Was Hitler a Darwinian?

DISPUTED QUESTIONS IN THE HISTORY OF EVOLUTIONARY THEORY

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CHAPTER TWO

Darwin's Theory of Natural Selection and Its Moral Purpose

Thomas Henry Huxley (1825–1895; fig. 2.1) recalled that after he had read Darwin's *Origin of Species* (1859), he exclaimed to himself: "How extremely stupid not to have thought of that!"[1] It is a famous but puzzling remark. In his contribution to Francis Darwin's *Life and Letters of Charles Darwin*, Huxley rehearsed the history of his engagement with the idea of transmutation of species. He mentioned the views of Robert Grant (1793–1874), an advocate of Lamarck (1744–1829), and Robert Chambers (1802–1871), who anonymously published *Vestiges of the Natural History of Creation* (1844), which advanced a crude idea of transmutation. He also recounted his rejection of Louis Agassiz's (1807–1873) belief that species were progressively replaced by the divine hand. He neglected altogether his friend Herbert Spencer's (1820–1903) early Lamarckian ideas about species development, which were also part of the long history of his encounters with the theory of descent. None of these sources moved him to adopt any version of the transmutation hypothesis.

Huxley was clear about what finally led him to abandon his long-standing belief in species stability: "The facts of variability, of the struggle for existence, of adaptation to conditions, were notorious enough; but none of us had suspected that the road to the heart of the species problem lay through them, until Darwin and Wallace dispelled the darkness, and the beacon-fire of the 'Origin' guided the benighted."[2]

1. Thomas Henry Huxley, "The Reception of the *Origin of Species*," in *Life and Letters of Thomas Henry Huxley*, 2 vols., ed. Leonard Huxley (New York: D. Appleton, 1900), 1:183.

2. Ibid., 183.

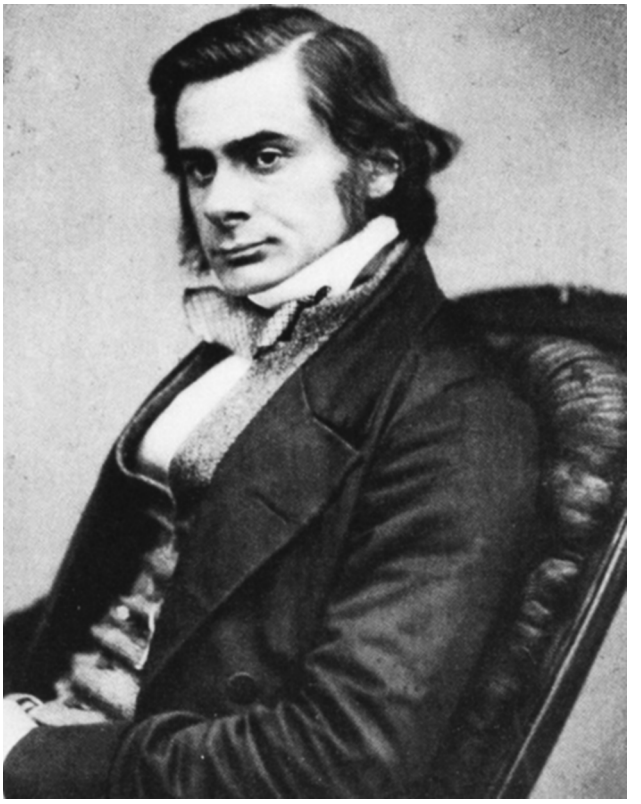

FIGURE 2.1 Thomas Henry Huxley (1826–1895), in 1857.
Photo from Leonard Huxley, *Life and Letters of Thomas H. Huxley*.

The elements that Huxley indicated—variability, struggle for existence, adaptation—form core features of Darwin's conception of natural selection. Thus what Huxley admonished himself for not immediately comprehending was not the fact of species change but the cause of that change. Huxley's exclamation suggests—and it has usually been interpreted to affirm—that the idea of natural selection was really quite simple and that when the few elements composing it were held before the mind's eye, the principle and its significance would flash out. The elements, it is supposed, fall together in this way: species members vary in their heritable traits from each other; more individuals are produced than the resources of the environment can sustain; those that by chance have traits that better fit them to their circumstances than others of their kind will

more likely survive to pass on those traits to offspring; consequently, the structural character of the species will continue to alter over generations until individuals appear specifically different from their ancestors.[3]

Yet if the idea of natural selection were as simple and fundamental as Huxley suggested and as countless scholars have maintained, why did it take so long for the theory to be published after Darwin supposedly discovered it? And why did it then require a very long book to make its truth obvious? In this chapter, I will try to answer these questions. I will do so by showing that the principle of natural selection is not simple but complex and that it only gradually took shape in Darwin's mind. In what follows, I will refer to the "principle" or "device" of natural selection, never the "mechanism" of selection. It is widely assumed that a singular feature of Darwin's accomplishment was that he introduced mechanism into nature. In a typical fashion, Richard Lewontin, Steven Rose, and Leon Kamin so render the identifying construct of Darwin's science: "Natural selection theory and physiological reductionism were explosive and powerful enough statements of a research program to occasion the replacement of one ideology—of God—by another: a mechanical, materialist science."[4] Though the phrase "mechanism of natural selection" comes trippingly to our tongues, it never came to Darwin's. Yet even when the focus is directly on the historical Darwin, scholars almost reflexively use this locution, thereby making the slide to a metaphysical conviction much easier.[5] I will not hesitate to use the term "evolution" to describe the idea of species descent with modification. Somehow the notion has gained currency that Darwin avoided the term because it suggested progressive development.[6] This assumption has

3. Waters succinctly provides the standard account in three principles: (1) variations appear in organisms without preadaptation to the environment; (2) some variations by chance work in the environment and give bearers an advantage over those lacking the traits; and (3) such variations are usually transmitted to progeny. Waters offers a comparably succinct and generally orthodox account of Darwin's entire argument. See C. Kenneth Waters, "The Arguments in the *Origin of Species*," in *Cambridge Companion to Darwin*, 2nd ed., ed. Jonathan Hodge and Gregory Radick (Cambridge: Cambridge University Press, 2009), 120–43; his distillation of natural selection is on p. 128. I do not doubt that these principles capture essential features of
Darwin's idea, but I argue that this abstract formulation misses much else in his conception of natural selection.

4. R. C. Lewontin, Steven Rose, and Leon Kamin, *Not in Our Genes* (New York: Pantheon, 1984), 51.

5. For example, see Michael Ruse, *Darwinism and Its Discontents* (Cambridge: Cambridge University Press, 2008), in which the linguistic reflex "mechanism of natural selection" is given ample play—some nineteen times in a moderately sized book.

6. Richard Lewontin, for one, claims that Darwin did not use the term "evolution" because it suggested a progressive development of organism, whereas his theory rejected a progressivist view. See my exchange with Lewontin, "Darwin and Progress," *New York Review of Books* 52, no. 20 (15 December 2005), letters.

no warrant for two reasons. First, the term is obviously present, in its participial form, as the very last word in the *Origin*, as well as being freely used as a noun in the last edition of the *Origin* (1872), in the *Variation of Animals and Plants under Domestication* (1868), and throughout the *Descent of Man* (1871) and the *Expression of the Emotions in Man and Animals* (1872). But the second reason for rejecting the assumption is that Darwin's theory is, indeed, progressivist, and his device of natural selection was designed to produce evolutionary progress.

Scholars have supposed that a red thread runs through a progressivist interpretation of nature, leading to the assumption that human beings are the goal of nature's strivings, an assumption they believe to be a remnant of antique theology and quite antithetic to Darwin's intentions. I rather believe that Darwin constructed his theory precisely with this teleological trajectory in mind. In this chapter, I argue that Darwin cast natural selection as the device by which, as he put it, "the most exalted object we are capable of conceiving" has been achieved: man as a moral creature. To trace the thread and determine its endpoint, one must start at the beginning of Darwin's theorizing.

DARWIN'S EARLY EFFORTS TO EXPLAIN SPECIES TRANSFORMATION, 1837–1838

Shortly after he returned from his voyage on H.M.S. *Beagle* (1831–36; fig. 2.2), Darwin began seriously to entertain the hypothesis of species change over time. He had been introduced to the idea, when a teenager, through reading his grandfather Erasmus Darwin's *Zoonomi*a (1794–96), which included speculations about species development; while at medical school in Edinburgh (1825–27), he studied Lamarck's *Système des animaux sans vertèbres* (1801) under the tutelage of Robert Grant, a convinced evolutionist. On the voyage, he packed into his cabin Lamarck's *Histoire naturelle des animaux sans vertèbres* (1815–22), in which the idea of evolutionary change was prominent. He got another large dose of the Frenchman's ideas during his time off the coast of South America, where he received by merchant ship the second volume of Charles Lyell's *Principles of Geology* (1831–33), which contained a searching discussion and negative critique of the fanciful supposition of an "evolution of one species out of another."[7] Undoubtedly the rejection of Lamarck by Lyell and most British naturalists gave Darwin pause; after his return to England,

7. Charles Lyell, *Principles of Geology*, 3 vols. (1830–33; repr., Chicago: University of Chicago Press, 1987), 2:60.

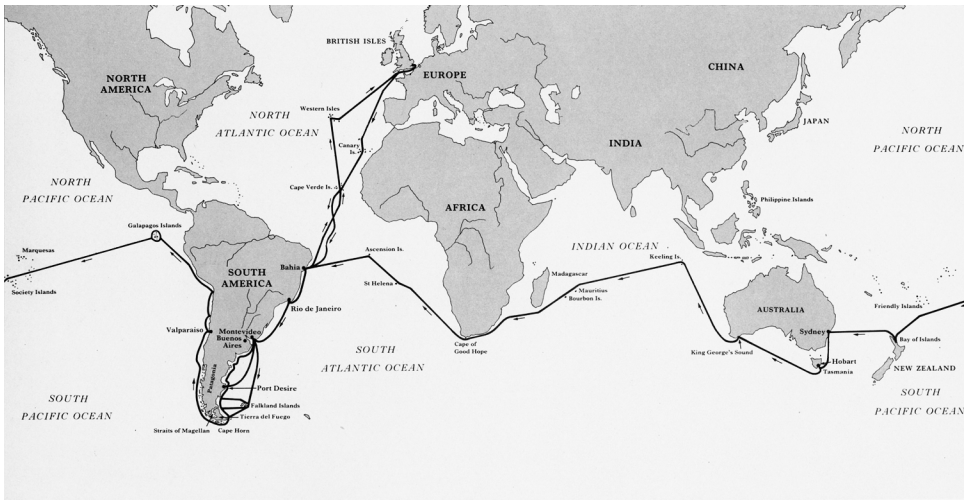

FIGURE 2.2 Voyage of H.M.S. *Beagle*. Departed Plymouth, December 1831; returned Falmouth, October 1836.

however, while sorting and cataloging his specimens from the Galapagos, he came to understand that his materials supplied compelling evidence for the suspect theory. Three groups of mockingbirds, which he had thought merely varieties of the mainland species, were identified by John Gould (1804–1881), chief ornithologist of the British Museum, as distinct species.[8] The revelation tripped a mind at the ready.

In his various early notebooks (January 1837–June 1838), Darwin began to work out different possibilities to explain species change.[9] Initially, he supposed that a species might be "created for a definite time," so that when its span of years was exhausted, it went extinct and another, affiliated species took its place.[10] He rather quickly abandoned the idea of species senescence and began to think in terms of Lamarck's notion of the direct effects of the environment, especially the possible impact of the imponderable fluids of heat and

8. Sulloway has persuasively argued that it was Gould's identification that convinced Darwin of the transmutational theory. See Frank Sulloway, "Darwin's Conversion: The *Beagle* Voyage and Its Aftermath," *Journal of the History of Biology* 15 (1982): 327–98.

9. Robert J. Richards, *Darwin and the Emergence of Evolutionary Theories of Mind and Behavior* (Chicago: University of Chicago Press, 1987), 85–98.

10. Charles Darwin, *Red Notebook* (MS p. 129), in *Charles Darwin's Notebooks, 1836–1844*, ed. Paul Barrett et al. (Ithaca: Cornell University Press, 1987), 62.

electricity.[11] If the device of environmental impact were to meet what seemed to be the empirical requirement—as evidenced by the pattern of fossil deposits, going from simple shells at the deepest levels to complex vertebrate remains at higher levels—then it had to produce progressive development. If species resembled ideas, then progressive change would seem to be a natural result, or so Darwin speculated: "Each species changes. Does it progress. Man gains ideas. The simplest cannot help.—becoming more complicated; & if we look to first origin there must be progress."[12] Being the conservative thinker that he was, Darwin retained in the *Origin* the idea that some species, under special conditions, might be transformed through direct environmental impact; at a deeper level in the book, his progressivist conviction, persisting from this early period, provided his theory a definite vector for the evolution of organisms.

Darwin seems to have soon recognized that the direct influence of surroundings on an organism could not account for its more complex adaptations, and so he began constructing another causal device. He had been stimulated by an essay of Frédéric Cuvier's (1773–1838), the great Georges Cuvier's (1769–1832) younger brother; the essay suggested that animals might acquire heritable traits through exercise in response to particular circumstances. Darwin quickly concluded that "all structures either direct effect of habit, or hereditary ‹& combined› effect of habit."[13] He thus assumed that new habits, if practiced by a population over long periods of time, would turn into instincts, and that these latter would eventually modify anatomical structures and so would alter species. Use-inheritance was, of course, a principal mode of species transformation for Lamarck.

In developing his own theory of use-inheritance, Darwin carefully distinguished his ideas from those of his discredited predecessor—or at least he was persuaded that their respective ideas were quite different. He attempted to distance himself from the French naturalist by proposing that habits introduced into a population would first gradually become instinctual before they altered anatomy. And instincts—innate patterns of behavior—would be expressed automatically, without the intervention of conscious willpower, the presumptive Lamarckian mode.[14] By early summer of 1838, Darwin thus had two devices by which to explain descent of species with modification: the direct effects of the environment and his habit-instinct device.

11. Charles Darwin, *Notebook B* (MS pp. 17–20), in *Charles Darwin's Notebooks*, 175.

12. Ibid. (MS p. 18).

13. Charles Darwin, *Notebook C* (MS p. 63), in *Charles Darwin's Notebooks*, 259. (The editors of the *Notebooks* use double wedges to indicate insertions by Darwin.)

14. Ibid. (MS p. 171), 292.

ELEMENTS OF THE THEORY OF NATURAL SELECTION

At the end of September 1838, Darwin paged through Thomas Malthus's (1766–1834; fig. 2.3) *Essay on the Principle of Population* (6th ed., 1826). As he later recalled in his *Autobiography*, this happy event changed everything for his developing conceptions:

FIGURE 2.3 Thomas Robert Malthus (1766–1834). Mezzotint. (© National Portrait Gallery)

> I soon perceived that selection was the keystone of man's success in making useful races of animals and plants. But how selection could be applied to organisms living in a state of nature remained for some time a mystery to me. In October 1838, that is, fifteen months after I had begun my systematic enquiry, I happened to read for amusement Malthus on Population, and being well prepared to appreciate the struggle for existence which everywhere goes on from long-continued observation of the habits of animals and plants, it at once struck me that under these circumstances favourable variations would tend to be preserved, and unfavourable ones to be destroyed. The result of this would be the formation of new species. Here, then, I had at last got a theory by which to work.[15]

Darwin's description supplies the classic account of his discovery, and it does capture a moment of that discovery, though not the complete character or full scope of his mature conception. The account in the *Autobiography* needs to be placed against the notebooks, essays, and various editions of the *Origin* and the *Descent of Man*. These comparisons reveal *many* moments of discovery, and a gradual development of his theory of natural selection from 1838 through the next several decades.

In the *Autobiography*, Darwin mentioned two considerations that had readied him to detect in Malthus a new possibility for the explanation of species development: the power of artificial selection and the role of struggle. Lamarck had suggested domestic breeding as the model for what occurred in nature. Undeterred by Lyell's objection that domestic animals and plants were specially created for man, Darwin sought guidance for determining how selection might operate in nature from breeders' manuals, such as those by John Sebright (1767–1846) and John Wilkinson (1797–1875).[16] This literature brought him to understand more clearly the power of domestic "selection"

15. Charles Darwin, *The Autobiography of Charles Darwin*, ed. Nora Barlow (New York: Norton, 1969), 119–20. Darwin's *Autobiography* puts the Malthusian moment in October 1838, but his notebooks testify that the inspiration came a bit earlier, at the end of September of that year.

16. Lyell, *Principles of Geology*, 2:41. John Sebright, *The Art of Improving the Breeds of Domestic Animals* (London: Howlett and Brimmer, 1809); John Wilkinson, "Remarks on the Improvement of Cattle, etc. in a Letter to Sir John Sanders Sebright, Bart. M.P.," Nottingham, 1820. Ruse shows how these breeders contributed to Darwin's understanding of the nature of artificial selection. See Michael Ruse, "Charles Darwin and Artificial Selection," *Journal of the History of Ideas* 36 (1975): 339–50. For an expansive review of Darwin's notions about artificial selection, see Bert Theunissen, "Darwin and His Pigeons, the Analogy between Artificial Selection and Natural Selection Revisited," *Journal of the History of Biology* 45 (2012):179–212.

(Sebright's term), but he remained puzzled, as his *Autobiography* suggests, about what might play the role of the natural selector or "picker." In midsummer of 1838, he observed: "The Varieties of the domesticated animals must be most complicated, because they are partly local & then the local ones are taken to fresh country & breed confined, to certain best individuals.—scarcely any breed but what some individuals are picked out.—in a really natural breed, not one is picked out."[17] This passage illustrates Darwin's perplexity: How could selection occur in nature when no agent was picking the few "best individuals" to breed?

In the *Autobiography*, Darwin indicated that the second idea that prepared him to divine the significance of Malthus's *Essay* was that of the struggle for existence. Lyell, in the *Principles of Geology*, had mentioned the observation of Augustin de Candolle (1778–1841) that all the plants of a country "are at war with one another." This kind of struggle, Lyell believed, would be the cause of "mortality" of species, of which fossils gave abundant evidence.[18] In his own reading of Lyell, Darwin took to heart the implied admonition to "study the wars of organic beings."[19]

These antecedent notions gleaned from Lamarck, Lyell, and the breeders led Darwin to the brink of a stable conception. In spring of 1837, for instance, he considered how a multitude of varieties might yield creatures better adapted to circumstances: "whether every animal produces in course of ages ten thousand varieties, (influenced itself perhaps by circumstances) & those alone preserved which are well adapted."[20] Here—eighteen months before he read Malthus—Darwin mentioned in passing a central element of his principle of natural selection without, apparently, detecting its significance. And a year later, something like both natural and sexual selection spilled onto the pages of his *Notebook C*: "Whether species may not be made by a little more vigour being given to the chance offspring who have any slight peculiarity of structure. «(hence seals take victorious seals, hence deer victorious deer, hence males armed & pugnacious all orders; cocks all war-like)»."[21] It is fair to say, nonetheless, that the foundations for Darwin's device of natural selection were laid on

17. Charles Darwin, *Notebook D* (MS p. 20), in *Charles Darwin's Notebooks*, 337.

18. Lyell, *Principles of Geology*, 2:131, 130.

19. Darwin, *Notebook C* (MS p. 73), 262.

20. Darwin, *Notebook B* (MS p. 90), 193.

21. Darwin, *Notebook C* (MS p. 61), 258. This entry is likely a gloss on Sebright, *Art of Improving the Breeds*, 15–16.

the ground of Malthus's *Essay*. His reading of that book caused those earlier presentiments to settle into a firm platform for further development.

THE MALTHUS EPISODE

Malthus had composed his book to investigate two questions: What has kept humankind from steadily advancing in happiness? And, can the impediments to happiness be removed? Famously, he argued that the chief barrier to the progress of civil society was that population increase would always outstrip the growth in the food supply, thus causing periodic misery and famine. What caught Darwin's eye in the opening sections of Malthus's *Essay*, as suggested by scorings in his copy of the book, was the notion of population pressure through geometric increase:

> In the northern states of America, where the means of subsistence have been more ample . . . the population has been found to double itself, for above a century and half successively, in less than twenty-five years. . . . It may safely be pronounced, therefore, that population, when unchecked, goes on doubling itself every twenty-five years, or increases in a geometrical ratio. . . . But the food to support the increase from the greater number will by no means be obtained with the same facility. Man is necessarily confined in room.[22]

Darwin found in those passages from Malthus a propulsive force that had two effects: it would severely restrict reproduction by reason of the better adapted pushing out the weaker and thus depriving them of resources, and consequently it would sort out, or transform, the population. On 28 September 1838, Darwin phrased it this way in his *Notebook D*:

> Even the energetic language of ‹Malthus› «Decandoelle» does not convey the warring of the species as inference from Malthus . . . population in increase at geometrical ratio in FAR SHORTER time than 25 years—yet until the one sentence of Malthus no one clearly perceived the great check amongst men. . . . One may say there is a force like a hundred thousand wedges trying force ‹into› every kind of adapted structure into the gaps ‹of› in the oeconomy of Nature, or rather forming gaps by thrusting out

22. Thomas R. Malthus, *An Essay on the Principle of Population*, 6th ed., 2 vols. (London: Murray, 1826), 1:5.

weaker ones. «The final cause of all this wedging, must be to sort out proper structure & adapt it to change».[23]

All the "wedging" caused by population pressure would have the effect, according to Darwin, of filtering out all but the most fit organisms and thus adapting them (actually, leaving them preadapted) to their circumstances. One should note, however, that Darwin does not emphasize the negative feature of this process, namely, the death of vast numbers of the population for lack of resources; rather he looks to the positive effect of sorting out and adapting the population. In the gradual construction of his theory, he constantly stressed the positive over the negative. He turned away from death.

Though natural selection is the linchpin of Darwin's theory of evolution, his notebooks indicate only the slow emergence of its ramifying features. He reflected on his burgeoning notions through the first week of October 1838 but then turned to other matters. Through the next few months, here and there, the implications became more prominent in his thought. In early December, for instance, he explicitly drew for the first time the analogy between natural selection and domestic selection: "It is a beautiful part of my theory, that «domesticated» races . . . are made by percisely [*sic*] same means as species."[24] But the most interesting reflections, which belie the standard assumptions about Darwin's theory, were directed to the final cause or purpose of evolution. This teleological framework would help organize several other elements constituting his developing notion.

THE PURPOSE OF PROGRESSIVE EVOLUTION: THE MORAL ANIMAL

The *Origin of Species* concludes with a great peroration that Darwin had honed over several decades: "Thus, from the war of nature, from famine and death, the most exalted object which we are capable of conceiving, namely, the production of the higher animals directly follows. There is grandeur in this view of life, with its several powers, having been originally breathed into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being, evolved."[25]

23. Darwin, *Notebook D* (MS p. 135e), 375–76.
24. Charles Darwin, *Notebook E* (MS pp. 71, 63), in *Charles Darwin's Notebooks*, 416, 414.
25. Charles Darwin, *On the Origin of Species* (London: Murray, 1859), 490.

In this lyrical conclusion, Darwin asserted a long-standing and permanent conviction, namely, that the "object," or purpose, of the "war of nature" is "the production of the higher animals." And the unspoken, but clearly intended, higher animals were human beings with their moral sentiments. Darwin imbedded his developing theory of natural selection in a decidedly progressivist and teleological framework, a framework quite obvious when one examines the initial construction of his theory.

Several passages from his early notebooks indicate Darwin's teleological perspective on the operations of natural selection in nature. As a coda to his reading of Malthus in late September 1838, he added this characteristic teleological mode of consideration: "The final cause of all this wedging, must be to sort out proper structure & adapt it to change—to do that, for form, which Malthus shows, is the final effect (by means of volition) of this populousness on the energy of Man."[26]

Darwin here construed the purpose of population pressure as the adaptation of organic form to changing circumstances. Thus at the very birth of the idea of natural selection, Darwin conceived the process as comparable to what happened when energetic colonists moved into new territories and intentionally drove out indigenous peoples.[27]

Darwin's use of the language of final causes might be thought only a *façon de parler*, something the careful historian need not take seriously. After all, many scholars have credited Darwin precisely with the abolition of final causes from nature. But we must bear in mind that Darwin, this herald of modern biology, was yet a nineteenth-century thinker. His conceptions were wrought in terms available to his time and circumstances. And he frequently enough deployed final causes as part of the explanation of natural processes. For example, when considering Lyell's descriptions of the virtually limitless geological periods before the appearance of man, Darwin recast them into a teleological account: "Progressive development gives final cause of enormous periods anterior to Man."[28] In other words, the purpose of the vast extents of time prior to the appearance of human beings was for the gradual progressive development of the necessary antecedent conditions. Or take a more salient example that appears in Darwin's notebook a month after his reading of Malthus. In an entry at the end of October 1838, Darwin considers how his theory could explain

26. Darwin, *Notebook D* (MS p. 135e), 375–76.

27. Malthus had argued that when populations grow large, the energetic offspring are urged to seek new territories, even those already settled by native societies. See Malthus, *Essay*, 1:94–95.

28. Darwin, *Notebook B* (MS p. 49), 182.

a puzzle that is still of interest—why sexual generation evolved instead of nature remaining satisfied with asexual modes of reproduction: "My theory gives great final cause «I do not wish to say only cause, but one great final cause . . .» of sexes . . . for otherwise there would be as many species, as individuals, & . . . few only social . . . hence not social instincts, which as I hope to show is «probably» the foundation of all that is most beautiful in the moral sentiments of the animated beings."[29]

In this intricate cascade of ideas, Darwin traced a path from sexual generation to its consequences: the establishment of stable species, then the appearance of social species, and finally the ultimate purpose of the process, the production of human beings with their moral sentiments. In other words, the end of the process makes intelligible the initial and intermediate stages in the process, indeed, explains their existence. Darwin capped this consideration with a general teleological evaluation that would structure his conception of the final goal of evolutionary nature—man as a moral being: "If man is *one* great object, for which the world was brought into present state . . . & if my theory be true then the formation of sexes rigidly necessary."[30] This particular trajectory needs further explication.

When Darwin opened his first transmutation notebook in spring 1837, he began with his grandfather's reflections on the differences between sexual generation and asexual kinds of reproduction. The grandson supposed that sexually produced offspring would, during gestation, recapitulate the forms of ancestor species. As he initially formulated the principle of recapitulation: "The ordinary kind [i.e., sexual reproduction], which is a longer process, the new individual passing through several stages (typical, ‹of the› or shortened repetition of what the original molecule has done)."[31] Darwin retained the principle of embryological recapitulation right through the several editions of the *Origin*, and thus was in complete accord with his disciple Ernst Haeckel (1834–1919), who made it a central principle of his own science.[32] Recapitulation produced an individual that gathered in itself all the progressive adaptations of its ancestors. But the key to progressive adaptation was the variability that came with sexual reproduction. In spring of 1837, he still

29. Darwin, *Notebook E* (MS pp. 48–49), 409.

30. Ibid.

31. Darwin, *Notebook B* (MS p. 1), 170.

32. I have traced Darwin's development and employment of the principle of embryological recapitulation in Richards, *The Meaning of Evolution: The Morphological Construction and Ideological Reconstruction of Darwin's Theory* (Chicago: University of Chicago Press, 1992), chap. 5. See chapter 6 in the current volume for a discussion of Haeckel's use of the principle of recapitulation.

did not understand exactly how variability might function in adaptation; he yet perceived that variable offspring could adjust to a changing environment in ways that clonally reproducing plants and animals could not. Moreover, in variable offspring, accidental injuries would not accumulate as they would in continuously reproducing asexual organisms. Hence stable species would result from sexual generation. For "without sexual crossing, there would be endless changes . . . & hence there could not be improvement . «& hence not «be» higher animals»."[33] But once stable species were established, social behavior and ultimately moral behavior might ensue.

The idea that Darwin banished final causes from nature, replacing them with mechanistic explanations, obviously cannot be sustained.[34] I have cited only a few instances of several, in the notebooks, of Darwin's use of final causality in the account of natural phenomena. If one adds the many instances in which he employed "purpose"—or its more obscure synonym "object," as in his remark above about man as the "one great object, for which the world was brought into present state"—then both the notebooks and the *Origin* are rife with final-cause language. "Purpose" or "object" occurs some sixty-three times in the *Origin*, while "mechanical," "mechanistic," or any of its forms occurs only five times—and none of them modifying "natural selection." Natural selection hardly operates in Darwin's theory like a Manchester spinning

33. Darwin, *Notebook E* (MS p. 50), 410.

34. Most scholars vigorously assert that Darwin eliminated the metaphysical conceit of teleology from nature. Michael Ghiselin is quite representative. See Ghiselin, "Darwin's Language Might Seem Teleological, but His Thinking Is Another Matter," *Biology and Philosophy* 9 (1994): 489–92. Without bothering to examine Darwin's notebooks, Ghiselin simply asserts: "I have said it before, I will say it again. The notion that Darwin somehow brought teleological thinking back into biology is a myth. In any non-trivial sense of that term, he did the exact opposite. He developed a new way of thinking that allows us to dispense altogether with that metaphysical delusion. I say this not just after having read the whole Darwinian corpus through more than once. Rather, I say it as a professional biologist, who has learned from his own experience, and from that of his colleagues, including Darwin" (489). Ghiselin was reacting to James Lennox, "Darwin *Was* a Teleologist," *Biology and Philosophy* 8 (1993): 409–21. Lennox focuses on the use of final-cause language in Darwin's *Various Contrivances by Which Orchids Are Fertilised by Insects* (1862). Lennox argues that Darwin sought to explain those contrivances by their consequences—that is, by the advantages they exhibited, and thus by natural selection. Lennox's account is quite within the Aristotelian notion of teleology: the final cause, that is, the consequence of a trait or process, illuminates for the biologist the *structure* of the trait or process. In Darwin's analysis, however, the existence of a trait is likely the result of spontaneous variation (or the accumulation of variations), that is, it results from something like an efficient cause in Aristotle's terms. Once in existence a trait, if of advantage, is simply not eliminated. I would side with Lennox over Ghiselin, but I believe there is yet a more fundamental notion of teleology at work in Darwin's theory, which is rather more like Kant's notion of teleology, which does require the assumption of an *archetypus intellectus*, a Divine mind, precisely the sort of entity that both Lennox and Ghiselin presumed Darwin had eliminated from biology.

loom but rather like a refined and morally concerned mind, as I'll try to make clear.[35]

The term "final cause" faded in Darwin's constant reworking of his theory over the two decades prior to the publication of the *Origin*, but the concept remained, supplying support to the whole of his argument. If one does a kind of archeological dig down through the principal documents charting the growth of the theory—from the *Origin*, back through the *Big Species Book* (the manuscript that gave birth to the *Origin*), to the essays of 1844 and 1842, and finally the notebooks—the intellectual layers reveal the structuring work of that teleological conception. So consider the strata underlying the conclusion drawn in the last paragraph of the *Origin*:

> 1. 1838 (*Notebook E*): "man is one great object, for which the world was brought into present state."[36]
> 2. 1842 (Essay of 1842): "the highest good, which we can conceive, the creation of the higher animals has directly come."[37]
> 3. 1844 (Essay of 1844): "the most exalted end which we are capable of conceiving, namely, the creation of the higher animals, has directly proceeded."[38]
> 4. 1859 (*Origin*): "the most exalted object, which we are capable of conceiving, namely, the production of the higher animals, directly follows."[39]

There is one use of "final cause" that Darwin does repudiate: when a purposive trait is ascribed to the direct action of the Deity instead of to the operations of natural law. In *Notebook M*, Darwin observed: "The unwillingness to consider Creator as governing by laws is probably that as long as we consider each object an act of separate creation, we admire it more, because we can compare it to the standard of our own minds, which ceases to be the case when we

35. Even a shrewd historian such as Gregory Radick easily falls into the locution of mechanism when referring to the way natural selection operates to produce adaptations. See Gregory Radick, "Is the Theory of Natural Selection Independent of Its History," in Hodge and Radick, *Cambridge Companion to Darwin*, 147–72.

36. Darwin, *Notebook E* (MS p. 49), 409.

37. Charles Darwin, "Essay of 1842," ibid., 52.

38. Charles Darwin, "Essay of 1844," in *Foundations of the Origin of Species*, ed. Francis Darwin (Cambridge: Cambridge University Press, 1909), 254.

39. Darwin, *Origin of Species*, 490.

consider the formation of the laws invoking laws, & giving rise at last even to the perception of a final cause."[40]

From the beginning of his theorizing, Darwin argued that events in nature had to be understood as occurring through natural law. But exactly how does that presumption square with his general teleological conception?

NATURAL SELECTION AS DESIGNED LAW

In the last paragraph of the *Origin of Species*, Darwin specified by way of summary the laws that he discriminated in his book. They included "Growth with Reproduction," "Inheritance," "Variability," "Struggle for Life," and "Natural Selection." Today, we would not likely refer to natural selection as a law but rather as shorthand for sufficient causal forces operative on an organism at a particular time. Darwin, however, in his nineteenth-century way, thought of natural selection as comparable to the law of gravity. In his *Autobiography*, he contrasted his law of natural selection with Paley's intervening deity: "The old argument of design in nature, as given by Paley, which formerly seemed to me so conclusive, fails, now that the law of natural selection has been discovered. We can no longer argue that, for instance, the beautiful hinge of a bivalve shell must have been made by an intelligent being, like the hinge of a door by man."[41] In his notebooks and in the *Origin*, Darwin would contend that the creation of new species occurred by law, the law of natural selection. But what did he mean by law, and how did natural selection operate as a law?

By law, Darwin seems to have meant causal interactions in the natural world that were fixed and of an unchangeable type. These interactions formed a network of radiating forces that governed all organic and inorganic formations. The most general physical causes—for example, slow geological changes—had a determining impact, he suggested, on a more specific range of causes, and these in turn were translated into environmental alterations that caused variations for organic adaptations. He considered this conception of a network of laws shaping organisms to be superior to the "cramped imagination that God created (warring against those very laws he established in all organic nature) the Rhinoceros of Java & Sumatra, that since the time of the Silurian, he has made a long succession of vile Molluscous animals."[42] Darwin's conception of a universe of fixed forces determining all events and even human behavior

40. Charles Darwin, *Notebook M* (MS p. 154), in *Charles Darwin's Notebooks*, 559.

41. Darwin, *Autobiography*, 87. Darwin remembered his Paley imperfectly; the divine also thought the Creator worked through natural laws.

42. Darwin, *Notebook M* (MS pp. 36–37), 343.

seems to have been a significant condition for the rise of the disenchanted modern world. And if one relied on the way both colleagues and enemies characterized his theory, this impression would be correct. This supposition, though, is mitigated both by his assumption concerning the ultimate cause of law itself and by his conception of the operations of the principal law of organic life, natural selection.

As the passage just quoted suggests, Darwin assumed a view of natural law quite common in the early nineteenth century, namely, that law by its very nature required a mind to formulate it and provide the power to enforce it. William Paley, in his *Natural Theology*, expressed this general view: "A law presupposes an agent, for it is only the mode according to which an agent proceeds; it implies a power, for it is the order according to which that power acts. Without this agent, without this power, which are both distinct from itself, the 'law' does nothing; is nothing."[43]

William Whewell (fig. 2.4), whose *History of the Inductive Sciences* Darwin read shortly after his return from the *Beagle* voyage, made a comparable assumption, which for him meant that natural law could be assigned the creative activity in nature; it could act as a surrogate for God. Whewell put it this way in his *Bridgewater Treatise*, in a passage Darwin used as an epigram for the *Origin of Species*: "But with respect to the material world, we can at least go so far as this—we can perceive that events are brought about not by insulated interpositions of Divine power, exerted in each particular case, but by the establishment of general law."[44]

Like Whewell, Darwin believed that the creative power of nature, and thus the explanatory power, lay in natural law. In the manuscript of the *Origin of Species*, Darwin simply defined nature as "the laws ordained by God to govern the Universe."[45] And as he put it to Asa Gray (fig. 2.5), his supporter in America: "I am inclined to look at everything as resulting from designed laws, with the details whether good or bad, left to the working out of what we may call chance."[46] This was no sop to Gray, an adept botanist and even more adroit clergyman. As Darwin confessed in his *Autobiography*, when he wrote the *Origin*, he believed in "a First Cause having an intelligent mind in some degree

43. William Paley, *Natural Theology* (London: Faulder, 1809), 416.

44. William Whewell, *Astronomy and General Physics Considered with Reference to Natural Theology* (Bridgewater Treatise) (Philadelphia: Carey, Lea and Blanchard, 1833), 267.

45. Charles Darwin, *Charles Darwin's Natural Selection, being the Second Part of His Big Species Book Written from 1856 to 1858*, ed. R. C. Stauffer (Cambridge: Cambridge University Press, 1975), 224.

46. Darwin to Asa Gray (22 May 1860), in *The Correspondence of Charles Darwin*, ed. Frederick Burkhardt et al., 19 vols. to date (Cambridge: Cambridge University Press, 1985–), 8:224.

FIGURE 2.4 William Whewell (1794–1866). Lithograph. (© National Portrait Gallery)

analogous to that of man."[47] There seems no good reason to doubt that Darwin was sincere when he contended that God created through secondary causes; it had been his conviction from the first period of his theorizing. His former teacher John Henslow, in a public forum, defended Darwin precisely as imputing to the Creator the ultimate power in the operations of natural law. Henslow

47. Darwin, *Autobiography*, 92–93.

FIGURE 2.5 Asa Gray (1810–1888). Photo.
(Courtesy of South Caroliniana Library)

described this defense in a letter to Joseph Hooker, also a close friend of Darwin's; he said that he had refused "to allow that he [Darwin] was guided by any but truthful motives, and [declared] that he himself believed he was exalting & not debasing our views of a Creator, in attributing to him a power of imposing laws on the Organic World by which to do his work."[48] What Darwin rejected during the period of the composition of his theory was not the notion that

48. John Henslow to Joseph Hooker (10 May 1860), in *Correspondence of Charles Darwin*, 8:200.

God had designed the world for man but that this design should be the handiwork of a tinkering Deity, a God who acted like an English joiner, cobbling the structure of nature ad hoc. Following Whewell, he maintained that the world had to be understood as the product of creative law.[49]

By the time he wrote Gray in spring of 1860, however, Darwin had begun to waiver in his conviction that natural law required an independent designing mind to provide its force. And by the end of the 1860s, he seems to have abandoned altogether the idea that God was a necessary foundation for his theory. What he never abandoned, however, was the ascription to natural selection itself of those properties of discrimination, power, and moral concern previously conferred on it by divine agency. These properties allowed the law of natural selection to lead to the end Darwin foresaw as the goal of the evolutionary process, an outcome that Whewell thought impossible in natural science and rather a conclusion that could be drawn only from theology, namely, the creation of man as a moral creature.

NATURAL SELECTION AS AN INTELLIGENT AND MORAL FORCE

At the end of October 1838, at the time he considered the "great final cause" of sexual generation—namely, the production of higher animals with their moral traits—Darwin opened his *Notebook N*, in which he began to compose an account of the moral sentiments. He worked out the kernel of his conception, which would later flower in the *Descent of Man*, in a fanciful example. He imagined the case of a dog with incipient moral instincts:

> Dog obeying instincts of running hare is stopped by fleas, also by greater temptation as bitch. . . . Now if dogs mind were so framed that he constantly compared his impressions, & wished he had done so & so for his interest, & found he disobeyed a wish which was part of his system, & constant, for a wish which was only short & might otherwise have been relieved, he would be sorry or have troubled conscience—therefore I say grant reason to any animal with social & sexual instincts «& yet with passions» he must have conscience—this is capital view.—Dogs conscience would not have been same with mans because original instinct different.[50]

49. See John Brooke's masterful discussion "'Laws Impressed on Matter by the Creator'? The *Origin* and the Question of Religion," in *Cambridge Companion to the "Origin of Species,"* ed. Michael Ruse and Robert J. Richards (Cambridge: Cambridge University Press, 2009), 256–74.

50. Charles Darwin, *Notebook N* (MS pp. 1–3), in *Charles Darwin's Notebooks*, 563–64.

Darwin believed that the moral instincts were essentially persistent social instincts that might continue to urge cooperative action even after being interrupted by a more powerful, self-directed impulse. As he suggested to himself at this time: "May not moral sense arise from our enlarged capacity ‹acting› «yet being obscurely guided» or strong instinctive sexual, parental & social instincts give rise 'do unto others as yourself,' 'love thy neighbour as thyself.' Analyse this out."[51] He would indeed continue to analyze out his theory, for at this point in its development he did not see how other-directed, social instincts, which gave no benefit to their carrier, could be produced by selection. This difficulty seems to have led him to retain the device of inherited habit to explain the origin of the social instincts. Thus in late spring 1839, he formulated what he called the "law of utility"—derived from Paley—which supposed that social utility would lead the whole species to adopt certain habits that, through dint of exercise, would become instinctive: "On Law of Utility Nothing but that which has beneficial tendency through many ages would be acquired [i.e., necessary social habits]. . . . It is probable that becomes instinctive which is repeated under many generations."[52] While Darwin never gave up the idea that habits could become inherited, he would solve the problem of the natural selection of social instincts only in the final throes of composing the *Origin*.

Darwin thus looked upon moral impulses as acquired during the course of animal development—not directly implanted in a soul by God. Such moral capacity developed along with more complex brain matter, much in the way the power of gravity became palpable with the increase of mass and as a force intrinsic to it. If mental processes, moral ability, were assigned to matter, would this, however, not be atheism, and thus justify the utter rejection that had already met Lamarck's theory? Darwin didn't think so. As he considered the subject, he bound his kind of materialism into an ennobling teleological framework: "This Materialism does not tend to Atheism. Inutility of so high a mind without further end just same argument. Without indeed we are step towards some final end.—production of higher animals—perhaps, say attribute of such *higher* animals may be looking back. Therefore consciousness, therefore reward in good life."[53]

Darwin here contended that his view of brain-mind did not lead to atheism because the sort of material that produced mind had the final purpose of

51. Darwin, *Notebook M* (MS p. 150), 558.
52. Charles Darwin, *Old and Useless Notes* (MS pp. 50–51), in *Charles Darwin's Notebooks*, 623.
53. Ibid., (MS p. 37), 614.

generating the higher animals, that is, organisms with consciousness, moral standing, and thus the capacity for leading a good life with its (eternal?) reward. As he would put it a few years later, in his essays of 1842 and 1844, this transmutational process led to "the most exalted end which we are capable of conceiving, namely the creation of the higher animals."[54] That, of course, was also the trajectory he specified in the last paragraph of the *Origin of Species.* From the beginning of his career to the publication of the *Origin*, the teleological goal of nature, as his theory construed it, was the production of human beings with their moral sentiments.

At the very end of October 1838, Darwin gave an analytic summary of his developing theory, a neat set of virtually axiomatic principles:

> Three principles, will account for all
> (1) Grandchildren. like grandfathers
> (2) Tendency to small change . . .
> (3) Great fertility in proportion to support of parents.[55]

These factors may be interpreted as follows: traits of organisms are heritable (with occasional reversions); traits vary slightly from generation to generation; and reproduction outstrips food resources (the Malthusian factor). These principles seem very much like those "necessary and sufficient" axioms advanced by contemporary evolutionary theorists: variation, heritability, and differential survival.[56] Such analytic reduction appears to render evolution by natural selection a quite simple concept, as Huxley supposed. These bare principles, however, do not identify a causal force that might scrutinize the traits of organisms to pick out just those that could provide an advantage and thus be preserved. Darwin would soon construct that force as both a moral and an intelligent agent, and the structure of that conception would sink deeply into the language of the *Origin*.

In 1842, Darwin roughly sketched the outlines of his theory, and two years later he enlarged the essay to compose a more complete and systematic version. In the first section of both essays, as in the first chapter of the *Origin*, he discussed artificial selection. He suggested that variations in traits of plants and animals were the result of the effects of the environment, both directly,

54. Darwin, "Essay of 1844," 254. This line, of course, occurs with slight alteration both in the essay of 1842 and in the *Origin of Species.*

55. Darwin, *Notebook E* (MS p. 58), 412–13.

56. See, for example, Richard Lewontin, "Adaptation," *Scientific American* 239 (1978): 212–28.

on features of the malleable body of young progeny, and also indirectly, by the environment's effect on the sexual organs of the parents.[57] Typically a breeder would examine variations in plant or animal offspring; if any captured his fancy, he would breed only from those suitable varieties and prevent backcrosses to the general stock. Backcrosses, of course, would overwhelm or swamp out any advantages that the selected organisms might possess.

In the next section of the essays, Darwin inquired whether variation and selection could be found in nature. Variations in the wild, he thought, would occur much as they did in domestic stocks. But the crucial, two-pronged issue was this: "Is there any means of selecting those offspring which vary in the same manner, crossing them and keeping their offspring separate and thus producing selected races [?]"[58] The first of these problems may be called the problem of *selection*; the second, keeping the selected organisms separate, the problem of *swamping out.* In beginning to engage with these difficulties (and more to come), Darwin proposed to himself a certain model against which he would construct his device of natural selection. This model would control his language and the concepts deployed in the *Origin*. In the 1844 essay, he described the model this way:

> Let us now suppose a Being with penetration sufficient to perceive the differences in the outer and innermost organization quite imperceptible to man, and with forethought extending over future centuries to watch with unerring care and select for any object the offspring of an organism produced under the foregoing circumstances; I can see no conceivable reason why he could not form a new race (or several were he to separate the stock of the original organism and work on several islands) adapted to new ends. As we assume his discrimination, and his forethought, and his steadiness of object, to be incomparably greater than those qualities in man, so we may suppose the beauty and complications of the adaptations of the new races and their differences from the original stock to be greater than in the domestic races produced by man's agency.[59]

The model Darwin had chosen to explain to himself the process of selection in nature was that of a powerfully intelligent being, one that had foresight and

57. Darwin, "Essay of 1842," 1–2.
58. Ibid., 5.
59. Darwin, "Essay of 1844," 85.

selected animals to produce beautiful and intricate structures. This prescient being made choices that were "infinitely wise compared to those of man."[60] As a wise breeder, this being would prevent backcrosses of his flocks. Nature, in the guise of this being, was thus conceived not as a machine but as a supremely intelligent force. In the succeeding sections of the essays of 1842 and 1844, Darwin began specifying the analogs for the model, that is, those features of nature that operated in a fashion comparable to the imaginary being. He stipulated, for instance, that variations in nature would be slight and intermittent due to the actions of a slowly changing environment. But, looking to his model, he supposed that nature would compensate for very slowly appearing minute variations by acting in a way "far more rigid and scrutinizing" than man could execute.[61] He then brought to bear the Malthusian idea of geometrical increase of offspring, and the consequent struggle for existence that would cull all but those having the most beneficial traits.

Many difficulties in the theory of natural selection were yet unsolved in the essays. Darwin had not really dealt with the problem of swamping. Nor had he succeeded in working out how nature might select social, or altruistic, instincts, the ultimate goal of evolution. As he considered the operations of natural selection, it seemed improbable that it could produce organs of great perfection, such as the vertebrate eye. His strategy for solving this last problem, however, seemed ready to hand—namely, to find a graduation of structures in various different species that would illustrate how organs such as the eye might have evolved over long periods of time. Moreover, if natural selection had virtually preternatural discernment, it could operate on exquisitely small variations to produce something as intricate as an eye.

DARWIN'S *BIG SPECIES BOOK*: COMMUNITY SELECTION AND THE MORALITY OF NATURE

In September 1854, Darwin wrote in his pocket diary, "Began sorting notes for Species theory." His friends had urged him not to delay in publishing his theory, lest someone else beat him to the goal. On 14 May 1856, he recorded: "Began by Lyell's advice writing species sketch."[62] By the following fall, the sketch had grown far beyond his initial intention. His expanding composition was to be called *Natural Selection*, though in his notes he referred to it

60. Darwin, "Essay of 1842," 21.

61. Ibid., 9.

62. Charles Darwin, personal journal, MS 34, DAR 158.1–76, Department of Manuscripts, Cambridge University Library.

affectionately as "my Big Species Book." And big it would have been: his efforts would have yielded a very large work, perhaps extending to two or three fat volumes. The writing was interrupted, however, when Lyell's prophesy of someone forestalling him came true. In mid-June 1858, Darwin received the famous letter from Alfred Russel Wallace (1823–1913), then in Malaya, in which that naturalist included an essay that could have been purloined from Darwin's own notebooks. After reassurances from friends that honor did not require him to toss his manuscript into the flames, Darwin compressed that part of the composition already completed and quickly wrote out the remaining chapters of what became the *Origin of Species*.

At the beginning of March 1858, a few months before he received Wallace's letter, Darwin had finished a chapter in his manuscript titled "Mental Powers and Instincts of Animals." In that chapter he solved a problem about which he had been worrying for almost a decade. In his study of the social insects—especially ants and bees—he recognized that the workers formed different castes with peculiar anatomies and instincts. Yet the workers were sterile, and so natural selection could not act on the individuals to preserve in their offspring any useful habits—they had no offspring. How then had these features of the social insects evolved? In a loose note, dated June 1848, in which he sketched out the problem, he remarked, "I must get up this subject—it is the greatest special difficulty I have met with."[63]

Although Darwin had identified the problem many years before, it was only in the actual writing of the *Big Species Book* that he arrived at a solution. He took his cue from William Youatt's *Cattle: Their Breeds, Management, and Disease*.[64] When breeders wished to produce a herd with desirable characteristics, they chose animals from several different family groups and slaughtered them. If one or another had, say, desired marbling, they would breed from the family of the animal with that characteristic. In the *Big Species Book*, Darwin rendered the discovery this way: "This principle of selection, namely not of the individual which cannot breed, but of the family which produced such individual, has I believe been followed by nature in regard to the neuters amongst social insects; the selected characters being attached exclusively not only to one sex, which is a circumstance of the commonest occurrences, but to a peculiar & sterile state of one sex."[65]

63. Charles Darwin, loose note, DAR 76.1–4, Department of Manuscripts, Cambridge University Library.

64. William Youatt, *Cattle: Their Breeds, Management, and Disease* (London: Library of Useful Knowledge, 1834).

65. Darwin, *Big Species Book*, 370.

Darwin thus came to understand that natural selection operated not only on individuals but also on whole families, hives, or tribes. This insight and the expansion of his theory of natural selection would have three important dividends: first, he could overcome a potentially fatal objection to his theory; second, he could exclude a Lamarckian explanation of the wonderful instincts of the social insects—since no acquired habits could be passed to offspring; and finally, his theory of family selection (or community selection as he came to call it) would enable him to solve the like problem in human evolution, namely, the origin of the altruistic instincts. In the *Descent of Man*, Darwin would mobilize the model of the social insects precisely to construct a theory of human moral behavior that contained a core of pure, unselfish altruism—that is, acts that benefited others at cost to self, something that could not occur under individual selection.[66] Hence, the final goal of evolution, as he originally conceived its telic trajectory, could be realized: the production of the higher animals with their moral sentiments. Yet not only did Darwin construe natural selection as producing moral creatures; he conceived of natural selection itself as a moral and intelligent agent.

The model of an intelligent and moral selector, which Darwin cultivated in his earlier essays, makes an appearance in the *Big Species Book*. In the chapter "On Natural Selection," he contrasted man's selection with nature's. The human selector did not allow "each being to struggle for life"; he rather protected animals "from all enemies." Further, man judged animals only on surface characteristics and often picked countervailing traits. He also allowed crosses that reduced the power of selection. And finally, man acted selfishly, choosing only the property that "pleases or is useful to him." Nature acted quite differently: "She cares not for mere external appearances; she may be said to scrutinize with a severe eye, every nerve, vessel & muscle; every habit, instinct, shade of constitution,—the whole machinery of the organization. There will be here no caprice, no favouring: the good will be preserved & the bad rigidly destroyed."[67]

Nature thus acted steadily, justly, and with divine discernment, separating the good from the bad. Nature, in this conception, was God's surrogate, which Darwin signaled by penciling in his manuscript above the quoted passage: "By nature, I mean the laws ordained by God to govern the Universe." As Darwin pared away the overgrowth of the *Big Species Book*, the intelligent and moral

66. See chapter 3 in the current volume.
67. Darwin, *Big Species Book*, 224.

character of natural selection stood out even more boldly in the précis, that is, in the *Origin of Species*.

NATURAL AND MORAL SELECTION IN THE *ORIGIN OF SPECIES*

In the first edition of the *Origin*, Darwin approached natural selection from two distinct perspectives, conveyed in two chapters whose titles suggest the distinction: "Struggle for Existence" and "Natural Selection" (chaps. 3 and 4). Although their considerations overlap, the first focuses on the details of the operations of selection and the second contains the more highly personified reconceptualization of its activities. In chapter 3, Darwin proposed that small variations in organisms would give some an advantage in the struggle for life. He then defined natural selection: "Owing to this struggle for life, any variation, however slight and from whatever cause proceeding, if it be in any degree profitable to an individual of any species, . . . will tend to the preservation of that individual, and will generally be inherited by its offspring. The offspring, also, will thus have a better chance of surviving. . . . I have called this principle, by which each slight variation, if useful, is preserved by the term Natural Selection."[68]

Darwin explained what he meant by "struggle" a bit later in the chapter, and I discuss that in a moment. Here, I note several revealing features of his definition. First, selection is supposed to operate on all variations, even those produced by the inheritance of acquired characters and not just those that arise accidentally from the environment acting on the sex organs of parents. Second, Darwin believed that virtually all traits, useful or not, would be heritable—what he called the "strong principle of inheritance." Third, although the initial part of the definition indicates it is the individual that is preserved, in the second part it is the slight variation that is preserved—which latter is the meaning of the phrase "natural selection."[69] The passage draws out "the chicken and egg" problem for Darwin: a trait gives an individual an advantage in its struggle, so that the individual is preserved; the individual, in turn, preserves the trait by passing it on to offspring. Finally, the definition looks to the future, when useful traits will be sifted out and the nonuseful extinguished, along with their carriers. In the short run, individuals are preserved; in the long run, it is their

68. Darwin, *Origin of Species*, 61.
69. Ibid., 5, 61, 81.

morphologies that are both perpetuated and slowly changed as the result of continued selection.

"We behold," Darwin observed (using a recurring metaphor), "the face of nature bright with gladness"; we do not, however, see the struggle that occurs beneath her beaming countenance. But what does "struggle" mean, and who are the antagonists in a struggle for existence? Darwin said he meant "struggle" in a "large and metaphorical sense," which, as he spun out his meandering notion, covered three or four distinct meanings.[70] First, an animal preyed upon will struggle with its aggressor. But as well, two canine animals will "struggle with one another to get food and live." Furthermore, struggle can be used to characterize a plant at the edge of the desert: it struggles "for life against the drought." In addition, one can say that plants struggle with other plants of the same and different species for their seeds to occupy fertile ground. These different kinds of struggle, in Darwin's estimation, can be aligned according to a sliding scale of severity. Accordingly, the struggle will move from most to least intense: between individuals of the same variety of a species; between individuals of different varieties of the same species; between individuals of different species of the same genus; between species members of quite different types; and finally, between individuals and climate. These various and divergent meanings of struggle seem to have come from the two different sources for Darwin's concept: Candolle, who proclaimed that all of nature was at war, and Malthus, who emphasized the population consequences of dearth. Today, we would say that struggle—granted its metaphorical sense—properly occurs only between members of the same species in their efforts to leave progeny. Adopting Candolle's emphasis on the warlike aspects of struggle may have led Darwin to distinguish natural selection from sexual selection, the latter of which concerns not a death struggle for existence but a struggle by males for mating opportunities.[71]

In the chapter "Natural Selection" in the *Origin*, Darwin reintroduced the notion of that powerful intelligence from his essays and the *Big Species Book*, even rendering it with a biblical inflexion:

> Man can act only on external and visible characters: nature cares nothing for appearances, except in so far as they may be useful to any being. She can act on every internal organ, on every shade of constitutional difference, on the whole machinery of life. Man selects only for his own good;

70. Ibid., 62, 62–63.
71. Ibid., 88–90.

> Nature only for that of the being which she tends. . . . Can we wonder, then, that nature's productions should be far "truer" in character than man's productions; that they should be infinitely better adapted to the most complex conditions of life, and should plainly bear the stamp of far higher workmanship? It may be said that natural selection is daily and hourly scrutinizing, throughout the world, every variation, even the slightest; rejecting that which is bad, preserving and adding up all that is good; silently and insensibly working whenever and wherever opportunity offers, at the improvement of each organic being.[72]

The biblical coloring of Darwin's text is condign for a nature that is the divine surrogate and that acts only altruistically for the welfare of creatures, unlike man who acts only for himself. That benevolence extended to every organism, since natural selection worked for "the improvement of each organic being." In the penultimate paragraph of the *Origin*, Darwin again affirmed the moral concern that natural selection evinced: "And as natural selection works solely by and for the good of each being, all corporeal and mental endowments will tend to progress towards perfection." These are not slips of the pen, since he made the same assertion several times throughout the book.[73] But, of course, from our perspective, natural selection does not work for the good of each being. It eliminates most beings; it destroys them. I believe Darwin's conception of a benevolent mind operating in nature had such deep roots in his theory that it overcame what appears to be, at least for us, an obvious consequence of the actions of natural selection—death and extirpation of creatures. In those brief moments when the patent logic of the situation did hit him, he found ways to assuage the consequences: "When we reflect on this struggle, we may console ourselves with the full belief, that the war of nature is not incessant, that no fear is felt, that death is generally prompt, and that the vigorous, the healthy, and the happy survive and multiply."[74]

Even here, Darwin suppressed what he had otherwise maintained, that natural selection is "daily and hourly scrutinizing throughout the world every variation." Natural selection did act constantly; the war of nature was incessant.[75] But Darwin's model of moral agency mitigated the force of Malthusian pitilessness and the implications of his own device.

72. Ibid., 83–84.
73. Ibid., 489. In addition to the passages mentioned, see also 83, 149, 194, and 201.
74. Ibid., 78.
75. Ibid., 84.

CONCLUSION

I have argued that Darwin did not come to his conception of natural selection in a flash that yielded a fully formed theory. What appears as the intuitive clarity of his device is, I believe, deceptive. I have tried to show that his notions about the parameters of natural selection, what it operates on and its mode of operation, gradually took shape in his mind and hardly came to final form even with the publication of the first edition of the *Origin of Species*. In outlining this gradual evolution of a concept—actually a set of concepts—I have emphasized the way Darwin characterized selection as a moral and intelligent agent. Most contemporary scholars have described Darwinian nature as mechanical, quite amoral in its ruthlessness. To be sure, when Wallace and others pointed out what seemed the misleading implications of the device, Darwin protested that, of course, he did not mean to argue that natural selection was actually an intelligent or moral agent. And by the time of his exchange with Wallace on the subject (1866), he had abandoned any assumption of Divine superintendence.[76] But even Darwin recognized, if dimly, that his original formulation of the device and the cognitively laden language of his writing carried certain consequences with which he did not wish to dispense—and, indeed, could not do so without altering his deeper conception of the character and goal of evolution. Darwin's language and metaphorical mode of thought gave his theory a meaning resistant to any mechanistic interpretation and unyielding even to his later, more cautious reflections.

My analysis depends on recognizing the way teleological conceptions molded Darwin's theory. The discriminating reader may find two conceptions of teleology afoot in Darwin's notebooks and essays, as well as in the *Origin*: one that the modern biologist might tolerate, the other that only the nineteenth-century biologist—at least in Britain—might find satisfactory. The first would be compatible with Aristotle's conception of teleology: granted that human beings now exist, what were the necessary antecedent steps that made their evolution possible? In this consideration, the end—human beings with their various features—would illuminate for the biologist just those determining earlier stages that gave rise to such creatures and, in that sense, would

76. Wallace chided him for the term "natural selection" since it suggested "an intelligent chooser was necessary." See Alfred Russel Wallace to Darwin (2 July 1866), in *Correspondence of Charles Darwin*, 14:228. Darwin had already begun to back away from the apparently intentional character of natural selection in the third edition (1861) of the *Origin*, where he corrected the misapprehension that natural selection expressed "an active power of Deity." See Charles Darwin, *The Origin of Species: A Variorum Text*, ed. Morris Peckham (Philadelphia: University of Pennsylvania Press, 1959), 165.

be a condition for understanding the process (Aristotle's original meaning of cause). The second kind of teleology, however, is usually the one that most scholars think Darwin rejected, namely, that processes in nature unfolded according to a plan. Yet the language of "designed laws," which Darwin explicitly invoked, indicates that the second meaning of teleology was also operative in the construction of his theory. Moreover, the moral solicitude with which natural selection acted and its inevitable progressivist consequences—these must lead, at least they did so for Darwin, to the most exalted object we were capable of conceiving, namely, the production of the highest animals, human beings with their moral instincts.

The theory of evolution by natural selection, embodied in the language and text of the *Origin of Species*, gives no succor to those scholars who would make Darwin's theory theologically and morally neutral. Elliott Sober, for instance, argues that Darwin practiced a kind of methodological naturalism of the sort appropriate for a good scientist today. Sober certainly recognizes Darwin's assertions that natural law stemmed from the Divine mind; he does not, however, appreciate the consequences of that view, which render nature morally saturated and directed to a definite goal. Sober attempts to exculpate Darwin's theory of supernatural taint by claiming that the English master's explanatory appeal to God as a first cause was an "argument for the existence of God," which was a *philosophical* use of his scientific theory; the notion of God as primary cause didn't penetrate or shape the science itself.[77] Now this analysis might save Darwin's conception for contemporary delectation, but it certainly misconstrues the theory as presented in the *Origin*. Darwin was not, pace Sober, demonstrating God's existence; he was assuming it and drawing on the traditional conceptions of God's benevolence and design for nature. Sober has imposed a contemporary construction to obscure the language of Darwin's text and its underlying logic.

Let me spell out some of the more specific consequences of my analysis to make clear how markedly Darwin's original notion of evolution by natural selection differs from what is usually attributed to him. Natural selection, in Darwin's view, moved very slowly and gradually, operating at a stately Lyellian pace (perhaps seizing on useful variations that might occur only after thousands of generations).[78] It compensated for meager variability by daily and hourly scrutinizing every individual, for even the slightest and most obscure variation, to

77. Elliott Sober, "Darwin and Naturalism," in Sober, *Did Darwin Write the Origin Backwards? Philosophical Essays on Darwin's Theory* (Amherst, NY: Prometheus Books, 2011), 121–52, quotation at 128.

78. Darwin, *Origin of Species*, 80, 82.

select just those that gave the organism an advantage.[79] A nineteenth-century machine could not be calibrated to operate on such small variations or on features that might escape human notice. If natural selection clanked along like a Manchester spinning loom, one would not have fine damask—only a skillful and intelligent hand could spin that—or the fabric of the eye.

Second, Darwin frequently remarked in the *Origin* that selection operated more efficiently on species with a large number of individuals in an extensive, open area—what today we call *sympatric speciation*.[80] He presumed that, as in the case of the human breeder, a large number of individual animals or plants would produce more favorable variations upon which selection might act. He had in mind the successful artificial breeders, who kept large flocks, as opposed to the less successful, who had only small stocks from which to breed. Yet in the wild, this scenario for selection could only occur if the watchful eye of an intelligent selector somehow gathered the favored varieties together and isolated them so as to prevent backcrosses into the rest of the stock. When Fleeming Jenkin, in his review of the *Origin*, pointed out the problem of swamping of single variations, Darwin suggested in the fifth edition of the *Origin* that groups of individuals would all vary in the same way due to the impact of the local environment.[81] Thus when the implications of his model of intelligent nature were recognized, Darwin had to invoke as analogue a Lamarckian scenario. Today, we assume that small breeding groups isolated by physical barriers would more likely furnish the requisite conditions for natural selection, thus *allopatric speciation*.

Third, a wise selector that has the good of creatures at heart would produce a progressive evolution, one that created ever more improved organization, which Darwin certainly thought to be the case. He believed that more recent creatures had accumulated progressive traits and would triumph over more ancient creatures regardless of the environments in which they might compete.[82] He summed up his view in the last section of the *Origin*: "And as natu-

79. This is one way of reading what seem contradictory statements in the *Origin*: on the one hand, variations occur only occasionally and at great intervals; on the other, that variations are constant and selection is ways adding them up. In chapter 3, I will suggest that these different conceptions about variations in nature and the pace of selection are an index of the long period over which Darwin constructed the argument of the *Origin*—a period during which he altered his view about the source of variations and about the operations of natural selection. Darwin himself inattentively included these different and warring conceptions in his book.

80. Darwin, *Origin of Species*, 41, 70, 102, 105, 125, 177, 179.

81. Darwin, *Origin: Variorum Text*, 179.

82. Darwin, *Origin of Species*, 336–37.

ral selection works solely by and for the good of each being, all corporeal and mental endowments will tend to progress towards perfection."[83]

Fourth, such an intelligent agent would not merely select for each creature's good but also for that of the community. Darwin, in the fifth and sixth editions of the *Origin*, extended his model of family selection to one that operated simply on a community: "In social animals it [natural selection] will adapt the structure of each individual for the benefit of the community; if this in consequence profits by the selected change."[84]

Finally, the intelligent and moral character of natural selection would produce the goal that Darwin had sighted early in his notebooks, namely, the production of the higher animals with their moral sentiments. Darwin thus concluded his volume with the Miltonic and salvific vision that he harbored from his earliest days: "Thus, from the war of nature, from famine and death, the most exalted object which we are capable of conceiving, namely, the production of the higher animals, directly follows."[85] Darwin's vision of the process of natural selection was anything but mechanical and brutal. Nature, while it may have sacrificed a multitude of its creatures, did so for the higher "object," or purpose, of creating those beings having a moral spine—out of death came life more abundant. We humans, Darwin believed, were the goal of evolution by natural selection. There was indeed "grandeur in this view of life."

APPENDIX 1. THE LOGIC OF DARWIN'S LONG ARGUMENT

Scholars commonly distinguish two separate conceptions that fly under the rubric "Darwin's theory": common descent of species with modification and natural selection as the causal means by which descent occurs. Ernst Mayr, one of the architects of the modern synthesis, thought that the master himself misled his readers by referring to both of these "very different and independent theories" under the simple designation of "my theory."[86] More recently Elliott Sober also contends that Darwin advanced two logically separate theories in the *Origin of Species*. He maintains that Darwin argued for natural selection in the first part of the book, perhaps for pedagogical reasons, and for common descent only in the later parts of the book. He thus wrote the *Origin*

83. Ibid., 489.
84. Darwin, *Origin: Variorum Text*, 172.
85. Darwin, *Origin of Species*, 490.
86. Ernst Mayr, *One Long Argument: Charles Darwin and the Genesis of Modern Evolutionary Theory* (Cambridge: Harvard University Press, 1991), 36.

backwards.[87] This paradoxical claim depends on the further assertion that the epistemic logic of the relationship entails that common descent ought to be established first and evidence for its causal structure be given only thereafter. Mayr, Sober, and other scholars have failed to take Darwin's own observation about his accomplishment seriously, namely, that his "whole volume is one long argument."[88]

I will focus on Sober's analysis since he makes articulately evident what others have simply assumed; he shows what is at stake in maintaining the logical independence of the conceptions of common ancestry and of natural selection. His argument has two parts, one quasi-empirical, about the actual structure of Darwin's book, and one logical, about the implicative relationships governing that structure. He maintains that Darwin "front-loads his discussion of natural selection and lets his full argument for common ancestry emerge only later and in somewhat fragmented form"; he suggests those arguments for the genealogical descent of species come principally in chapter 13, which deals with classification, morphology, embryology, and rudimentary organs.[89] Darwin intended to show, according to Sober, how these various approaches revealed similarities among species, thus providing evidence for common descent. Sober's assertion about the general structure of Darwin's book—that he delayed discussion of common descent to the last part of his treatise—is, on the surface, implausible, as a brief overview of the chapters makes clear.

Chapter 1, "Variation under Domestication," discusses the descent of various races of domestic animals from common ancestral forms. Chapter 2, "Variation in Nature," argues that there is no real difference between varieties and species and that patterns of their relationship, as described by naturalists, provide evidence of species descent from a common ancestor. The second part of chapter 4, "Natural Selection," details Darwin's principle of divergence, which explains the kind of branching characteristic of phylogenetic descent. Chapter 5, "Laws of Variation," specifies evidence of similar variability to argue for common descent. Chapter 6, "Difficulties on the Theory," sketches the wonderfully imaginative possibilities of common descent: whales from bears and birds from flying fish. Chapter 7, "Instinct," argues for the likely descent of the honey bee from something like the Mexican *Melipona*, and they from something like the humble bee. Chapters 9 and 10 on the geological record are, of course, all about common descent from evidence of the fossil record. Chap-

87. Sober, *Did Darwin Write the Origin Backwards?* chap. 1.
88. Darwin, *Origin of Species*, 459.
89. Sober, *Did Darwin Write the Origin Backwards?* 33.

ters 11 and 12 explore biogeographical relationships—particularly how it can occur that species of a common genus can be found at significant geographical distances from each other, though they "must originally have proceeded from the same source, as they have descended from the same progenitor."[90] Arguments about descent with modification thus occupy three of the first four chapters of Darwin's book and can be found throughout virtually every chapter thereafter. Moreover, natural selection runs in tandem with arguments for common ancestry through most of the chapters of the book. Darwin structured his chapters this way for good, logical reasons. An examination of the first three chapters of the *Origin* will bring into relief the logical connections he established between common descent and his device of natural selection.

Chapter 1 of the *Origin* deals with what we call "artificial selection." Darwin believed that once his readers understood the process by which breeders actually produced domestic stocks, he would have a persuasive analogy for selection in nature. Lamarck had used the breeder's selection as a model for his theory of the descent of species. Lyell countered that artificial selection could not act as a model for species descent, since savages originally had chosen as domestic animals those that were morphologically malleable—thus we should not expect to find such animals in nature.[91] Darwin attempted to nullify Lyell's argument in two ways. He first pointed out that savages could not have known antecedently which animals would prove to be more plastic. But this was not a powerful argument, and Darwin knew it. What was powerful was his demonstration that the weird and wonderful array of fancy pigeons—fantails, pouters, nuns, tumblers, and the many others—had a common descent from the ordinary rock pigeon, *Columba livia*. Most breeders had assumed that the various breeds of pigeon had been found originally in nature. If that were so, then artificial selection, as Darwin newly conceived it, could not be shown to be an effective device for transforming organisms, and thus it could not serve as a model for natural selection. So Darwin had to demonstrate common descent from the rock pigeon in order to show the power of artificial selection and to set the grounds for natural selection.

Darwin himself had become a pigeon fancier, raising pigeons by the score in his backyard.[92] He had several arguments for the common descent of fancy pigeons, but the most powerful were his experiments in cross-breeding of varieties to reveal in the offspring strong coloring traits of the rock pigeon. These

90. Darwin, *Origin of Species*, 351.
91. Lyell, *Principles of Geology*, 2:26.
92. I discuss Darwin's pigeon-breeding activities in more detail in chapter 3.

experiments made the case for the effectiveness of the breeder's selection and ultimately of nature's selection. Darwin, however, had another task in this first chapter: he also had to show what artificial selection amounted to so that he might argue persuasively for common descent from the rock pigeon. Exactly what the breeder was doing in producing domestic stocks was little understood when Darwin wrote; his chapter helped clarify the process by which breeders selected variations that happened to occur and cross-bred those animals bearing the favored traits.

From variation in domestication, Darwin turned in chapter 2 to variation in nature. He deployed the term "variation" in different, though related senses: it referred, first, to the way offspring would vary from their parents and from each other, and, second, to the way groups of individuals would vary within a species—that is, would form varieties. And Darwin extended his analysis to the way species would constitute varying forms of a genus, and genera of a family, right up the taxonomic categories. He wanted to demonstrate that these various conceptions of variety carried an implication important for his theory: by the term "variety . . . community of descent is almost universally implied."[93] He devoted the first half of the chapter to showing that no qualitative distinction, only degrees of similarity, distinguished individual differences from varieties, and varieties from species—certainly some experts, he pointed out, would describe as a species what others would describe as a variety. He concluded that "these differences blend into each other in an insensible series; and a series impresses the mind with the idea of an actual passage"—that is, a passage of common descent.[94]

The second part of chapter 2 provides statistical evidence for the kind of descent relations referred to in the first part. Darwin scrutinized some twelve large flora books to discover patterns of descent.[95] He determined that of the possible patterns, his theory predicted the one that was the most prominent, namely, that in large genera (i.e., genera with a large number of species) the species were also large (i.e., had a large number of varieties), supporting the thesis that current species derived from past varieties. Had his statistical analysis shown, say, that large genera had small species (i.e., each with a small number of varieties), his hypothesis would not have been confirmed. Darwin drew a complementary kind of evidence for descent, when he argued on the basis of analogy: "species of large genera present a strong analogy with varieties.

93. Darwin, *Origin of Species,* 44.
94. Ibid., 51.
95. See chapter 3 of this volume for the elaboration of Darwin's statistical arguments.

And we can clearly understand these analogies if species have once existed as varieties, and have thus originated: whereas, these analogies are utterly inexplicable if each species has been independently created."[96] These were ingenious arguments for common descent from patterns of species relationships. But regardless of the validity of his conclusions, it is quite obvious that the second chapter of the *Origin* was devoted to arguments for common ancestry. Sober's belief that Darwin reserved arguments for genealogical descent only to the later chapters of his book simply cannot stand.

Chapter 3 of the *Origin*, "Struggle for Existence," shows what must be the consequence of the kind of variation demonstrated in chapter 2: because of great fecundity of organisms, there must be a struggle for existence among the different creatures within a variety, of different varieties within a species, of different species within a genus, and so on. Thus, without variation in nature, comparable to what the domestic breeder found within his stocks, natural selection could not operate. So the theory of natural selection required, logically required, a demonstration of the kinds of variety and of their relationships that Darwin evinced in chapter 2.

Sober argues that Darwin began the exposition of his theory concentrating on natural selection, giving it causal priority and saving the arguments for descent from a common ancestor until the latter part of his book. If he were writing the *Origin* in an epistemically logical fashion, he would have given, Sober maintains, common descent evidentiary priority—that is, he would have put it at the beginning of his book. I have tried to demonstrate in this appendix that common descent is argued for in the first several chapters of the *Orign*, where it is logically intertwined with the conception of natural selection. Let me close with a crucial logical point.

Sober and other scholars depict Darwin as deploying the kind of abstract considerations that might regard common descent and natural selection as logically distinct: "Darwin's case for common ancestry," Sober declares, "does not depend at all on natural selection's causing evolution."[97] Perhaps this makes sense for a contemporary philosopher of biology. (But even this, I doubt: for if there is a rational or epistemically proper order, the theories of descent and natural selection cannot be logically separate.) In dealing with the historical Darwin, however, we must look at the logic he actually deployed—and therein lies a difference.

96. Darwin, *Origin of Species*, 59.
97. Sober, *Did Darwin Write the Origin Backwards?* 44.

Darwin assumed that his readers would be quite aware of the Linnaean systematic arrangements, as well as those of other systematists; all such schemes were based on affinities or resemblances among the groupings. Darwin did indeed discuss such similarities in chapter 13 of the *Origin* (as well as in many other chapters). But these similarities could not be taken in logical isolation as evidence for common ancestry—and indeed, were not so taken by professional naturalists before Darwin. In every category that Darwin mentioned in chapter 13, the similarities had been noted by many naturalists, and that recognition did not lead them to posit descent from common ancestors, rather to reveal a common plan of the Creator. Similarities could be taken as evidence for common descent only after the introduction of an effective causal device that might explain transitions from one species to another. After Darwin made the case for his causal device, then resemblance, which all zoologists had recognized, could be turned into evidence for common descent—when a natural principle could render resemblance into a process of nature instead of a plan devised by the Creator. Lamarck tried it, but his device seemed ineffective and the range of the evidence insufficient. Darwin, like Lamarck, started with artificial selection, but showed, as his predecessor had not, what was really involved in domestic breeding—how the breeder selected out certain variations, mated their carriers, and continued that process until a different morphological type was produced. He then argued in reverse, as it were: from the cross-breeding of established varieties of fancy pigeons to their common ancestor in the rock pigeon. In the first chapter of the *Origin*, Darwin thus provided mutually implicative arguments for common ancestry and for an effective model of what occurs in nature. This general pattern of argument followed in the rest of the chapters. And that is why both descent and natural selection ran hand in hand throughout the *Origin*—each logically dependent on the other. Darwin had constructed one long, epistemically structured argument.

APPENDIX 2. THE HISTORICAL ONTOLOGY AND LOCATION OF SCIENTIFIC THEORIES

The question of the location of Darwin's theory may seem anomalous. Yet, we take for granted that his theory exists and that, therefore, it has an ontology, and thus presumably some kind of location. The question of where it exists is not, then, outré, especially if we allow some latitude as to what counts as a possible place. Karl Popper had an answer to the question; he claimed scientific theories existed in a third, quasi-Platonic world, which he distinguished from

two other worlds. He conceived the geography in this way: "first, the world of physical objects or of physical states; secondly, the world of states of consciousness, or of mental states, or perhaps of behavioural dispositions to act; and thirdly, the world of *objective contents of thought*, especially of scientific and poetic thoughts and of works of art."[98]

Scientific theories exist, according to Popper, in the same way and in the same abstract manner as Euclid's Pythagorean Theorem. It is what we think about when we think about the Pythagorean Theorem. When Euclid demonstrated that the sum of the areas of squares drawn on the legs of a right triangle was equal to the area of the square drawn on the hypotenuse, he was not proving this of a triangle sketched in the sand or one imagined by himself—strictly speaking, these would fail to be right triangles; he demonstrated the properties of The Right Triangle, the objective triangle of which we might discover yet further attributes. As I suggested in chapter 1, this view of theories, without further qualification, could easily lead to the presumption that a theory like Darwin's might have instantiations in 1859 and today while remaining essentially the same abstract structure, with the further consequence that we might easily read our current notions about evolution back into Darwin's original theory. I believe we are faced with this outcome often in the large literature describing Darwin's accomplishment, bereft as it often is of what it means to be an early nineteenth-century thinker.

We cannot exorcise Plato's ghost completely, however. We would not wish to identify Darwin's theory simply with ink smudges on the paper sitting in John Murray's warehouse or on the paper that holds the reproduction of those smudges in the Harvard University Press paperback. Darwin's theory has a logic and set of implications that transcend ink on paper. Nor does it quite do to presume that the theory existed as a collection of ideas in Darwin's head. Darwin no longer exists, but his theory surely does exist for us; moreover, the theory, at least as most historians would regard it, has depths that might have escaped even Darwin's explicit awareness at any particular time. For example, in his *Autobiography*, Darwin claimed that in the 1830s and early 1840s, he never explicitly formulated a theory but simply collected facts in a wholesale manner. But we see from his notebooks that the phrase "according to my theory" lies scattered through their pages. When he wrote the *Autobiography*, he knew that a good scientist worked in a Baconian manner, collecting facts

98. Karl Popper, "Epistemology without a Knowing Subject," in Popper, *Objective Knowledge: An Evolutionary Approach* (Oxford: Oxford University Press, 1972), 106.

before using them to construct a theory.[99] That presumption falsified his own memory of his achievement.

My analysis in this chapter supposes that the book *Origin of Species* expresses Darwin's theory, points to it, and that the theory as so expressed is the culmination of a development that began at least as far back as the *Beagle* voyage; this developing theory, I believe, has depths not entirely transparent even to Darwin himself. This relative opacity led him later to reject Wallace's suggestion that he drop the phrase "natural selection" and replace it with Spencer's "survival of the fittest."[100] Darwin agreed with Wallace that "survival of the fittest" seemed adequately to perform the function of "natural selection," yet, he demurred. He thought his original expression captured something necessary to his theory, something beyond the substitute suggested by Wallace, though he could not exactly say what that something was. I have urged that the missing features, not quite obvious even to Darwin himself in the mid-1860s, were the intentional and teleological structures that originally came to invest the theory during its early development. Popper was right in this respect: scientific theories have features not simply identified with words on a page. Yet, in Darwin's case, the theory and its logic were generated by the words he jotted in his notebooks and essays, and, of course, by the ideas in his head. That logical structure so generated became a permanent part of Darwin's theory, at least as it existed in 1859, but the theory did continue to evolve through the mid-1860s.

Darwin's theory has an existence comparable to that of a species. We don't identify a species with this or that individual organism or even with the entire group of species members existing at any one time. We don't make this nominalist identification since we typically include as members of the species individuals that no long exist and those that will shortly come to exist. But, of course, there is a further reason for not identifying species with its members. Certain individuals reproductively related to others may not exhibit all of the traits identified with the species—that is, we may attribute features to the species not exactly realized in some of its members; for example, bipedalism may be characteristic of the human species, though there will be members who are, for a number of causes, without lower limbs. Moreover, and this is the primary reason for not identifying a species with its members, species evolve but individuals do not. Evolution is a trait of species but not of individuals or collections of individuals. In this latter respect, we might compare theories

99. Darwin, *Autobiography*, 119.
100. Alfred Russel Wallace to Darwin (2 July 1866).

with species: theories also evolve, though neither the words on a page nor even the individual ideas in the mind of the theorist evolve. I believe we want to say something such as the following: theories have an abstract existence, though generated by individual acts of a theorist and intimately tied to those particular acts.

If theories have this abstract but temporally anchored existence, they transcend the individual instantiations that gave them rise, and this accounts for their public and objective character. They are not simply individual creatures of the theorist's brain. But if they have a public existence, how exactly are they apprehended by the public, that is, by the consumers of theory, including historians? I believe this understanding occurs through a grasp of the words, in their contemporaneous meanings, instantiating the theory. So, when the historian tries to come to terms—literally, come to terms—with, say, Darwin's theory, he or she will construe the meaning of the words Darwin used in the way a mid-nineteenth-century individual of considerable education would. But even beyond that, the exacting historian will take into account the local environment of Darwin's theorizing to determine any inflections of meaning that his particular usage would suggest.

A theory has a transcendent existence, though one continuously generated by the acts of the scientist. Yet because a theory escapes the private realm through the public meaning of words, it has an abstract and objective character, and that character may have features not completely transparent to even its originator. A well-developed scientific theory is like a well-wrought urn: it has a public existence and manifests aesthetic and logical features perhaps unanticipated by the craftsman. Hence it is possible for the historian to say of a theorist like Darwin that he did not fully appreciate his own theory, especially when reflecting back on it at a subsequent time.

A theory with the kind of existence I am suggesting never strays far from the acts that brought it into existence, so it is always located temporally in conjunction with those acts. Yet it continues to evolve, at the hands of both its creator and others who take it up. As it undergoes evolution, much like a species, it is impossible to be precise about exactly when it comes into existence and when it passes into another theory—when Darwinian theory becomes, for example, "neo-Darwinian theory," to use George Romanes's locution, or "ultra-Darwinian theory," to use another of Romanes's formulations.[101] Just so, it is

101. Romanes coined both "neo-Darwinian" and "ultra-Darwinian." See George Romanes, *Darwin and after Darwin*, 4th ed., 3 vols. (Chicago: Open Court, 1916), 2:7, 232. By both designations he principally meant Friedrich Weismann's theory, which precluded Lamarckian devices.

something of an arbitrary decision to mark the temporal joint where therapsids, the mammal-like reptiles, became mammals.

While my analysis here descends into the hazards of metaphysics, most historians remain wary of these vertiginous deeps. Careful historians nonetheless make implicit assumptions that bring them close to the very edge of such considerations.