BY STEPHEN JAY GOULD IN
NORTON PAPERBACK

EVER SINCE DARWIN
Reflections in Natural History

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Ever Since Darwin

Reflections in Natural History

Stephen Jay Gould

W · W · NORTON & COMPANY · NEW YORK · LONDON

1 Darwiniana

1 | Darwin's Delay

FEW EVENTS INSPIRE more speculation than long and unexplained pauses in the activities of famous people. Rossini crowned a brilliant operatic career with *William Tell* and then wrote almost nothing for the next thirty-five years. Dorothy Sayers abandoned Lord Peter Wimsey at the height of his popularity and turned instead to God. Charles Darwin developed a radical theory of evolution in 1838 and published it twenty-one years later only because A. R. Wallace was about to scoop him.

Five years with nature aboard the *Beagle* destroyed Darwin's faith in the fixity of species. In July, 1837, shortly after the voyage, he started his first notebook on "transmutation." Already convinced that evolution had occurred, Darwin sought a theory to explain its mechanism. After much preliminary speculation and a few unsuccessful hypotheses, he achieved his central insight while reading an apparently unrelated work for recreation. Darwin later wrote in his autobiography:

> In October 1838 . . . 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 favorable variations would tend to be preserved and unfavorable ones to be destroyed. The result of this would be the formation of new species.

Darwin had long appreciated the importance of artificial selection practiced by animal breeders. But until Malthus's vision of struggle and crowding catalyzed his thoughts, he had not been able to identify an agent for natural selection. If all creatures produced far more offspring than could possibly survive, then natural selection would direct evolution under the simple assumption that survivors, on the average, are better adapted to prevailing conditions of life.

Darwin knew what he had achieved. We cannot attribute his delay to any lack of appreciation for the magnitude of his accomplishment. In 1842 and again in 1844 he wrote out preliminary sketches of his theory and its implications. He also left strict instructions with his wife to publish these alone of his manuscripts if he should die before writing his major work.

Why then did he wait for more than twenty years to publish his theory? True, the pace of our lives today has accelerated so rapidly—leaving among its victims the art of conversation and the game of baseball—that we may mistake a normal period of the past for a large slice of eternity. But the span of a man's life is a constant measuring stick; twenty years is still half a normal career—a large chunk of life even by the most deliberate Victorian standards.

Conventional scientific biography is a remarkably misleading source of information about great thinkers. It tends to depict them as simple, rational machines pursuing their insights with steadfast devotion, under the drive of an internal mechanism subject to no influence but the constraints of objective data. Thus, Darwin waited twenty years—so the usual argument runs—simply because he had not completed his work. He was satisfied with his theory, but theory is cheap. He was determined not to publish until he had amassed an overwhelming dossier of data in its support, and this took time.

But Darwin's activities during the twenty years in question display the inadequacy of this traditional view. In particular, he devoted eight full years to writing four large volumes on the taxonomy and natural history of barnacles. Before this single fact, the traditionalists can only offer pap—something like: Darwin felt that he had to understand species thoroughly before proclaiming how they change; this he could do only by working out for himself the classification of a difficult group of organisms—but not for eight years, and not while he sat on the most revolutionary notion in the history of biology. Darwin's own assessment of the four volumes stands in his autobiography.

> Besides discovering several new and remarkable forms, I made out the homologies of the various parts . . . and I proved the existence in certain genera of minute males complemental to and parasitic on the hermaphrodites. . . . Nevertheless, I doubt whether the work was worth the consumption of so much time.

So complex an issue as the motivation for Darwin's delay has no simple resolution, but I feel sure of one thing: the negative effect of fear must have played at least as great a role as the positive need for additional documentation. Of what, then, was Darwin afraid?

When Darwin achieved his Malthusian insight, he was twenty-nine years old. He held no professional position, but he had acquired the admiration of his colleagues for his astute work aboard the *Beagle*. He was not about to compromise a promising career by promulgating a heresy that he could not prove.

What then was his heresy? A belief in evolution itself is the obvious answer. Yet this cannot be a major part of the solution; for, contrary to popular belief, evolution was a very common heresy during the first half of the nineteenth century. It was widely and openly discussed, opposed, to be sure, by a large majority, but admitted or at least considered by most of the great naturalists.

An extraordinary pair of Darwin's early notebooks may contain the answer (see H. E. Gruber and P. H. Barrett, *Darwin on Man*, for text and extensive commentary). These so-called M and N notebooks were written in 1838 and 1839, while Darwin was compiling the transmutation notebooks that formed the basis for his sketches of 1842 and 1844. They contain his thoughts on philosophy, esthetics, psychology,

and anthropology. On rereading them in 1856, Darwin described them as "full of metaphysics on morals." They include many statements showing that he espoused but feared to expose something he perceived as far more heretical than evolution itself: philosophical materialism—the postulate that matter is the stuff of all existence and that all mental and spiritual phenomena are its by-products. No notion could be more upsetting to the deepest traditions of Western thought than the statement that mind—however complex and powerful—is simply a product of brain. Consider, for example, John Milton's vision of mind as separate from and superior to the body that it inhabits for a time (*Il Penseroso*, 1633).

> Or let my lamp, at midnight hour,
> Be seen in some high lonely tower,
> Where I may oft outwatch the Bear,
> With thrice-great Hermes,[1] or unsphere
> The spirit of Plato, to unfold
> What worlds or what vast regions hold
> The immortal mind that hath forsook
> Her mansion in this fleshly nook.

The notebooks prove that Darwin was interested in philosophy and aware of its implications. He knew that the primary feature distinguishing his theory from all other evolutionary doctrines was its uncompromising philosophical materialism. Other evolutionists spoke of vital forces, directed history, organic striving, and the essential irreducibility of mind—a panoply of concepts that traditional Christianity could accept in compromise, for they permitted a Christian God to work by evolution instead of creation. Darwin spoke only of random variation and natural selection.

1 | "The Bear" refers to the constellation of Ursa major (the Great Bear), better known to us by its tail and hindquarters—the big dipper. "Thrice great Hermes" is Hermes Trismegistus (a Greek name for Thoth, Egyptian god of wisdom). The "hermetic books," supposedly authored by Thoth, are a collection of metaphysical and magical works that exerted great influence in seventeenth century England. They were equated by some with the Old Testament as a parallel source of pre-Christian wisdom. They waned in importance when exposed as a product of Alexandrian Greece, but survive in various doctrines of the Rosicrucians, and in our phrase "hermetic seal."

In the notebooks Darwin resolutely applied his materialistic theory of evolution to all phenomena of life, including what he termed "the citadel itself"—the human mind. And if mind has no real existence beyond the brain, can God be anything more than an illusion invented by an illusion? In one of his transmutation notebooks, he wrote:

> Love of the deity effect of organization, oh you materialist! . . . Why is thought being a secretion of brain, more wonderful than gravity a property of matter? It is our arrogance, our admiration of ourselves.

This belief was so heretical that Darwin even sidestepped it in *The Origin of Species* (1859), where he ventured only the cryptic comment that "light will be thrown on the origin of man and his history." He gave vent to his beliefs, only when he could hide them no longer, in the *Descent of Man* (1871) and *The Expression of the Emotions in Man and Animals* (1872). A. R. Wallace, the codiscoverer of natural selection, could never bring himself to apply it to the human mind, which he viewed as the only divine contribution to the history of life. Yet Darwin cut through 2,000 years of philosophy and religion in the most remarkable epigram of the M notebook:

> Plato says in *Phaedo* that our "imaginary ideas" arise from the preexistence of the soul, are not derivable from experience—read monkeys for preexistence.

In his commentary on the M and N notebooks, Gruber labels materialism as "at that time more outrageous than evolution." He documents the persecution of materialistic beliefs during the late eighteenth and early nineteenth century and concludes:

> In virtually every branch of knowledge, repressive methods were used: lectures were proscribed, publication was hampered, professorships were denied, fierce invective and ridicule appeared in the press. Scholars and scien-

tists learned the lesson and responded to the pressures on them. The ones with unpopular ideas sometimes recanted, published anonymously, presented their ideas in weakened forms, or delayed publication for many years.

Darwin had experienced a direct example as an undergraduate at the University of Edinburgh in 1827. His friend W. A. Browne read a paper with a materialistic perspective on life and mind before the Plinian Society. After much debate, all references to Browne's paper, including the record (from the previous meeting) of his intention to deliver it, were expunged from the minutes. Darwin learned his lesson, for he wrote in the M notebook:

> To avoid stating how far, I believe, in Materialism, say only that emotions, instincts, degrees of talent, which are hereditary are so because brain of child resembles parent stock.

The most ardent materialists of the nineteenth century, Marx and Engels, were quick to recognize what Darwin had accomplished and to exploit its radical content. In 1869, Marx wrote to Engels about Darwin's *Origin:*

> Although it is developed in the crude English style, this is the book which contains the basis in natural history for our view.

A common bit of folklore—that Marx offered to dedicate volume 2 of *Das Kapital* to Darwin (and that Darwin refused)—turns out to be false. But Marx and Darwin did correspond, and Marx held Darwin in very high regard. (I have seen Darwin's copy of *Das Kapital* in his library at Down House. It is inscribed by Marx who calls himself a "sincere admirer" of Darwin. Its pages are uncut. Darwin was no devotee of the German language.)

Darwin was, indeed, a gentle revolutionary. Not only did he delay his work for so long, but he also assiduously avoided any public statement about the philosophical implications of his theory. In 1880, he wrote:

> It seems to me (rightly or wrongly) that direct arguments against Christianity and Theism hardly have any effect

> on the public; and that freedom of thought will best be promoted by that gradual enlightening of human understanding which follows the progress of science. I have therefore always avoided writing about religion and have confined myself to science.

Yet the content of his work was so disruptive to traditional Western thought that we have yet to encompass it all. Arthur Koestler's campaign against Darwin, for example, rests upon a reluctance to accept Darwin's materialism and an ardent desire once again to invest living matter with some special property (see *The Ghost in the Machine* or *The Case of the Midwife Toad*). This, I confess, I do not understand. Wonder and knowledge are both to be cherished. Shall we appreciate any less the beauty of nature because its harmony is unplanned? And shall the potential of mind cease to inspire our awe and fear because several billion neurons reside in our skulls?

2 Darwin's Sea Change, or Five Years at the Captain's Table

GROUCHO MARX ALWAYS delighted audiences with such outrageously obvious questions as "Who's buried in Grant's tomb?" But the apparently obvious can often be deceptive. If I remember correctly, the answer to who framed the Monroe Doctrine? is John Quincy Adams. Most biologists would answer "Charles Darwin" when asked, "Who was the naturalist aboard the H.M.S. *Beagle*?" And they would all be wrong. Let me not sound too shocking at the outset. Darwin was on the *Beagle* and he did devote his attention to natural history. But he was brought on board for another purpose, and the ship's surgeon, Robert McKormick, originally held the official position of naturalist. Herein lies a tale; not just a nit-picking footnote to academic history, but a discovery of some significance. Anthropologist J. W. Gruber reported the evidence in "Who Was the *Beagle*'s Naturalist?" written in 1969 for the *British Journal for the History of Science.* In 1975, historian of science H. L. Burstyn attempted to answer the obvious corollary: If Darwin wasn't the *Beagle*'s naturalist, why was he on board?

No document specifically identifies McKormick as an official naturalist, but the circumstantial evidence is overwhelming. The British navy, at the time, had a well-established tradition of surgeon-naturalists, and McKormick had deliberately educated himself for such a role. He was an adequate, if not brilliant, naturalist and performed his tasks with distinction on other voyages, including Ross's Antarctic expedition (1839–1843) to locate the position of the South Magnetic Pole. Moreover, Gruber has found a letter from the Edinburgh naturalist Robert Jameson addressed to "My dear Sir" and full of advice to the *Beagle*'s naturalist on collection and preservation of specimens. In the traditional view, no one but Darwin himself could have been the recipient. Fortunately, the name of the addressee is on the original folio. It was written to McKormick.

Darwin, to cut the suspense, sailed on the *Beagle* as a companion to Captain Fitzroy. But why would a British captain want to take as a companion for a five-year journey a man he had only met the previous month? Two features of naval voyages during the 1830s must have set Fitzroy's decision. First of all, voyages lasted for many years, with long stretches between ports and very limited contact by mail with friends and family at home. Secondly (and however strange it may seem to our psychologically more enlightened century), British naval tradition dictated that a captain have virtually no social contact with anyone down the chain of command. He usually dined alone and met with his officers primarily to discuss ship's business and to converse in the most formal and "correct" manner.

Now Fitzroy, when he set sail with Darwin, was only 26 years old. He knew the psychological toll that prolonged lack of human contact could take from captains. The *Beagle*'s previous skipper had broken down and shot himself to death during the Southern Hemisphere winter of 1828, his third year away from home. Moreover, as Darwin himself affirmed in a letter to his sister, Fitzroy was worried about "his hereditary predisposition" to mental derangement. His illustrious uncle, the Viscount Castlereagh (suppressor of the Irish rebellion of 1798 and Foreign Secretary during the defeat of Napoleon), had slit his own throat in 1822. In fact, Fitzroy did break down and temporarily relinquish his command during the *Beagle*'s voyage—while Darwin was laid up with illness in Valparaiso.

Since Fitzroy had so little social contact with any of the ship's official personnel, he could gain it only by taking along a "supernumerary" passenger by his own arrangement. But

the Admiralty frowned upon private passengers, even captains' wives; a gentleman companion brought for no other stated purpose would never do. Fitzroy had taken other supernumeraries aboard—a draftsman and an instrument-maker among others—but neither could serve as a companion because they were not of the right social class. Fitzroy was an aristocrat, and he traced his ancestry directly to King Charles II. Only a gentleman could share his meals, and a gentleman Darwin surely was.

But how could Fitzroy entice a gentleman to accompany him on a voyage of five years' duration? Only by providing an opportunity for some justifying activity that could not be pursued elsewhere. And what else but natural history?—even though the *Beagle* had an official naturalist. Hence, Fitzroy advertised among his aristocratic friends for a gentleman naturalist. It was, as Burstyn argues, "A polite fiction to explain his guest's presence and an activity attractive enough to lure a gentleman on board for a long voyage." Darwin's sponsor, J. S. Henslow, understood perfectly. He wrote to Darwin: "Capt. F. wants a man (I understand) more as a companion than a mere collector." Darwin and Fitzroy met, they hit it off, and the pact was sealed. Darwin sailed as Fitzroy's companion, primarily to share his table at mealtime for every shipboard dinner during five long years. Fitzroy, in addition, was an ambitious young man. He wished to make his mark by setting a new standard for excellence in exploratory voyages. ("The object of the expedition," Darwin wrote, "was to complete the survey of Patagonia and Tierra del Fuego . . . to survey the shores of Chile, Peru, and of some islands in the Pacific—and to carry a chain of chronometrical measurements round the world.") By augmenting the official crew with technicians and engineers brought at his own expense, Fitzroy used his wealth and prestige to reach his goal. A "supernumerary" naturalist meshed well with Fitzroy's scheme to beef up the *Beagle*'s scientific mettle.

Poor McKormick's fate was sealed. Initially, he and Darwin cooperated, but their ways inevitably parted. Darwin had all the advantages. He had the captain's ear. He had a servant. At ports of call, he had the money to move ashore and hire

native collectors, while McKormick was bound to the ship and his official duties. Darwin's private efforts began to outstrip McKormick's official collections, and McKormick, in disgust, decided to go home. In April 1832, at Rio de Janeiro, he was "invalided out" and sent home to England aboard H.M.S. *Tyne*. Darwin understood the euphemism and wrote to his sister of McKormick's "being invalided, i.e. being disagreeable to the Captain. . . . He is no loss."

Darwin did not care for McKormick's brand of science. He wrote to Henslow in May 1832: "He was a philosopher of rather antient [*sic*] date; at St. Jago by his own account he made general remarks during the first fortnight and collected particular facts during the last." In fact, Darwin didn't seem to care for McKormick at all. "My friend the doctor is an ass, but we jog on very amicably; at present he is in great tribulation, whether his cabin shall be painted french gray or dead white—I hear little except this subject from him."

If nothing else, this story illustrates the importance of social class as a consideration in the history of science. How different would the science of biology be today if Darwin had been the offspring of a tradesman and not the son of a very wealthy physician. Darwin's personal riches gave him the freedom to pursue research without encumbrance. Since his various illnesses often permitted only two to three hours of fruitful work per day, any need to make an honest living would probably have shut him off from research entirely. We now learn that Darwin's social standing also played a crucial role at a turning point in his career. Fitzroy was more interested in his mealtime companion's social graces than his competence in natural history.

Might something deeper be hidden in the unrecorded mealtime conversations of Darwin and Fitzroy? Scientists have a strong bias for attributing creative insights to the constraints of empirical evidence. Hence, tortoises and finches have always received the nod as primary agents in the transformation of Darwin's world view, for he joined the *Beagle* as a naïvely pious student for the ministry, but opened his first notebook on the transmutation of species less than a year after his return. I suggest that Fitzroy himself might

have been an even more important catalyst.

Darwin and Fitzroy maintained a tense relationship at best. Only the severe constraints of gentlemanly cordiality and pre-Victorian suppression of emotion kept the two men on decent terms with each other. Fitzroy was a martinet and an ardent Tory. Darwin was an equally committed Whig. Darwin scrupulously avoided any discussion with Fitzroy of the great Reform Bill then pending in Parliament. But slavery brought them into open conflict. One evening, Fitzroy told Darwin that he had witnessed proof of slavery's benevolence. One of Brazil's largest slaveholders had assembled his captives and asked them whether they wished to be freed. Unanimously, they had responded "no." When Darwin had the temerity to wonder what a response made in the owner's presence was worth, Fitzroy exploded and informed Darwin that anyone who doubted his word was not fit to eat with him. Darwin moved out and joined the mates, but Fitzroy backed down and sent a formal apology a few days later.

We know that Darwin bristled in the face of Fitzroy's strong opinions. But he was Fitzroy's guest and, in one peculiar sense, his subordinate, for a captain at sea was an absolute and unquestioned tyrant in Fitzroy's time. Darwin could not express his dissent. For five long years, one of the most brilliant men in recorded history kept his peace. Late in life, Darwin recalled in his autobiography that "the difficulty of living on good terms with a Captain of a Man-of-War is much increased by its being almost mutinous to answer him as one would answer anyone else; and by the awe in which he is held —or was held in my time, by all on board."

Now Tory politics was not Fitzroy's only ideological passion. The other was religion. Fitzroy had some moments of doubt about the Bible's literal truth, but he tended to view Moses as an accurate historian and geologist and even spent considerable time trying to calculate the dimensions of Noah's Ark. Fitzroy's *idée fixe,* at least in later life, was the "argument from design," the belief that God's benevolence (indeed his very existence) can be inferred from the perfection of organic structure. Darwin, on the other hand, accepted the idea of excellent design but proposed a natural

explanation that could not have been more contrary to Fitzroy's conviction. Darwin developed an evolutionary theory based on chance variation and natural selection imposed by an external environment: a rigidly materialistic (and basically atheistic) version of evolution (see essay 1). Many other evolutionary theories of the nineteenth century were far more congenial to Fitzroy's type of Christianity. Religious leaders, for example, had far less trouble with common proposals for innate perfecting tendencies than with Darwin's uncompromisingly mechanical view.

Was Darwin led to his philosophical outlook partly as a response to Fitzroy's dogmatic insistence upon the argument from design? We have no evidence that Darwin, aboard the *Beagle,* was anything but a good Christian. The doubts and rejection came later. Midway through the voyage, he wrote to a friend: "I often conjecture what will become of me; my wishes certainly would make me a country clergyman." And he even coauthored with Fitzroy an appeal for the support of Pacific missionary work entitled, "The Moral State of Tahiti." But the seeds of doubt must have been sown in quiet hours of contemplation aboard the *Beagle.* And think of Darwin's position on board—dining every day for five years with an authoritarian captain whom he could not rebuke, whose politics and bearing stood against all his beliefs, and whom, basically, he did not like. Who knows what "silent alchemy" might have worked upon Darwin's brain during five years of insistent harangue. Fitzroy may well have been far more important than finches, at least for inspiring the materialistic and antitheistic tone of Darwin's philosophy and evolutionary theory.

Fitzroy, at least, blamed himself as his mind became unhinged in later life. He began to see himself as the unwitting agent of Darwin's heresy (indeed, I am suggesting that this may be true in a more literal sense than Fitzroy ever imagined). He developed a burning desire to expiate his guilt and to reassert the Bible's supremacy. At the famous British Association Meeting of 1860 (where Huxley creamed Bishop "Soapy Sam" Wilberforce), the unbalanced Fitzroy stalked about, holding a Bible above his head and shouting, "The Book, The Book." Five years later, he slit his throat.

3 Darwin's Dilemma: The Odyssey of Evolution

THE EXEGESIS OF evolution as a concept has occupied the lifetimes of a thousand scientists. In this essay, I present something almost laughably narrow in comparison—an exegesis of the word itself. I shall trace how organic change came to be called *evolution.* The tale is complex and fascinating as a purely antiquarian exercise in etymological detection. But more is at stake, for a past usage of this word has contributed to the most common, current misunderstanding among laymen of what scientists mean by evolution.

To begin with a paradox: Darwin, Lamarck, and Haeckel —the greatest nineteenth-century evolutionists of England, France, and Germany, respectively—did not use the word evolution in the original editions of their great works. Darwin spoke of "descent with modification," Lamarck of "transformisme." Haeckel preferred "Transmutations-Theorie" or "Descendenz-Theorie." Why did they not use "evolution" and how did their story of organic change acquire its present name?

Darwin shunned evolution as a description of his theory for two reasons. In his day, first of all, evolution already had a technical meaning in biology. In fact, it described a theory of embryology that could not be reconciled with Darwin's views of organic development.

In 1744, the German biologist Albrecht von Haller had coined the term *evolution* to describe the theory that em-

bryos grew from preformed homunculi enclosed in the egg or sperm (and that, fantastic as it may seem today, all future generations had been created in the ovaries of Eve or testes of Adam, enclosed like Russian dolls, one within the next—a homunculus in each of Eve's ova, a tinier homunculus in each ovum of the homunculus, and so on). This theory of evolution (or preformation) was opposed by the epigeneticists who believed that the complexity of adult shape arose from an originally formless egg (see essay 25 for a fuller account of this debate). Haller chose his term carefully, for the Latin *evolvere* means "to unroll"; indeed, the tiny homunculus unfolded from its originally cramped quarters and simply increased in size during its embryonic development.

Yet Haller's embryological evolution seemed to preclude Darwin's descent with modification. If the entire history of the human race were prepackaged into Eve's ovaries, how could natural selection (or any other force for that matter) alter the preordained course of our sojourn on earth?

Our mystery seems only to deepen. How could Haller's term be transformed into a nearly opposite meaning? This became possible only because Haller's theory was in its death throes by 1859; with its demise, the term that Haller had used became available for other purposes.

"Evolution" as a description of Darwin's "descent with modification" was not borrowed from a previous technical meaning; it was, rather, expropriated from the vernacular. Evolution, in Darwin's day, had become a common English word with a meaning quite different from Haller's technical sense. The *Oxford English Dictionary* traces it to a 1647 poem of H. More: "Evolution of outward forms spread in the world's vast spright [spirit]." But this was "unrolling" in a sense very different from Haller's. It implied "the appearance in orderly succession of a long train of events," and more important, it embodied a *concept of progressive development* —an orderly unfolding from simple to complex. The *O.E.D.* continues, "The process of developing from a rudimentary to a mature or complete state." Thus evolution, in the vernacular, was firmly tied to a concept of progress.

Darwin did use evolve in this vernacular sense—in fact it is the very last word of his book.

> 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.

Darwin chose it for this passage because he wanted to contrast the flux of organic development with the fixity of such physical laws as gravitation. But it was a word he used very rarely indeed, for Darwin explicitly rejected the common equation of what we now call evolution with any notion of progress.

In a famous epigram, Darwin reminded himself never to say "higher" or "lower" in describing the structure of organisms—for if an amoeba is as well adapted to its environment as we are to ours, who is to say that we are higher creatures? Thus Darwin shunned evolution as a description for his descent with modification, both because its technical meaning contrasted with his beliefs and because he was uncomfortable with the notion of inevitable progress inherent in its vernacular meaning.

Evolution entered the English language as a synonym for "descent with modification" through the propaganda of Herbert Spencer, that indefatigable Victorian pundit of nearly everything. Evolution, to Spencer, was the overarching law of all development. And, to a smug Victorian, what principle other than progress could rule the developmental processes of the universe? Thus, Spencer defined the universal law in his *First Principles* of 1862: "Evolution is an integration of matter and concomitant dissipation of motion; during which the matter passes from an indefinite, incoherent homogeneity to a definite coherent heterogeneity."

Two other aspects of Spencer's work contributed to the establishment of evolution in its present meaning: First, in writing his very popular *Principles of Biology* (1864–67), Spencer constantly used "evolution" as a description of organic

change. Second, he did not view progress as an intrinsic capacity of matter, but as a result of "cooperation" between internal and external (environmental) forces. This view fit nicely with most nineteenth-century concepts of organic evolution, for Victorian scientists easily equated organic change with organic progress. Thus evolution was available when many scientists felt a need for a term more succinct than Darwin's descent with modification. And since most evolutionists saw organic change as a process directed toward increasing complexity (that is, to us), their appropriation of Spencer's general term did no violence to his definition.

Ironically, however, the father of evolutionary theory stood almost alone in insisting that organic change led only to increasing adaptation between organisms and their own environment and not to an abstract ideal of progress defined by structural complexity or increasing heterogeneity—never say higher or lower. Had we heeded Darwin's warning, we would have been spared much of the confusion and misunderstanding that exists between scientists and laymen today. For Darwin's view has triumphed among scientists who long ago abandoned the concept of necessary links between evolution and progress as the worst kind of anthropocentric bias. Yet most laymen still equate evolution with progress and define human evolution not simply as change, but as increasing intelligence, increasing height, or some other measure of assumed improvement.

In what may well be the most widespread antievolutionary document of modern times, the Jehovah's Witnesses' pamphlet "Did Man Get Here by Evolution or by Creation?" proclaims: "Evolution, in very simple terms, means that life progressed from one-celled organisms to its highest state, the human being, by means of a series of biological changes taking place over millions of years. . . . Mere change within a basic type of living thing is not to be regarded as evolution."

This fallacious equation of organic evolution with progress continues to have unfortunate consequences. Historically, it engendered the abuses of Social Darwinism (which Darwin himself held in such suspicion). This discredited theory

ranked human groups and cultures according to their assumed level of evolutionary attainment, with (not surprisingly) white Europeans at the top and people dwelling in their conquered colonies at the bottom. Today, it remains a primary component of our global arrogance, our belief in dominion over, rather than fellowship with, more than a million other species that inhabit our planet. The moving finger has written, of course, and nothing can be done; yet I am rather sorry that scientists contributed to a fundamental misunderstanding by selecting a vernacular word meaning progress as a name for Darwin's less euphonious but more accurate "descent with modification."

4 | Darwin's Untimely Burial

IN ONE OF THE numerous movie versions of *A Christmas Carol,* Ebenezer Scrooge encounters a dignified gentleman sitting on a landing, as he mounts the steps to visit his dying partner, Jacob Marley, "Are you the doctor?" Scrooge inquires. "No," replies the man, "I'm the undertaker; ours is a very competitive business." The cutthroat world of intellectuals must rank a close second, and few events attract more notice than a proclamation that popular ideas have died. Darwin's theory of natural selection has been a perennial candidate for burial. Tom Bethell held the most recent wake in a piece called "Darwin's Mistake" (*Harper's,* February 1976): "Darwin's theory, I believe, is on the verge of collapse. . . . Natural selection was quietly abandoned, even by his most ardent supporters, some years ago." News to me, and I, although I wear the Darwinian label with some pride, am not among the most ardent defenders of natural selection. I recall Mark Twain's famous response to a premature obituary: "The reports of my death are greatly exaggerated."

Bethell's argument has a curious ring for most practicing scientists. We are always ready to watch a theory fall under the impact of new data, but we do not expect a great and influential theory to collapse from a logical error in its formulation. Virtually every empirical scientist has a touch of the Philistine. Scientists tend to ignore academic philosophy as an empty pursuit. Surely, any intelligent person can think

straight by intuition. Yet Bethell cites no data at all in sealing the coffin of natural selection, only an error in Darwin's reasoning: "Darwin made a mistake sufficiently serious to undermine his theory. And that mistake has only recently been recognized as such. . . . At one point in his argument, Darwin was misled."

Although I will try to refute Bethell, I also deplore the unwillingness of scientists to explore seriously the logical structure of arguments. Much of what passes for evolutionary theory is as vacuous as Bethell claims. Many great theories are held together by chains of dubious metaphor and analogy. Bethell has correctly identified the hogwash surrounding evolutionary theory. But we differ in one fundamental way: for Bethell, Darwinian theory is rotten to the core; I find a pearl of great price at the center.

Natural selection is the central concept of Darwinian theory—the fittest survive and spread their favored traits through populations. Natural selection is defined by Spencer's phrase "survival of the fittest," but what does this famous bit of jargon really mean? Who are the fittest? And how is "fitness" defined? We often read that fitness involves no more than "differential reproductive success"—the production of more surviving offspring than other competing members of the population. Whoa! cries Bethell, as many others have before him. This formulation defines fitness in terms of survival only. The crucial phrase of natural selection means no more than "the survival of those who survive"—a vacuous tautology. (A tautology is a phrase—like "my father is a man"—containing no information in the predicate ("a man") not inherent in the subject ("my father"). Tautologies are fine as definitions, but not as testable scientific statements—there can be nothing to test in a statement true by definition.)

But how could Darwin have made such a monumental, two-bit mistake? Even his severest critics have never accused him of crass stupidity. Obviously, Darwin must have tried to define fitness differently—to find a criterion for fitness independent of mere survival. Darwin did propose an independent criterion, but Bethell argues quite correctly that he relied upon analogy to establish it, a dangerous and slippery

strategy. One might think that the first chapter of such a revolutionary book as *Origin of Species* would deal with cosmic questions and general concerns. It doesn't. It's about pigeons. Darwin devotes most of his first forty pages to "artificial selection" of favored traits by animal breeders. For here an independent criterion surely operates. The pigeon fancier knows what he wants. The fittest are not defined by their survival. They are, rather, allowed to survive because they possess desired traits.

The principle of natural selection depends upon the validity of an analogy with artificial selection. We must be able, like the pigeon fancier, to identify the fittest beforehand, not only by their subsequent survival. But nature is not an animal breeder; no preordained purpose regulates the history of life. In nature, any traits possessed by survivors must be counted as "more evolved"; in artificial selection, "superior" traits are defined before breeding even begins. Later evolutionists, Bethell argues, recognized the failure of Darwin's analogy and redefined "fitness' as mere survival. But they did not realize that they had undermined the logical structure of Darwin's central postulate. Nature provides no independent criterion of fitness; thus, natural selection is tautological.

Bethel then moves to two important corollaries of his major argument. First, if fitness only means survival, then how can natural selection be a "creative" force, as Darwinians insist. Natural selection can only tell us how "a given type of animal became more numerous"; it cannot explain "how one type of animal gradually changed into another." Secondly, why were Darwin and other eminent Victorians so sure that mindless nature could be compared with conscious selection by breeders. Bethell argues that the cultural climate of triumphant industrial capitalism had defined any change as inherently progressive. Mere survival in nature could only be for the good:"It is beginning to look as though what Darwin really discovered was nothing more than the Victorian propensity to believe in progress."

I believe that Darwin was right and that Bethell and his colleagues are mistaken: criteria of fitness independent of survival can be applied to nature and have been used consis-

tently by evolutionists. But let me first admit that Bethell's criticism applies to much of the technical literature in evolutionary theory, especially to the abstract mathematical treatments that consider evolution only as an alteration in numbers, not as a change in quality. These studies do assess fitness only in terms of differential survival. What else can be done with abstract models that trace the relative successes of hypothetical genes A and B in populations that exist only on computer tape? Nature, however, is not limited by the calculations of theoretical geneticists. In nature, A's "superiority" over B will be *expressed* as differential survival, but it is not *defined* by it—or, at least, it better not be so defined, lest Bethell et al. triumph and Darwin surrender.

My defense of Darwin is neither startling, novel, nor profound. I merely assert that Darwin was justified in analogizing natural selection with animal breeding. In artificial selection, a breeder's desire represents a "change of environment" for a population. In this new environment, certain traits are superior a priori; (they survive and spread by our breeder's choice, but this is a *result* of their fitness, not a definition of it). In nature, Darwinian evolution is also a response to changing environments. Now, the key point: certain morphological, physiological, and behavioral traits should be superior a priori as designs for living in new environments. These traits confer fitness by an engineer's criterion of good design, not by the empirical fact of their survival and spread. It got colder before the woolly mammoth evolved its shaggy coat.

Why does this issue agitate evolutionists so much? OK, Darwin was right: superior design in changed environments is an independent criterion of fitness. So what? Did anyone ever seriously propose that the poorly designed shall triumph? Yes, in fact, many did. In Darwin's day, many rival evolutionary theories asserted that the fittest (best designed) must perish. One popular notion—the theory of racial life cycles—was championed by a former inhabitant of the office I now occupy, the great American paleontologist Alpheus Hyatt. Hyatt claimed that evolutionary lineages, like individuals, had cycles of youth, maturity, old age, and death

(extinction). Decline and extinction are programmed into the history of species. As maturity yields to old age, the best-designed individuals die and the hobbled, deformed creatures of phyletic senility take over. Another anti-Darwinian notion, the theory of orthogenesis, held that certain trends, once initiated, could not be halted, even though they must lead to extinction caused by increasingly inferior design. Many nineteenth-century evolutionists (perhaps a majority) held that Irish elks became extinct because they could not halt their evolutionary increase in antler size (see essay 9); thus, they died—caught in trees or bowed (literally) in the mire. Likewise, the demise of saber-toothed "tigers" was often attributed to canine teeth grown so long that the poor cats couldn't open their jaws wide enough to use them.

Thus, it is not true, as Bethell claims, that any traits possessed by survivors must be designated as fitter. "Survival of the fittest" is not a tautology. It is also not the only imaginable or reasonable reading of the evolutionary record. It is testable. It had rivals that failed under the weight of contrary evidence and changing attitudes about the nature of life. It has rivals that may succeed, at least in limiting its scope.

If I am right, how can Bethell claim, "Darwin, I suggest, is in the process of being discarded, but perhaps in deference to the venerable old gentleman, resting comfortably in Westminster Abbey next to Sir Isaac Newton, it is being done as discreetly and gently as possible with a minimum of publicity." I'm afraid I must say that Bethell has not been quite fair in his report of prevailing opinion. He cites the gadflies C. H. Waddington and H. J. Muller as though they epitomized a consensus. He never mentions the leading selectionists of our present generation—E. O. Wilson or D. Janzen, for example. And he quotes the architects of neo-Darwinism—Dobzhansky, Simpson, Mayr, and J. Huxley—only to ridicule their metaphors on the "creativity" of natural selection. (I am not claiming that Darwinism should be cherished because it is still popular; I am enough of a gadfly to believe that uncriticized consensus is a sure sign of impending trouble. I merely report that, for better or for worse, Darwinism is alive and thriving, despite Bethell's obituary.)

But why was natural selection compared to a composer by Dobzhansky; to a poet by Simpson; to a sculptor by Mayr; and to, of all people, Mr. Shakespeare by Julian Huxley? I won't defend the choice of metaphors, but I will uphold the intent, namely, to illustrate the essence of Darwinism—the creativity of natural selection. Natural selection has a place in all anti-Darwinian theories that I know. It is cast in a negative role as an executioner, a headsman for the unfit (while the fit arise by such non-Darwinian mechanisms as the inheritance of acquired characters or direct induction of favorable variation by the environment). The essence of Darwinism lies in its claim that natural selection creates the fit. Variation is ubiquitous and random in direction. It supplies the raw material only. Natural selection directs the course of evolutionary change. It preserves favorable variants and builds fitness gradually. In fact, since artists fashion their creations from the raw material of notes, words, and stone, the metaphors do not strike me as inappropriate. Since Bethell does not accept a criterion of fitness independent of mere survival, he can hardly grant a creative role to natural selection.

According to Bethell, Darwin's concept of natural selection as a creative force can be no more than an illusion encouraged by the social and political climate of his times. In the throes of Victorian optimism in imperial Britain, change seemed to be inherently progressive; why not equate survival in nature with increasing fitness in the nontautological sense of improved design.

I am a strong advocate of the general argument that "truth" as preached by scientists often turns out to be no more than prejudice inspired by prevailing social and political beliefs. I have devoted several essays to this theme because I believe that it helps to "demystify" the practice of science by showing its similarity to all creative human activity. But the truth of a general argument does not validate any specific application, and I maintain that Bethell's application is badly misinformed.

Darwin did two very separate things: he convinced the scientific world that evolution had occurred and he proposed the theory of natural selection as its mechanism. I am quite

willing to admit that the common equation of evolution with progress made Darwin's first claim more palatable to his contemporaries. But Darwin failed in his second quest during his own lifetime. The theory of natural selection did not triumph until the 1940s. Its Victorian unpopularity, in my view, lay primarily in its denial of general progress as inherent in the workings of evolution. Natural selection is a theory of *local* adaptation to changing environments. It proposes no perfecting principles, no guarantee of general improvement; in short, no reason for general approbation in a political climate favoring innate progress in nature.

Darwin's independent criterion of fitness is, indeed, "improved design," but not "improved" in the cosmic sense that contemporary Britain favored. To Darwin, improved meant only "better designed for an immediate, local environment." Local environments change constantly: they get colder or hotter, wetter or drier, more grassy or more forested. Evolution by natural selection is no more than a tracking of these changing environments by differential preservation of organisms better designed to live in them: hair on a mammoth is not progressive in any cosmic sense. Natural selection can produce a trend that tempts us to think of more general progress—increase in brain size does characterize the evolution of group after group of mammals (see essay 23). But big brains have their uses in local environments; they do not mark intrinsic trends to higher states. And Darwin delighted in showing that local adaptation often produced "degeneration" in design—anatomical simplification in parasites, for example.

If natural selection is not a doctrine of progress, then its popularity cannot reflect the politics that Bethell invokes. If the theory of natural selection contains an independent criterion of fitness, then it is not tautological. I maintain, perhaps naïvely, that its current, unabated popularity must have something to do with its success in explaining the admittedly imperfect information we now possess about evolution. I rather suspect that we'll have Charles Darwin to kick around for some time.