—how, conversely, organisms modify their environments; and inclusive or 'extra-genetic' inheritance—the transmissions of traits outside the bounds of genetic inheritance.[1] All of these factors have a bearing on how evolutionary history unfolds.

Another set of issues concerns the status of evolutionary biology as a science, and its relation to other sciences. Because physics is often held up as the gold standard for how science ought to be conducted—think here of Nobel Prize–winning physicist Ernest Rutherford's dismissive pronouncement that 'all science is either physics or stamp collecting'—biology has sometimes been regarded as the poorer relation of the more precise physical sciences. As already mentioned, the lack of deterministic laws in biology means that it tends to be rather light on prediction, and might be regarded as having limited capacity for testing its empirical claims. It follows that one of the much touted tests for distinguishing genuine from spurious science, Karl Popper's criterion of falsifiability, is difficult to apply to some of the claims of evolutionary biology.[2] The absence

[1] For a brief overview of these factors see Laland, et al. (2014).

[2] Popper once infamously remarked that 'I have come to the conclusion that Darwinism is not a testable scientific theory, but a *metaphysical research programme*—a possible framework for testable scientific theories' (1976, 168). He subsequently clarified his position (1978, 344f), essentially retracting this earlier conclusion.

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of laws and tests raises the further question of what counts as a valid scientific explanation and whether biology is concerned more with description than explanation. Added to this, Darwin's incorporation of chance events into the heart of evolution was at odds with a long standing conviction, dating back to the ancient Greeks, according to which contingent events—events that may or may not have happened—could not be part of the subject matter of genuine science. This persistent prejudice against chance and contingency lies behind Einstein's well-known remark that 'God does not play dice.'

The central role ascribed to chance and contingency in evolutionary biology has given rise to a third set of concerns to do with the broader philosophical and religious implications of the evolutionary standpoint. One of the most disconcerting features of Darwinian evolution is its implication that the history of life might have turned out very differently. While we do not yet know how life on earth began, what we do know is that once it did, it seems that evolutionary history could have taken an almost infinite number of diverse paths. This is the import of Stephen Jay Gould's striking metaphor of 'replaying the tape of life.' Reflecting on the countless different paths that evolution might have followed, Gould observed that if we rewound the tape of life back to the moment of its origin and let the tape run again, it would result in a completely different history to that currently depicted in the fossil record.[3] Crucially, it would have been astronomically unlikely to have led to the arrival of human beings. The implication that the appearance of human beings on the planet is a highly improbable accident was something that in the nineteenth century even some of Darwin's most ardent supporters found difficult to accept, and it remains a key point of contention with many who hold religious views about the nature and purpose of human life. Is it a necessary corollary of evolution that, as Richard Dawkins has uncompromisingly put it, the universe exhibits 'no design, no purpose, no evil, no good, nothing but pitiless indifference' (1996, 155)? And if human beings are simply the accidental outcome of highly contingent natural processes, what does this say about the status of our most impressive and cherished cultural achievements, including our systems of morality, religion, art, literature, music, and the sciences themselves? Does it follow from the apparent lack of purpose and direction in evolution that there can be no transcendental meaning to human life?

These questions about the broader implications of evolution lead us to a fourth and final concern, and that is the capacity for evolutionary thinking to be elevated into an all-encompassing philosophy. For a few champions of evolution, the explanatory scope of the theory extends well beyond biology to embrace all aspects of human culture. The philosopher Daniel Dennett, for example, has recently claimed that 'the idea of evolution by natural selection unifies the realm of life, meaning and purpose with the realm of space and time, cause and effect, mechanism and physical law' (1995, 21). Again, the historical character of evolutionary processes is one of the factors behind these extracurricular ambitions. Unlike those sciences that lack the capacity to be expressed in narrative form, the theory of evolution enables us to tell a *story* about the gradual emergence of life on this planet. Like the creation myths of the world religions, it is a story of epic proportions that has the potential to be invested with meaning and value. It is the narrative power of the evolutionary story that prompted the distinguished Harvard biologist E. O. Wilson to declare that 'the evolutionary epic is probably the best myth we will ever have' (1978, 201; cf Wilson, 2013, 9-10). Recent proponents of 'big history,' who seek to locate human history within a broader context of the development of the cosmos and of life on earth, have similarly sought to imbue evolution with a mythic status (Hesketh, 2014). These attempts trade on both the scientific status of evolution and the story-telling capacity of history, but arguably transgress the legitimate boundaries of both disciplines.

The task of explicating the historical character of evolutionary thinking, of considering its broader implications, and perhaps even of adjudicating between some of them, is a task that transcends the scope of any single discipline. This collection is motivated by the belief that the best hope for a genuinely illuminating discussion of these issues would come by combining insights from the disciplines of biology, philosophy, and history. Biologists themselves are best equipped to explicate the issues internal to the discipline and reflect on the current state of play within evolutionary biology. Philosophers can help shed light on the broader questions to do with the status of evolution as a science, its modes of explanation, and some of its implications for deeper questions of meaning and purpose. Historians can offer a history of the development of evolutionary thinking and its emergence as a scientific discipline, while also providing an account of how explanation works in history as compared to the physical sciences. Accordingly we have assembled a team of historians of science, philosophers, and evolutionary biologists to address the issues set out above in this special number of *Studies in History and Philosophy of Biological and Biomedical Sciences.* The volume begins with some historical considerations before moving on to biology and philosophy.

In the first article, Peter Harrison traces a long-standing distinction in Western thought between scientific and historical modes of explanation. This distinction is particularly significant when considering the nineteenth-century emergence of the discipline of biology and its gradual eclipse of the more traditional discipline of natural history. One of the consequences of this transition from natural history to scientific biology was that while modern evolutionary theory retained significant historical components, these were often overlooked as biology sought to accommodate itself to a model of scientific explanation that involved appeals to laws of nature. The scientific aspirations of biology, when combined with amnesia about its origins as a historical enterprise, rendered it susceptible to a line of philosophical critiques of evolutionary theory according to which explanations in terms of natural selection are essentially vacuous. But, as Harrison points out, what such critiques overlook is the fact that there are legitimate modes of historical explanation that do not require recourse to laws of nature, and the history of the discipline of biology helps remind us of this.

Bernard Lightman continues the focus on the category of natural history and its importance for an understanding of the status of modern evolutionary biology. One of the key differences between natural history and biology was that the former was incipiently theological, while the latter was self-consciously secular and naturalistic. In the seventeenth and eighteenth centuries, natural history had been closely connected to theology, particularly in England. Natural theology provided crucial integrating principles for the discipline of natural history by focusing on the adaptations (or 'contrivances') of living things and proposing that together these pointed to the activities of a wise and beneficent Deity. Darwin was the beneficiary of this focus, insofar as he also sought to offer an explanation of the adaptations of living things so helpfully catalogued by preceding generations of natural theologians. But his idea of evolution by means of natural selection allowed for a naturalistic account of how these adaptations come to be while at the same time providing an alternative unifying narrative.

Lightman shows how Darwinism was appropriated by his contemporaries Thomas Henry Huxley and Herbert Spencer, both of

[3] While Gould is best known for his emphasis on contingency, he nonetheless also believed in evolutionary laws of a kind. For a recent account of this apparent paradox see Haufe (2015).