Darwinism and Natural Theology

Darwinism and Natural Theology: Evolving Perspectives

Edited by

Andrew Robinson

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Andrew Robinson, April 2012.

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Neil Spurway avidly read the Gifford lectures as VIth former. He studied physiology and physics at Cambridge, 1957-60 and continued to a PhD in membrane biophysics (but incurred disapproval for playing truant to philosophy and theology lectures, and editing an SCM journal). Attracted by mountains and sea to Glasgow in 1963, he served over 30 years on the Gifford Lectureships committee. He retired as Professor of Exercise

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CHAPTER ONE

INTRODUCTION

ANDREW ROBINSON

The year 2009 saw the 200th anniversary of the birth of Charles Darwin (12 February 1809) and the 150th anniversary of the publication of his *Origin of Species* (November 1859).[1] Various events and conferences marked this double cause for commemoration and reflection, one of the largest being the Darwin Festival hosted by the University of Cambridge in July of the bicentennial year. In one session, four eminent scholars of the field of science and religion reflected on the ways in which theology is affected by, and may thrive within, the Darwinian context.[2] The large lecture theatre was packed to overflowing – evidence itself of the level of interest in the relationship between Darwinism and religion. During questions from the audience a memorable incident occurred. From almost the back row of the steeply banked seating an imposing figure with a Darwinesque beard announced himself as "one of the four horsemen of the apocalypse." The horseman was the philosopher and 'new atheist' Daniel Dennett. He went on to say that the new atheists are often criticized for not engaging sufficiently with the insights and subtleties of real academic theology. But, he continued, he could not tell from anything he had heard that afternoon that theology had anything concrete to offer him by way of additional understanding the world – anything comparable to the insights

[1] Charles Darwin, *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life* (London: John Murray, 1859).

[2] "Theology in a Darwinian Context," *Darwin Festival* conference session, Cambridge, 6 July 2009. The session was chaired by Professor Sarah Coakley. The speakers were Philip Clayton, Denis Alexander, Fraser Watts, and J. Wentzel van Huyssteen.

available from science – and he therefore remained unrepentant about his alleged underestimation of the relevance of the discipline.[3]

Dennett's apocalyptic intervention was very much in my mind when, two months later, the Science and Religion Forum convened in Cambridge for its own annual conference. The Forum had, naturally, chosen to link the conference with the Darwin anniversaries. However, conscious, of the fact that many of the big issues arising from Darwinism would already have been pored over in other settings during the year, the Forum had decided to focus its conference on a specific theme. The area it had chosen to discuss was the place of 'natural theology' in the light of Darwinian evolutionary biology. Although planned many months previously, it could not have chosen a better context in which to test Dennett's assertion that theology has no traction with real knowledge of the world. For it must be acknowledged that part of the reason that his intervention at the Darwin Festival was memorable was that his remarks stung: there is indeed a legitimate question about whether the way in which theology engages with Darwinism amounts to anything more than a set of purely defensive and rather desperate moves.

To understand how this book may contribute to responding to that challenge we must consider briefly the meaning(s) of the term 'natural theology'. Natural theology is normally contrasted with 'revealed theology'. Revealed theology is knowledge of God derived from God's special self-revelation in Scripture, in special acts of providence, and for Christians preeminently in the life, death and resurrection of Christ.[4] Natural theology, on the other hand, is knowledge of God derived from reflection on the ordinary working of the natural world. The question arises, how are these paths to knowledge of God related? Classically they are thought to operate somewhat independently of each other. According to this view, natural theology is exemplified by the standard arguments for

[3] This incident is also recalled by Sarah Coakley in Chapter 7 (p. 97). If my recollection of it is imperfect I can only apologise and note that such inaccuracy would stand in a venerable tradition of dubious reporting of Darwinian debates (I think, of course, of the doubts surrounding the canonical accounts of the Huxley-Wilberforce exchange at the 1860 meeting of the British Association for the Advancement of Science).

[4] Although the conference at which the papers in this volume were presented focussed on Christian theology, the Science and Religion Forum encourages dialogue between enquirers of all faiths or none. This engagement with a variety of faith traditions is reflected in previous volumes arising from the Forum's conferences. See, for example, Neil Spurway, ed., *Creation and the Abrahamic Faiths* (Newcastle: Cambridge Scholars Publishing, 2008).

the existence of God (paradigmatically in Aquinas's 'five ways', though the extent to which Aquinas himself regarded these as operating independently of revealed theology is a matter of debate). Thus arguments such as the argument from a series of causes to an uncaused cause, or the argument from the regularities of natural processes to a designer outside the world, yield conclusions about the probability of the existence of God. However, whilst such arguments point to the existence of God they cannot, it is often said, provide knowledge of the nature or essence of that God; such knowledge is available through revelation but not through reason.

This understanding of natural theology – as an enterprise that operates independently of revealed theology – has been extensively criticized. Philosophical criticisms of natural theology can be traced to Hume and Kant and rest on criticisms of the premises from which deductive or inductive arguments for the existence of God begin, or on criticisms of the legitimacy of the process of such deductive or inductive reasoning. For example, Hume argued against the reliability of inductive reasoning: from the fact that many *known* As (e.g., instances of order) are caused by Bs (designers) we cannot conclude that *every* A is caused by a B. And the unreliability of inductive reasoning is especially to be guarded against when we consider that invoking a human designer as the cause of a humanly designed artifact is something of which we can give many examples, whereas invoking God as the designer of the world as a whole is (if it is true) a unique relationship of which we have no other comparable examples.

Criticisms of natural theology have also come from within theology itself, notably in the twentieth century from the Reformed theologian Karl Barth. The burden of theological criticisms of classical natural theologies is that they imply that humans have some capacity to know God that is independent of God's gracious self-revelation, and hence deny the absolute sovereignty and transcendence of God. Furthermore (and this is part of Barth's concern, writing as he did in the context of a church all too accepting of Nazism) by seeking knowledge that potentially circumvents the message of Scripture and the incarnation of God's Word in the person of Jesus our theologies may easily be contaminated by something alien to the gospel.

Philosophical and theological criticisms of classical natural theology must clearly be taken seriously. The extent to which such criticisms should be considered decisive is beyond the scope of the present remarks, and indeed beyond the scope of this volume. Rather, the issue that lurks behind the chapters that follow is, in effect, whether natural and revealed theology

are in fact properly regarded as distinct and independent paths to knowledge of God. To put the matter rather simply, is it not the case that revealed theology always depends on the operation of some elements of reason and experience that lie outside, say, scripture? Would it be possible to read and understand scripture entirely in isolation, without any prior experience or knowledge of the world? If not, it must surely be the case that some kind of 'natural' knowledge is required before we can receive the revelation contained in scripture. And why should the capacity for such 'natural' knowledge not be regarded as being as much a gift of the absolutely transcendent Creator as that of scripture itself? Conversely, is it possible to have any 'natural' knowledge of the world without some prior metaphysical (including, but not necessarily limited to, religious) commitments that shape such knowledge? Is the mechanistic, atheistic world-view of the new atheists any more free of metaphysical commitments than a theology of nature which takes the Christian gospel as its overarching framework? In short, aren't natural theology and revealed theology much more mutually dependent than the standard view would tend to imply? If so, Christian theology may have more to learn from reflection on the 'natural' world than the theological critics of natural theology tend to grant. But similarly, agnostic or atheist explorers of the 'natural' world may have more to gain from examining their metaphysical presuppositions than they suppose, and possibly something to learn from a specifically Christian reading of the book of nature.

The present volume brings together the papers presented at the Science and Religion Forum's conference in Cambridge in the Darwin bicentennial year. It offers historical, philosophical and theological perspectives on the ways in which Christian theology has been, and may continue to be, generatively informed by engagement with the understanding of the world arising from Darwinian evolutionary biology. It includes a call for theologians to be bolder in their expectations of the possibilities for natural theology positively to shape the metaphysical presuppositions of working scientists, and some examples of such an emboldened natural theology in operation.

Such a nuanced and potentially enriched view of the relation between 'natural' and 'revealed' theologies may, admittedly, not be sufficient to unseat the four horsemen of the apocalypse. But perhaps, in light of this evidence of the vitality of the interaction between Christianity and Darwinism, those knights of the 'new atheism' would be well advised to slow their thundering gallop to a more circumspect trot.

* * *

The volume is divided into four parts. Part 1 is mainly concerned with historical background – with Darwinism and with the variety of positions taken up in response to Darwin's work by those who found it possible to regard themselves as Christian Darwinians. In Chapter 2 R.J. Berry introduces the scientific basis of Darwinism, tracing the development of evolutionary biology from Darwin's own thought, through the neo-Darwinian synthesis of the 1930s and 1940s, to some more recent aspects of the scientific debate. He goes on to offer his own distinctive theological reading of evolutionary biology, proposing that although the scientific account of human evolution is true as far as it goes, it does not explain how humanity may be understood to be called into relation with God. This relationship required, according to Berry, a transformation of humanity from the biological species *Homo sapiens* to the species made in the image of God, *Homo divinus*. In Chapter 3 Celia Deane-Drummond welcomes Berry's outline of the development of Darwinism, particularly his setting of this in the context of Darwin's personal biography and his acknowledgment of the mixed initial reception of Darwin's ideas within both the scientific and religious communities. However, she robustly criticizes Berry's notion of a historical transformation of humanity by a special divine act not describable in terms of evolutionary biology. In doing so she argues against a literal interpretation of the accounts of the early chapters of Genesis, without denying the theological truthfulness of those accounts on matters such as the fallenness of human beings. It is possible, she suggests, to accept Darwinism and yet remain religiously conservative, and it is not necessary to assume that the two can only be held together by denying the fully natural origin of humankind.

In Chapter 4 John Hedley Brooke considers how natural theology fared in the aftermath of Darwin's *Origin of Species*. He reminds us that traditional natural theology – the deduction of God's existence and attributes from the details of nature – was already under pressure even before Darwin's theory saw the light of day. He goes on to argue that, while it is important to recognize that not all religious responses to Darwin were negative, nevertheless there was great diversity among the sympathetic responses, and that this diversity was often itself theologically divisive. In the course of this theological wrestling with Darwinism traditional natural theology diversified into various species of argument concerned mostly with consilience and based on religiously-committed reflection on nature, rather than claiming to be stand-alone arguments for theism. David Knight follows in Chapter 5 by offering further examples of the diversity of religious response to the *Origin*, suggesting that the early varieties of Christian Darwinian fall into four distinct species: parson

naturalists, Christian agnostics, Incarnationalists, and pillars of the Establishment. He reminds us of advice sometimes given to historians – to read until you 'hear the voices' – and suggests that when we hear the voices of the early respondents to Darwin we can understand why it was, and still is, possible to be a Christian Darwinian.

Part 2 tightens the focus on the implications of Darwinism for natural theology. In Chapter 6 David Fergusson outlines a typology of natural theologies, arguing that each of the types (which he acknowledges may themselves be sub-dividable) has flourished under specific historical and intellectual conditions. Type 1 natural theologies claim to offer an alternative and superior route to knowledge of God compared to that afforded by revealed theology. Type 2 natural theologies are less sceptical about revealed theology, but nevertheless claim to offer a necessary rational grounding for knowledge of God derived from the testimony of scripture, signs and wonders. Type 3 natural theologies are exemplified by Thomas Aquinas, for whom the human capacity to attain some knowledge of God by means of reason is complementary to, and neither superior to or normative for God's gracious self-revelation in scripture. Interpreters differ, however, in their views of precisely how this relation is understood by Aquinas. Type 4 natural theologies are those employed for the apologetic role of "defeating the defeaters," offering arguments against the various rational criticisms of faith. In this role natural theology has "a defensive and subsidiary role, rather than a foundational or preparatory one." Finally, Type 5 natural theologies seek (merely) to establish the possibility of coherence between the specific claims of Christian faith and knowledge of the world derived from other disciplines or areas of life. Fergusson traces the effects of Darwinism on natural theology in terms of the conceptions of the respective roles of scientific and theological explanation, the relation of chance to divine providence, the intensification of the problem of evil, and the perceived threat to human significance. He suggests that the upshot, through the twentieth century, was a general abandonment of (strong) type 1 and type 2 natural theologies in favour (*pace* Barth) of recognition of a significant but auxiliary role for (weaker) type 4 and type 5 approaches.

Sarah Coakley responds in Chapter 7 by lamenting that Fergusson's analysis in effect concedes that theology must be on the back foot in relation to an epistemological agenda set by (functionally atheistic) science. She proposes instead that Fergusson's type 3 natural theology should be developed in such a way as to avoid the assumption that science, philosophy and theology must all operate within a 'flat' epistemological plane determined by science. This bolder approach, she suggests, would

see theologians presenting challenges to scientists about the philosophical and metaphysical basis of current scientific research programmes, with the promise that such interventions would make concrete differences to the actual practice of experimental science. (The counterpoint of Professor Fergusson's fine analysis and Professor Coakley's response was a pivotal moment in the conference, accented by the latter's characteristically pithy delivery. I am therefore glad that Sarah agreed to allow a sense of the dynamism of that interaction to be preserved by presenting her paper for publication largely as delivered, without further scholarly embellishment.)

One possible candidate for a contemporary form of natural theology is Intelligent Design (ID) theory, which is predicated on the claim that Darwinism (and naturalistic explanations in general) cannot explain certain kinds of biological complexity. In Chapter 8 Denis Alexander delivers a thorough critique of ID theory in the form of an extended review of Stephen Meyer's recent book *The Signature in the Cell*. Alexander finds ID to be flawed scientifically (in curtailing science's search for explanations for things not currently understood but for which naturalistic explanations can reasonably be anticipated) and philosophically (in presenting ID theory as science even though it fails to meet many of the criteria by which scientific forms of enquiry may be identified). He also finds it wanting theologically, in that it fails to recognize that the Christian doctrine of creation is concerned with the absolute dependence of the created order on God, not with how particular instances of biological complexity arose. Alexander's contribution is the only chapter that was not presented in substantially its current form at the original conference. For that reason Sjoerd Bonting's response at the conference is not reproduced here, though Neil Spurway (Chapter 14) recalls a telling question of Bonting's concerning the appropriate theological interpretation of the occurrence of deleterious genetic mutations.

In Chapter 9 Christopher Southgate and I outline some of our work on the use of C.S. Peirce's semiotics (theory of signs) as a mediating philosophical framework for science and theology. On the theological side we apply this framework to the Christian understanding of God as Trinity and the idea that Jesus was the incarnate Word of the Father. On the scientific side we report how the field of semiotics my illuminate and stimulate work in fields as diverse as origin of life research and the study of human evolution. The result, we suggest, is an example of the kind of audacious version of Type 3 natural theology advocated by Sarah Coakley in Chapter 7. Kenneth Wilson responds to our paper in Chapter 10, emphasizing the significance of the communal nature of human enquiry

and the way in which the Peircean perspective encourages a view of theology as a vital dimension of such enquiry.

Part 3 brings us to the contributed short papers that were presented at the conference. The first two of these explore the relation between Darwinism and natural theology in the context of the work of two theologians, one Reformed and the other Catholic, each of whose thought has been highly influential in the debate. In spite of Karl Barth's well known strictures against natural theology, in Chapter 11 Philip Chapman finds methodological reasons for pursuing the possibility of dialogue between a Barthian approach to revelation and scientific understandings of the human person. In Chapter 12 Michael Burdett argues that Pierre Teilhard de Chardin's religious appropriation of the cosmic narrative of evolution still has something to offer by way of theological reflection on the emergence of humankind through (and beyond) natural processes, even though Teilhard's biology is arguably more Bergsonian than Darwinian.

In Part 4 we are offered some wider perspectives on the opportunities and challenges presented by Darwinism to theology. In Chapter 13 Fabien Revol, in the third of the contributed papers from the conference, suggests that Darwinism offers seven gifts to theology. These are: a new framework for thinking about nature; the end of static conceptions of the universe; the possibility of a new understanding of divine design; the eviction of certain non-Christian conceptions of God; a kenotic approach to the problem of suffering; the possibility of a new understanding of the ultimate purposes of God in creation; and the recovery of the theme of divine immanence. Together these gifts point away from an old-style approach to natural theology and towards a form of theology of nature; that is, towards "[seeking] to interpret the theological meaning of nature's history rather than attempting to discover or deduce the existence of God and his attributes from the causal details of nature."

Finally, in Chapter 14, Neil Spurway offers a critical overview of the volume. This leads him to suggest four points for further reflection. First, the enrichment of the gene-focussed twentieth century approaches to Darwinian evolution by the newer multi-dimensional picture that is emerging under the banner of 'eco-evo-devo' may have fresh implications for theology. The resulting effect on theology will be, he suggests, similar in kind to that adopted by some of the earliest Christian Darwinians; namely, an ever stronger view of God's indwelling in the material order of creation. Second, he wishes to press, further than is explicit in any of the conference papers, the way in which Darwinism may point us away from certain conceptions of the nature of divine action. Indeed, he finds good theological reasons, implicit in some of the chapters, for regarding the

otherness of God as so absolute that questions about divine action must always shade into mysticism and apophatic humility. Third, he wishes to emphasize the limitations of evolved minds when it comes to speaking intelligibly of that which transcends the material world to which the capacities of such minds are adapted. Fourth, and summing up the previous three points, he contends that no theology worth its salt can be anything other than a 'natural' theology.

Not surprisingly, the authors of these conference papers do not speak with a single voice. Perhaps the greatest contrast is that between the approaches of the first and the last. R.J. Berry's way of relating the theological concept of the *imago dei* to the scientific account of human evolution arguably gives theology an unusually free rein in relation to scientific knowledge. In contrast, Neil Spurway's view of the evolutionary constraints on epistemology implies a theology firmly bridled by science. Some readers may judge that one or other of these approaches – the one effectively giving the leading role to theology and the other to science – offers the only plausible way of conceiving how they might travel together. On the other hand, the reader may want to consider whether the two pivotal chapters in the book – David Fergusson's typology of natural theologies and Sarah Coakley's challenging response – provide a key to reading the other chapters as pointers to a new way of integrating the enterprises of science and theology, one which suggests a necessary (but not necessarily symmetrical) yoking of the two.

PART I:

DARWINISM AND CHRISTIAN DARWINIANS

CHAPTER TWO

BIOLOGY SINCE DARWIN

R.J. BERRY

Charles Darwin was born in Shrewsbury on 12th February 1809, the same day as Abraham Lincoln. It has been said that Lincoln liberated slaves from physical bondage while Darwin liberated thought from the constraints of out-dated views of God and nature.[1] Darwin attended the local grammar school, where he did not excel. He wrote in his *Autobiography*, "When I left the school, I was for my age neither high nor low in it; I believe that I was considered by all my masters and by my father as a very ordinary boy, rather below the common standard in intellect. To my deep mortification my father once said to me, 'You care for nothing but shooting, dogs and rat-catching; you will be a disgrace to yourself and all your family.'"[2]

The young Darwin may have been an indifferent scholar, but he was an avid collector of minerals and insects and a dedicated observer of the natural world. His response to reading Gilbert White's *Selborne* was to make notes on the habits of birds; he recorded that "In my simplicity I remember wondering why every gentleman did not become an ornithologist."[3]

The reality was that Charles Darwin was first and foremost a naturalist. Fifty years after the announcement of natural selection at the Linnean Society, Alfred Russel Wallace declared that Darwin and he had hit on the mechanism for evolution because "in early life both Darwin and myself became ardent beetle-hunters … [we] had an intense interest in the mere variety of living things."[4] Darwin's own apprehension of himself was: "I

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[1] William E. Phipps, *Darwin's Religious Odyssey* (Harrisburg: Trinity International, 2001).

[2] Nora Barlow, ed., *The Autobiography of Charles Darwin 1809-1882* (London: Collins, 1958), 28.

[3] Barlow, *Autobiography of Charles Darwin*, note 2, 45.

[4] The Darwin-Wallace celebration held on Thursday, 1st July 1908, by the Linnean

have no great quickness of apprehension or wit which is so remarkable in some clever men, for instance Huxley. I am therefore a poor critic; a paper or book, when first read, generally excites my admiration, and it is only after considerable reflection that I perceive the weak points. My power to follow a long and purely abstract train of thought is very limited; I should never have succeeded with metaphysics or mathematics. … On the favourable side of the balance, I think I am superior to the common run of men in noticing things which easily escape attention, and in observing them carefully. My industry has been nearly as great as it could have been in the observation and collection of facts."[5]

Six months after Darwin's birth, Jean Baptiste Lamarck published his *Philosophie Zoologique* (on 14 August 1809). It was inspired partly by theology. In it, Lamarck avoided the difficulty of extinction, which implied that God's original creation was not perfect, and suggested a progressive upward path for humankind. It is commonly portrayed as a precursor to the *Origin of Species*. This is not so.[6] Darwin had a low opinion of Lamarck's science. Although he wrote in the 'Historical Sketch' added to the Third Edition of the *Origin* that Lamarck had done the "eminent service of arousing attention to the probability of change in the organic world," he wrote to Joseph Hooker (11 January 1844), "Heaven forfend me from Lamarck[']s nonsense of a 'tendency to progression' 'adaptations from the slow willing of animals' &c.—but the conclusions I am led to are not widely different from his—though the means of change are wholly so" and again (10 November 1844) "Lamarck's is veritable rubbish."[7]

1859 and After

Darwin followed his father and elder brother to medical school in Edinburgh (1825-27), but found himself too squeamish for a medical career. He transferred to Cambridge, reading for a general degree (1828-31). This was followed by five much more exciting years (1832-36) as a "gentleman naturalist" on *HMS Beagle*, commissioned under the command of Robert Fitzroy to survey the southern coasts of South America. The

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Society of London (London: Linnean Society, 1908), 7.

[5] Barlow, *Autobiography of Charles Darwin*, note 2, 140.

[6] Although in Britain they were welcomed by intellectual radicals as a justification for attacking the social status quo. Adrian Desmond, *The Politics of Evolution* (Chicago: Chicago University Press, 1989).

[7] Frederick Burkhardt and Sydney Smith, *The Correspondence of Charles Darwin, Volume 4 1844-1846* (Cambridge: Cambridge University Press, 1988), 1 and 77.

Beagle went on to circumnavigate the globe, most famously spending five weeks (16 September to 20 October 1835) around the islands of the equatorial Galapagos Archipelago, 1000 km west of the South American mainland.

Darwin never left Britain again. His scientific reputation was made by his account of the *Voyage of the Beagle*, published in 1839. In the same year he was elected a Fellow of the Royal Society and married his cousin, Emma Wedgwood (granddaughter of the founder of the Wedgwood pottery firm). The couple lived first in London (in a house where the Biology Department of University College London now stands) and then at Down House near Bromley in Kent until their deaths – Charles in 1882 and Emma in 1896.

Darwin's assumption had been that he would seek ordination after his Cambridge degree. After leaving Edinburgh, he had read with approval the evangelical Bishop of Chester's *Evidences of Christianity*.[8] At Cambridge, he was required to study William Paley's *Evidences of Christianity;*[9] he found Paley's logic "irresistible." In his *Autobiography* he notes, "The logic of this book and I may add of his *Natural Theology* gave me as much delight as did Euclid. The careful study of these works … was the only part of the Academic Course which, as I then felt and still believe, was of the least use to me in the education of my mind."[10] He wrote home at an early stage of the *Beagle*'s voyage, "Although I like this knocking about, I find I steadily have a distant prospect of a very quiet parsonage & I can see it even through a grove of Palms."

But during his time on the *Beagle*, he began to drift away from the idea of career as a clergyman. He did not become an atheist; in his *Autobiography* he insisted that he continued to believe in some form of God. Three years before his death he wrote to a correspondent, "I have never been an atheist in the sense of denying the existence of God." Notwithstanding, as Janet Browne comments,

> It is clear that his kind of belief, though orthodox, was a very loose, English-style orthodoxy in which it was far less trouble to believe than it was to disbelieve. … For Darwin, as for countless others, belonging to the Church of England was as much a statement of social position and attitude as it was a profession of any particular doctrine. … No sane man could

[8] J.B. Sumner, *Evidences of Christianity derived from its Nature and Reception* (London: J. Hatchard and son, 1821). Sumner was Archbishop of Canterbury 1848-62.
[9] William Paley, *Evidences of Christianity* (London, 1802).
[10] Barlow, *Autobiography of Charles Darwin*, note 2, 59.

> believe in miracles, he decided. … Yet he went to church regularly throughout the voyage, attending the shipboard ceremonies conducted by Fitzroy and services on shore whenever possible."[11]

Paley's comfortable picture of a contented creation came increasingly under pressure during the first half of the nineteenth century through:

- The discovery of 'deep space' as telescopes improved. In 1783 William Herschel had shown that the Milky Way itself was moving through space.
- The acceptance from fossils and geological strata that the universe was much older than the few thousand years implied by the biblical genealogies. Such 'deep time' was the Achilles heel of traditional natural theology. A creator could presumably design an organism perfectly adapted to a particular environment, but this perfection would disappear if the environment was not constant. Adaptation to changes in climate, to the physical structure of the Earth's surface, or to predators and competitors is possible only if organisms change. By Darwin's time, the majority of Bible expositors accepted a non-literal interpretation of the early chapters of Genesis.[12]
- The increasing knowledge of the distribution of animals and plants from scientific voyaging – by Banks, Solander and Herschel, by Humboldt, Darwin, Hooker and others. Noah's Ark faded into the history of thought;[13] the possibility of multiple centres of creation became increasingly discussed.

Darwin was, of course, aware of these tensions, and found the Platonic stasis of Paley increasingly difficult as he read the ideas of gradual geological change propounded by Charles Lyell in his *Principles of Geology*.[14] During his time on the *Beagle*, he was faced with:

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[11] Janet Browne, *Charles Darwin: Voyaging* (London: Jonathan Cape, 1995), 325.
[12] C.L.E. Lewis and S.J. Knell, eds., *The Age of the Earth: from 4004 BC to AD 2002* (London: Geological Society Special Publication No. 190, 2001).
[13] Janet Browne, *The Secular Ark: Studies in the History of Biogeography* (New Haven: Yale University Press, 1983).
[14] Darwin took the first volume of the *Principles* with him when he embarked on the Beagle; he received the second volume in Montevideo; and the third volume when the ship reached the Falkland Islands.

- South American fossils similar but obviously different to living forms. In the Argentine he was astonished to find a fossil of a giant sloth (*Megatherium*) as big as an elephant.
- Replacement of species with latitude, apparent as the *Beagle* sailed south along the South American coast.
- Major effects on topography and earthquakes affecting land uplift; Darwin experienced such an event in Chile.
- The occurrence of many unusual species in archipelagos.

It is now common knowledge that Darwin did not have a Damascus Road experience in the Galapagos as was once believed.[15] Notwithstanding, he recorded his belief in the possible importance of islands in his notes made after leaving the Galapagos.

The *Beagle* arrived back in Britain in October 1836. Six months later (March 1837), Darwin was told by John Gould, the ornithologist at London Zoo that the Galapagos Islands were home to a number of different bird species; in September of the same year he read "for amusement" *An Essay on the Principle of Population* by Thomas Malthus. His ideas of a mechanism for evolutionary change (or 'transformism' in the language of the time) began to gel. His starting point was a Paleyian belief that the creator creates by laws.[16] By 1842, he was sufficiently sure of his new understanding to describe it in a brief 35 page 'Sketch'; he expanded this into a 200 page 'Essay' in 1844. The latter subsequently formed the basis of the *Origin of Species*, published in 1859.

Darwin invoked a very simple mechanism for evolutionary change, based on three facts and two deductions from these facts. He started with the observation that virtually all species have a large potential for increase in number (think of the number of acorns produced by an oak tree or the masses of spawn laid by every female frog), but (second observation) numbers remain roughly constant. The inference from this is that there must be a *struggle for existence*, with only a small proportion of young surviving. The existence of such a struggle is essentially an ecological deduction and one well understood in Darwin's time; it had forced itself on Darwin's awareness when he read Malthus's *Essay*. Darwin's genius was in linking a third fact – heritable variation – to the ever-prevalent

[15] Frank J. Sulloway, "Darwin and his finches. The evolution of a legend," *Journal of the History of Biology* 15: 1-53.
[16] Dov Ospovat, *The Development of Darwin's Theory* (Cambridge: Cambridge University Press, 1979).