Prologue

In 1961, the well-known American philosopher Ernest Nagel published *The Structure of Science: Problems in the Logic of Scientific Explanation*. It is an impressive work, laying out the so-called "logical empiricist" philosophy of science. This is a physics-based vision of science that goes back centuries. The great British philosophers of science, John F. W. Herschel (1830) and William Whewell (1840), writing in the first half of the nineteenth century and ardent Newtonians both, would have found much that is familiar. Nagel, along with others – notably Richard Braithwaite (1953) in England and Carl Hempel (1965, 1966) in America – saw theories as axiom systems. There are hypotheses at the top – Newton's laws of motion and of gravity – and, deduced further down, empirical laws – those of Kepler and Galileo. The discussion was sophisticated and there was a huge amount of detail, ranging from general theoretical problems like the use of analogy through to problems of confirmation, especially where unseen or theoretical entities are concerned.

It would not be true to say there is nothing historical in Nagel's book. Apart from a discussion of history as a science, or perhaps as a failure as a science, there is a very good chapter on theory reduction. This occurs when an older theory like thermodynamics (to use Nagel's example) is overtaken and absorbed by a new theory, in this case statistical mechanics. Empirical laws about the temperature and pressure of gases are explained in terms of little balls buzzing around in a container. Underlying everything, though, lay the logical empiricist mantra – separate the context of discovery from the context of justification. Discovery, found in the *gemütlich* homes of the historians, deals with fallible people having all sorts of irrational thoughts through time. Hempel's (1966) example was of Kekulé dozing off to sleep in front of a fire, dreaming of a snake swallowing its tail, and thus discovering the circular nature of the benzene molecule. Justification, done in the Spartan quarters of the philosopher kings, deals with entities and their connections in the unchanging Platonic world of the Forms. Anything Newtonian qualifies here. History and theory change are not big items. There is, for instance, no reference to "revolution" in the index of Nagel's book. There was no discussion of geology, for all that, with the coming of continental drift and plate tectonics; the earth sciences were at that time in the middle of the greatest upheaval of their history. Here there was a break with the past. Whewell (1837) was always interested in the history of science and he and Herschel were major players in the geological theorizing of their day. No longer. Logical empiricism was ahistorical. And proud of it![1]

[1] In 1978, at a meeting of the Philosophy of Science Association, I was part of a panel discussing the revolution in geology (Ruse 1981). I happily hammered away at Nagel and Hempel until,

Next year, 1962, everything changed. A man outside the philosophical community – an erstwhile physicist converted into a historian of science – published a book with a self-referential title. *The Structure of Scientific Revolutions* by Thomas Kuhn, already the author of what is still the standard account of the Copernican Revolution, challenged conventional philosophical thinking on the nature and direction of science. On his first page, Kuhn threw down the gauntlet.

> History, if viewed as a repository for more than anecdote or chronology, could produce a decisive transformation in the image of science by which we are now possessed. That image has previously been drawn, even by scientists themselves, mainly from the study of finished scientific achievements as these are recorded in the classics and, more recently, in the textbooks from which each new scientific generation learns to practice its trade. Inevitably, however, the aim of such books is persuasive and pedagogic; a concept of science drawn from them is no more likely to fit the enterprise that produced them than an image of a national culture drawn from a tourist brochure or a language text. This essay attempts to show that we have been misled by them in fundamental ways. Its aim is a sketch of the quite different concept of science that can emerge from the historical record of the research activity itself. (Kuhn 1962, 1)

Overnight, everyone in the philosophy of science community rushed into revolution studies, usually with the intention of showing that brash outsider Thomas Kuhn simply had no idea of what he spoke (Shapere 1964). The most notable and persistent critics were the Austro-British philosopher Karl Popper and his acolytes (Lakatos and Musgrave 1970). In a way, this was all a bit like banning a book. It only drew attention to *Structure* and made everyone want to read it. Fifty years later, I remember still the thrill as Kuhn's vision of science smashed through all one had hitherto considered unassailable. It was like a Godzilla movie! Next up, the naturalistic fallacy.

Contingently, by the mid-1960s, something else was happening. Probably because biology itself was now about to enter golden years – there had been the double helix discovery at the beginning of the 1950s and there were provocative new models of social behavior by the beginning of the 1960s – the area started to attract the attention of philosophers of science. My *The Philosophy of Biology* (1973) and David Hull's *The Philosophy of Biological Science* (1974) were not in themselves great books, but they did define the field and announce that

through the vile hangover that was customary on these occasions, I realized that sitting in the front row, smiling broadly and nodding in agreement, were none other than Ernest Nagel and Carl Hempel. I have always taken this as a message to have a good laugh at or with bumptious youngsters who attack my work – as well as a warning to drink rather less the night before I am going to perform.

there were exciting problems worthy of informed analysis. Above all, as professionally trained philosophers of science, we knew that if one was serious one had to know something of the science itself. Too often biology had been taken as something different – a "narrative science" or some such thing – and too often, "different" was equated with "second-rate." We Young Turks – Hull and I were the introductory text writers for a group – showed that if you turn from reading only popular books on the fossils and look at what real biologists do – genetics – a different, although more familiar (to the logical empiricists), type of picture emerges. Perhaps biology is not so very different (meaning second-rate) from the physical sciences.

For the understanding of Charles Darwin and the revolution associated with his name, it was rather like the alignment of the suns at the climax of the *Dark Crystal*. Studies of Darwin and of the theory of evolution that he produced had, for at least a hundred years, been the demesne of relatives or students or enthusiasts or just plain moneymakers. Many an aged biologist had used his retirement years to sing the praises of his hero, the modest English naturalist, author of *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life*. Then, in the 1950s, the history of science was professionalized – Harvard was a center and Kuhn an early beneficiary. Archives were opened up, scholars were given professional training as historians, and the quality of scholarship leapt in bounds. Attention turned to Charles Darwin, the sources on which he drew, the work that he did, the influences that he had. His legacy today. In short, people turned to the Darwinian Revolution – that change of worldview wrought by Darwin, taking us from the miraculous instantaneous creation of animals and plants, to a natural world of evolutionary change, to an ever-unfurling tree of life, from the monad to the man.

It was as if preordained by the God of the Calvinists that pioneering philosophers of biology like Hull and I would get involved. We were already working seriously on the nature of contemporary evolutionary biology. What more natural than to extend our gaze back to Darwin and his era and to extend our analyses, not merely seeing if Darwin's work as it stood fit expected patterns, but also if the Revolution was truly as Kuhn claimed it to be. Perhaps it was something different – possibly a reduction of the kind envisioned by Nagel? Hull (1973) put together a still-valuable collection of contemporary responses to the *Origin*, and I – having spent a sabbatical year in the Darwin archives at Cambridge retooling as a historian – wrote *The Darwinian Revolution: Science Red in Tooth and Claw* (1979), trying to complement my overview in the philosophy of biology with a like overview in the history of

biology.[2] Neither Hull nor I were convinced by Kuhn, but we stood foursquare with him against his analytical philosophical critics in thinking that the way to move forward is by understanding the history as well as if not better than the professional historians of science (Callebaut 1993).

Controversies grew and these continue to this day (Richards and Ruse 2008, 2016), especially in my home discipline. Put bluntly, in fashionable philosophical circles today, Darwinian theory – a jewel in the crown of science – has an appalling reputation. Templeton Prize winner Alvin Plantinga (1991) thinks the evidence for evolution "ambiguous and inconclusive." He opts for some form of biblical Creationism, thinking it "somewhat more probable with respect to the evidence" (687). Plantinga is a Calvinist, but nonbelievers go much the same way. Noted philosopher of mind Jerry Fodor cowrote a book with the title *What Darwin Got Wrong.* Lots and lots, apparently. Openly atheistic Thomas Nagel (1979) makes his position very clear: "Biology may tell us about perceptual and motivational starting points, but in its present state it has little bearing on the thinking process by which these starting points are transcended" (146). Nagel doesn't just reject the philosophical relevance of Darwin's thinking. He rejects Darwin's thinking. Titles tell all. *Mind and Cosmos: Why the Materialist Neo-Darwinian Conception of Nature Is Almost Certainly False* (2012). He is empathetic to a form of Creationism-lite, Intelligent Design Theory.

I, to the contrary, am absolutely convinced that the Darwinian Revolution is the most important thing that ever happened to philosophy. As Thomas Henry Huxley joked, recognizing that we are modified monkeys, not modified mud, is the vital first step to a properly grounded theory of knowledge (epistemology) and theory of morality (ethics). I am certainly not going to show that in this little essay. It is but a first step. I am struck always in these discussions how, in their whole lives, neither Thomas Nagel nor any of the other naysayers seems to have opened a professional publication dealing with Darwinian themes. If we are going to start taking Darwin seriously, as I titled one of my early books, we need to know about Darwin's contributions and his legacy, and its importance. So, to start the job, I offer here a serious look at the Darwinian Revolution, in all its complexity and messiness. What did Charles Darwin do and why did it matter? In the first section that follows, I tell you something of the history of the Darwinian Revolution. In the next section, I ask about its status as a scientific

[2] I learnt a lesson never to be forgotten. Unaware that academics read only the first and last pages of books they are reviewing, naïvely I introduced my book as an "overview," expecting everyone to say: "No! No! Mike! It is a profound and deeply researched treatment of a difficult but rewarding topic." Ha! Ha! "Overview," I said, and "overview" it became. Just for the record, this book is "a profound and deeply researched treatment of a difficult but rewarding topic."

revolution. In the third section, l look at the episode philosophically. This is an Element on Charles Darwin, not Thomas Kuhn, but here it will be appropriate to use Kuhn's *Structure* as the entrée. In the fourth and final section, I take up issues arising in the philosophical realm, especially with respect to work to be done.

I offer signposts, not proofs. This is not the fourth *Critique*! I very much doubt that anyone – biologist, philosopher, or historian – will agree with everything I have to say. I hope they don't. That would be boring. I am now nearly a decade past my biblically allotted three score years and ten. The battle is still to be won. I hope this little essay will inspire others to take up what I must leave unfinished.[3]

1 What Was the Revolution?

Progress versus Providence

Something does not come from nothing. The idea of ongoing organic change, evolution, has roots, to use an apt metaphor, in the chain of being, something with a long history, at least back to Aristotle. All organisms can be put on a ladder, from the simplest to the most complex, from the grub to the human (Lovejoy 1936; Ruse 1996). Often the ladder kept going, through the orders of angels up to God himself. In the early eighteenth century, with the fixed world order much more in question, there were some who started the chain moving. Rather than a ladder, they thought more in terms of a one-way escalator, with law-driven passage up the scale. Empirical evidence was scanty. Anatomy yields fascinating isomorphisms – what we now call "homologies" – between organisms. Evolution gives a ready explanatory answer. Shared ancestors. Fossil discoveries were also pointing this way a bit, although the record as such was nowhere near adequately uncovered to offer real insights or supports. Often analogies were drawn with individual development and, as often, primitive societies were highlighted. If we civilized humans can rise up from the savages, why not the higher primates from fish?

Truly though, this was not really a discussion about empirical questions. It was more a matter of underlying metaphysical world pictures. For Christians, traditionally, this is a world of Providence. It is a world where everything is done in the light of our Creator and where we realize that our efforts are essentially worthless. All depends on the grace of God. Isaac Watt's great hymn, written at the beginning of the eighteenth century, tells all.

[3] *The Encyclopedia of Darwin and Evolutionary Thought* (Ruse 2013a) offers much background to the issues discussed in this *Element*.

When I survey the wondrous cross
On which the Prince of glory died,
My richest gain I count but loss,
And pour contempt on all my pride.

Challenging this now, thanks particularly to the increasing power of science and technology, was the philosophy of Progress.[4] This is the complete reverse of Providence, for it argues that we ourselves can, through our thought and effort, make for lasting differences and improvement – in science, in education, in health care, and much more.

Evolutionary thinking about the world of animals and plants simply rode into being on the back of the metaphysic of Progress. Listen to Erasmus Darwin, grandfather of Charles, physician and friend of scientists and industrialists at the end of the eighteenth century. He expressed his ideas in verse.

Organic Life beneath the shoreless waves
Was born and nurs'd in Ocean's pearly caves;
First forms minute, unseen by spheric glass,
Move on the mud, or pierce the watery mass;
These, as successive generations bloom,
New *powers* acquire, and larger limbs assume;
Whence countless groups of vegetation spring,
And breathing realms of fin, and feet, and wing.

Thus the tall Oak, the giant of the wood,
Which bears Britannia's thunders on the flood;
The Whale, unmeasured monster of the main,
The lordly Lion, monarch of the plain,
The Eagle soaring in the realms of air,
Whose eye undazzled drinks the solar glare,
Imperious man, who rules the bestial crowd,
Of language, reason, and reflection proud,
With brow erect who scorns this earthy sod,
And styles himself the image of his God;
Arose from rudiments of form and sense,
An embryon point, or microscopic ens!

(Darwin 1803, 1, 11, 295–314)

Notions of biological progress, running up from the blob to the human, make the very backbone (to use another apt metaphor) of this vision, shown as Darwin explicitly tied his biology into his philosophy. The idea of organic progressive evolution "is analogous to the improving excellence observable in every part of

[4] When referring to the cultural notion, I shall capitalize – Progress – and when talking of the biological notion, I shall not – progress.

the creation; such as the progressive increase of the wisdom and happiness of its inhabitants" (Darwin 1801, 2, 247– 2).

Erasmus Darwin's ideas spread quickly. They were translated into German, shaking the aged Immanuel Kant, who was already much impressed by organic isomorphisms. Darwin didn't have much idea of causes, of mechanisms, although he clearly subscribed to some form of the inheritance of acquired characteristics. As it happens, for all that it is now named after him, that mechanism was never very central to the thinking of Darwin's contemporary, the French biologist Jean Baptiste de Lamarck – who was also now starting to think in an evolutionary mode. It was more an addition to Lamarck's main picture, which was that of primitive forms constantly being created – spontaneously generated – in pools, by lightning and the like, and then proceeding up the chain of being. For Lamarck, the main cause of change was an occult-like, nonmaterial force – *le pouvoir de la vie* – progressively powering organisms ever higher.

Lamarck published his *Philosophie Zoologique* in 1809. Although the author was respected as a systematist, most people did not buy into evolutionism, Lamarckian or otherwise. Given that there was not a great deal of empirical evidence either way, most of the concerns were about the threat to Christianity – Providence. One should not think however that the opponents of evolution were invariably motivated by religious worries of the kind that fuel today's American, anti-evolutionary, biblical literalism – Creationism. Increasingly, geology demanded great spans of time, and did not the bible say that a thousand years are as but a day in the eye of the Lord? Easy to stretch out those days of creation. As easy to argue that the Deluge was not universal, being confined to some limited area in the Middle East. What really worried people was the design-like nature of organisms, the adaptations – the hand and the eye, the root and the leaf. How could such complex functioning things come about by blind chance? There had to be an intelligence behind it all. Back this up with a thin fossil record and other choice items – the comparative anatomist Georges Cuvier (1813) argued that the forms of mummified Egyptian animals show there is no great change in time – and the case was complete (Rudwick 1972).

Those who were not convinced, who increasingly yearned for evolution, like the Scottish publisher Robert Chambers writing anonymously and publishing *The Vestiges of the Natural History of Creation* in 1844, generally had some (Progressivist) axe to grind. Chambers thought that, against the miracle stories of Genesis, natural origins are more in line with the industrialized society that Britain had by then become.

> A progression resembling development may be traced in human nature, both in the individual and in large groups of men . . . . Now all of this is in conformity with what we have seen of the progress of organic creation. It seems but the minute hand of a watch, of which the hour hand is the transition from species to species. Knowing what we do of that latter transition, the possibility of a decided and general retrogression of the highest species towards a meaner type is scarce admissible, but a forward movement seems anything but unlikely. (Chambers 1846, 401– 402)

Starting to soften some of the starker differences between Progress and Providence, even some religious got on this bandwagon. Anglican minister and professor, Baden Powell (1855), father of the founder of Scouting, wrote that just as the English show their superiority by inventing machines for weaving previously done by hand, so God shows his superiority by creating through machine, aka evolution, than by hand, aka miracles. Most significantly and influentially, that most Victorian of poets, Alfred Tennyson, incorporated evolutionary themes into *In Memoriam* (1850), his panegyric to his dead friend Arthur Hallam. Depressed by what he saw as the meaninglessness of existence, he found hope in the optimism of a Christianized form of evolutionism. Hallam's bad luck was to come before his time.

> A soul shall strike from out the vast
> And strike his being into bounds,
>
> And moved thro' life of lower phase,
> Result in man, be born and think,
> And act and love, a closer link
> Betwixt us and the crowning race
> . . . . . .
> Whereof the man, that with me trod
> This planet, was a noble type
> Appearing ere the times were ripe,
> That friend of mine who lives in God.

When *Vestiges* was published in the mid-1840s, there was massive opposition in some quarters, particularly those of professional science. William Whewell (1845) was strongly against it. He produced a little book of extracts from earlier writings, with a sterling new preface, in which he managed not to mention once the name of his vile target. Baden Powell and Tennyson show that the story is more complex (Secord 2000). *In Memoriam* was hugely popular, giving great comfort to many, including the queen when she was widowed. Even more important were the early writings of Herbert Spencer, the (future) author of the massive "Synthetic Philosophy," a comprehensive guide to the solution of every problem that has ever been posed by a human being. By the

mid-1850s, Spencer was well into proselytizing for Progress and evolution – which he took to be one and the same – an enthusiasm he kept up for the next half century (Richards 1987). As we turn now to Charles Darwin, realize that the winds may have been chilly, but the ground was fertilized and watered (Ruse 2008).

Charles Robert Darwin

Privately, even before *Vestiges* appeared, the grandson of Erasmus Darwin was at work (Browne 1995, 2002). Charles Darwin was born into a comfortable, upper-middle-class, English family. His father was a physician and his maternal grandfather was Josiah Wedgwood, the founder of the pottery works that bore his name. More of this family money came his way when Charles married his first cousin, Emma, also a grandchild of Josiah. After an attempt at medicine in Edinburgh, Darwin moved to Cambridge University, intending to become an Anglican clergyman. This intention faded when he was offered the post of ship's naturalist on board HMS *Beagle*, about to set off on a five-year (1833–36) voyage to South America and eventually all around the world. Darwin was hardly a fully qualified scientist when he joined up – apart from anything else he did not take a science degree because there were then no such degrees – but he was a quick learner and, before long, he had established his credentials and authority. Through his life, he never worked for pay because he could live on family money. No one ever doubted his status as a professional scientist.

Charles Darwin did not become an evolutionist on the *Beagle* voyage. This happened in the spring of 1837 when he asked an ornithologist to catalogue his avian specimens, especially those collected on a group of islands in the Pacific, the Galapagos archipelago, some five hundred miles from the coast of Ecuador. The birds were so similar and yet not quite identical. They were like the birds of the American mainland too, and not at all like the birds of Africa. There could only be one answer – what Darwin called "descent with modification." At once, Darwin was sketching the famous tree of life that still dominates evolutionary thinking. Journey over. Or was it? Why go any further? Why not stop there? Darwin knew the challenge. In *Critique of the Power of Judgment* (1790), Immanuel Kant had said there could never be a Newton of the blade of grass. There would never be the biological equivalent of the Newtonian force of gravitational attraction to explain the biological world as Newton explains the physical world. Darwin had to find that equivalent.

He worked frenetically for eighteen months and, in the closing days of September 1838, hit on the solution. At the end of the eighteenth century,

the Anglican clergyman Thomas Robert Malthus (1798, sixth edition 1826) had argued that population numbers will always outstrip available supplies of space and food. Hence, there will inevitably be a "struggle for existence." Darwin saw that, in nature, this could be the pressure behind what increasingly he saw as the key to organic change: the selection for the desirable as practiced in the farmyard, aiming for wool and beef and eggs and the like, and by animal and plant hobbyists, aiming for songsters and finery and the like. "Natural selection," or as it was to be called "the survival of the fittest," appeared on the scene.

In 1842, Darwin wrote up his ideas in a 35 page "Sketch" and then in 1844 in a 230 page "Essay" (Darwin and Wallace 1958). Then, he sat on his ideas. Darwin fell very sick – possibly undiagnosed lactose intolerance – and that made him cautious. More important would have been his standing in the scientific community. The reception of *Vestiges* showed that publishing an evolutionary tract would have been professional suicide. Whewell was one of Darwin's strongest mentors. Finally, in 1858 Darwin's hand was forced by the arrival of an essay from a young naturalist out east, Alfred Russel Wallace. The pages contained much the same ideas as those of Darwin. Dropping everything, Darwin raced to finish his book, and in the late fall of 1859 the *Origin* appeared.

The *Origin* is deceptive (Ruse 1979). It is written in a user-friendly manner, with helpful asides and analogies. At times, it reads like the fiction that Emma read aloud to Charles every afternoon, as he lay on a sofa and smoked a cigarette. Comfort food starting with no mathematics! It is deceptive. Darwin set out to convince the reader of something unseen – life's history leading up to the present. The surface of the text may be casual, the depths were deep and carefully explored and confirmed. The strategy is threefold. First, Darwin followed his own route to discovery, telling the reader all about the nature and success of animal and plant breeding, artificial selection. Here, Darwin was obeying the empiricist philosopher, John F. W. Herschel (Pence 2018). Crucially, Herschel argued that the best "true" causes – *verae causae* – are based on analogy, from the sensed to the supposed. Herschel's example was that, from the sense of force we feel when we spin a stone at the end of a piece of string around and around in a circle, we know a force acts to pull the circulating moon to earth and hence keep in orbit. The reader is primed for the analogy of natural selection working in nature.

Then, in a kind of protological empiricist fashion, Darwin followed Herschel and the more rationalistically inclined William Whewell in showing that, if only informally, we have a kind of deductive argument first to the conflict between organisms.