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DARWIN'S MIDDLE ROAD*

"We began to sail up the narrow strait lamenting," narrates Odysseus. "For on the one hand lay Scylla, with twelve feet all dangling down; and six necks exceeding long, and on each a hideous head, and therein three rows of teeth set thick and close, full of black death. And on the other mighty Charybdis sucked down the salt sea water. As often as she belched it forth, like a cauldron on a great fire she would seethe up through all her troubled deeps." Odysseus managed to swerve around Charybdis, but Scylla grabbed six of his finest men and devoured them in his sight-"the most pitiful thing mine eyes have seen of all my travail in searching out the paths of the sea."

False lures and dangers often come in pairs in our legends and metaphors—consider the frying pan and the fire, or the devil and the deep blue sea. Prescriptions for avoidance either emphasize a dogged steadiness—the straight and narrow of Christian evangelists—or an averaging between unpleasant alternatives—the golden mean of Aristotle. The idea1 of steering a course between undesirable extremes emerges as a central prescription for a sensible life.

The nature of scientific creativity is both a perennial topic of discussion and a prime candidate for seeking a golden mean. The two extreme positions have not been directly competing for allegiance of the unwary. They have, rather, replaced each other sequentially, with one now in the ascendancy, the other eclipsed.

The first—inductivism—held that great scientists are primarily great observers and patient accumulators of information. For new and significant theory, the inductivists claimed, can only arise from a firm foundation of facts. In this architectural view, each fact is a brick in a structure built without blueprints. Any talk or thought about theory (the completed building) is fatuous and premature before the bricks arc set. Inductivism once commanded great prestige within science, and even represented an "official" position of sorts, for it touted, however falsely, the utter honesty, complete objectivity, and almost automatic nature of scientific progress towards final and incontrovertible truth.

Yet, as its critics so rightly claimed, inductivism also depicted science as a heartless, almost inhuman discipline offering no legitimate place to quirkiness, intuition, and all the other subjective attributes adhering to our vernacular notion of genius. Great scientists, the critics claimed, are distinguished more by their powers of hunch and synthesis, than their skill in experiment or observation. The criticisms of inductivism are certainly valid and I welcome its dethroning during the past thirty years as a necessary prelude to better understanding. Yet, in attacking it so strongly, some critics have tried to substitute an alternative equally extreme and unproductive in its emphasis on the essential subjectivity of creative thought. In this "eureka" view, creativity is an ineffable something, accessible only to persons of genius. It arises like a bolt of lightning, unanticipated, unpredictable and unanalyzable—but the bolts strike only a few special people. We ordinary mortals must stand in awe and thanks. (The name refers, of course, to the legendary story of Archimedes running naked through the streets of Syracuse shouting eureka [I have discovered it] when water displaced by his bathing body washed the scales abruptly from his eyes and suggested a method (or measuring volumes.)

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* From *The Panda's Thumb* (1980).

I am equally disenchanted by both these opposing extremes. Inductivism reduces genius to dull, rote operations; eurekaism grants it an inaccessible status more in the domain of intrinsic mystery than in a realm where we might understand and learn from it. Might we not marry the good features of each view, and abandon both the elitism of eurekaism and the pedestrian qualities of inductivism? May we not acknowledge the personal and subjective character of creativity, but still comprehend it as a mode of thinking that emphasizes or exaggerates capacities sufficiently common to all of us that we may at least understand if not hope to imitate?

In the hagiography of science, a few men hold such high positions that all arguments must apply to them if they are to have any validity. Charles Darwin, as the principal saint of evolutionary biology, has therefore been presented both as an inductivist and as a primary example of eurekaism. I will attempt to show that these interpretations are equally inadequate, and that recent scholarship on Darwin's own odyssey towards the theory of natural selection supports an intermediate position.

So great was the prestige of inductivism in his own day, that Darwin himself fell under its sway and, as an old man, falsely depicted his youthful aecol1lplisluncnts in its light. In an autobiography, written as a lesson in morality for his children and not intended for publication, he penned some famous lines that misled historians for nearly a hundred years. Describing his path to the theory of natural selection, he claimed: "I worked on true Baconian principles, and without any theory collected facts on a wholesale scale."[1]

The inductivist interpretation focuses on Darwin's five years aboard the *Beagle* and explains his transition from a student for the ministry to the nemesis of preachers as the result of his keen powers of observation applied to the whole world. Thus, the traditional story goes, Darwin's eyes opened wider and wider as he saw, in sequence, the bones of giant South American fossil mammals, the turtles and finches of the Galapagos, and the marsupial fauna of Australia. The truth of evolution and its mechanism of natural selection crept up gradually upon him as he sifted facts in a sieve of utter objectivity.

The inadequacies of this tale are best illustrated by the falsity of its conventional premier example—the so-called Darwin's finches of the Galapagos. We now know that although these birds share a recent and common ancestry on the South American mainland, they have radiated into an impressive array of species on the outlying Galapagos. Few terrestrial species manage to cross the wide oceanic barrier between South America and the Galapagos. But the fortunate migrants often find a sparsc1y inhabited world devoid of the competitors that limit their opportunities all the crowded mainland. Hench, the finches evolved into roles normally occupied by other birds and developed their famous set of adaptations for feeding-seed crushing, insect eating, even grasping and manipulating a cactus needle to dislodge insects from plants. Isolation—both of the islands from the mainland and among the islands themselves—provided an opportunity for separation, independent adaptation, and speciation.

According to the traditional view, Darwin discovered these finches, correct]y inferred their history, and wrote the famous lines in his notebook: "If there is the slightest foundation for these remarks the zoology of Archipelagoes will be worth examining; for such facts would undermine the stability of Species." But, as with so many heroic tales from Washington's cherry tree to the piety of Crusaders, hope rather than truth motivates the common reading. Darwin found the finches to be sure. But he didn't recognize them as variants of a common stock. In fact, he didn't even record the island of discovery for many of them—some of his labels just

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1 Francis Bacon (156]-1626), English philosopher, statesman, and essayist, and the first apostle of inductivism.

read "Galapagos Islands." So much for his immediate recognition of the role of isolation in the formation of new species. He reconstructed the evolutionary talc only after his return to London, when a British Museum ornithologist correctly identified all the birds as finches.

The famous quotation from his notebook refers to Galapagos tortoises and to the claim of native inhabitants that they can "at once pronounce from which Island any Tortoise may have been brought" from subtle differences in size and shape of body and scales. This is a statement of different, and much reduced, order from the traditional tale of finches. For the finches are true and separate species—a living example of evolution. The subtle differences among tortoises represent minor geographic variation within a species. It is a jump in reasoning, albeit a valid one as we now know, to argue that such small differences can be amplified to produce a new species. AI] creationists, after all, acknowledged geographic variation (consider human races), but argued that it could not proceed beyond the rigid limits of a created archetype.

I don't wish to downplay the pivotal influence of the *Beagle* voyage on Darwin's career. It gave him space, freedom and endless time to think in his favored mode of independent self-stimulation. (His ambivalence towards university life and his middling performance there by conventional standards, reelected his unhappiness with a curriculum of received wisdom.) He writes from South America in 1834: "I have not one clear idea about cleavage, stratification, lines of upheaval. I have no books, which tell me much and what they do I cannot apply to what I sec. In consequence I draw my own conclusions, and most gloriously ridiculous ones they are." The rocks and plants and animals that he saw did provoke him to the crucial attitude of doubt—midwife of all creativity. Sydney, Australia—1836. Darwin wonders why a rational God would create so many marsupials on Australia since nothing about its climate or geography suggests any superiority for pouches: "I had been lying on a sunny bank and was reflecting on the strange character of the animals of this country as compared to the rest of the World. An unbeliever in everything beyond his own reason might exclaim, "Surely two distinct Creators must have been at work."

Nonetheless, Darwin returned to London without an evolutionary theory. He suspected the truth of evolution, but had no mechanism to explain it. Natural selection did not arise from any direct reading of the *Beagle's* facts, but from two subsequent years of thought and struggle as reflected in a series of remarkable notebooks that have been unearthed and published during the past twenty years. In these notebooks, we see Darwin testing and abandoning a number of theories and pursuing a multitude of false leads—so much For his later claim about recording facts with an empty mind. He read philosophers, poets, and economists, always searching for meaning and insight—so much for the notion that natural selection arose inductively from the *Beagle's* facts. Later, he labeled one notebook as "full of metaphysics on morals."

Yet if this tortuous path belies the Scylla of inductivism, it has engendered an equally simplistic myth—the Charybdis of eurekaism. In his maddeningly misleading autobiography, Darwin does record a eureka and suggests that natural selection struck him as a sudden, serendipitous flash after more than a year of groping frustration:

> In October 1838, that is, fifteen months after I had begun my systematic inquiry, I happened to read for amusement Malthus on Population,[2] and being well prepared to appreciate the struggle for existence which everywhere goes 011 from long-continued observation of the habits of animals and p1ants, it at once struck

[2] Thomas Ma[thus (1766-1834), whose work on population was published under several titles between 1798 and 1817.

> 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. Here, then, I had at last got a theory by which to work.

Yet, again, the notebooks belie Darwin's later recollections-in this case by their utter failure to record, at the time it happened, any special exultation over his Malthusian insight. He inscribes it as a fairly short and sober entry without a single exclamation point, though he habitually used two or three in moments of excitement. He did not drop everything and reinterpret a confusing world in its light. On the very next day, he wrote an even longer passage on the sexual curiosity of primates.

The theory of natural selection arose neither as a workmanlike induction from nature's facts, nor as a mysterious bolt from Darwin's subconscious, triggered by an accidental reading of Malthus. It emerged instead as the result of a conscious and productive search, proceeding in a ramifying but ordered manner, and utilizing both the facts of natural history and an astonishingly broad range of insights from disparate disciplines far from his own. Darwin trod the middle path between inductivism and eurekaism. His genius is neither pedestrian nor inaccessible.

Darwinian scholarship has exploded since the centennial] of the *Origin;*[3] in 1959. The publication of Darwin's notebooks and the attention devoted by several scholars to the two crucial years between the *Beagle's* docking and the demoted Malthusian insight has clinched the argument for a "middle path" theory of Darwin's creativity. Two particularly important works focus on the broadest and narrowest scales. Howard E. Gruber's masterful intellectual and psychological biography of this phase in Darwin's life, *Darwin on Man,* traces all the false leads and turning points in Darwin's search. Gruber shows that Darwin was continually proposing, testing, and abandoning hypotheses, and that he never simply collected facts in a blind way. He began with a fanciful theory involving the idea that new species arise with a prefixed life span, and worked his way gradually, if fitfully, towards an idea of extinction by competition in a world of struggle. He recorded no exultation upon reading Malthus, because the jigsaw puzzle was only missing a piece or two at the time.

Silvan S. Schweber has reconstructed, in detail as minute as the record will allow, Darwin's activities during the few weeks before Malthus (The Origin of the *Origin* Revisited, *Journal* of *the History* of *Biology,* 1977).. He argues that the final pieces arose not from new facts in natural history, but from Darwin's intellectual wanderings in distant fields. In particular, he read a long review of social scientist and philosopher Auguste Comtc's most famous work, the *Cours de philosophie posiiive.* He was particularly struck by Comte's insistence that a proper theory be predictive and at least potentially quantitative. He then turned to Dugald Stewart's *On the Life and Writing* of *Adam Smith*[4]*,* and imbibed the basic belief of the Scottish economists that theories of overall social structure must begin by analyzing the unconstrained actions of individuals. (Natural selection is, above all, a theory about the struggle of individual organisms for success in reproduction.) Then, searching for quantification, he read a lengthy analysis of work by the most famous statistician of his time—the Belgian Adolphe Quetelet. In the review of Quetelet, he found, among other things, a forceful statement of Malthus's quantitative

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[3] *The Origin of Species* (1859).

[4] *Cours de phitosophie positive* (Course in Positivist Philosophy) (1830-42). Dugald Stewart (1753-1828) wrote a brief biography of Adam Smith in 1811, which was frequently included in editions of Smith's *The Wealth of Nations* (1776).

claim—that population would grow geometrically and food supplies only arithmetically, thus guaranteeing an intense struggle for existence. In fact, Darwin had read the Malthusian statement several times before; but only now was he prepared to appreciate its significance. Thus, he did not turn to Malthus by accident, and he already knew what it contained. His "amusement," we must assume, consisted only in a desire to read in its original formulation the familiar statement that had so impressed him in Quetelet's secondary account.

In reading Schweber's detailed account of the moments preceding Darwin's formulation of natural selection, I was particularly struck by the absence of deciding influence from his own field of biology. The immediate precipitators were a social scientist, an economist, and a statistician. If genius has any common denominator, I would propose breadth of interest and the ability to construct fruitful analogies between fields.

In fact, I believe that the theory of natural selection should be viewed as an extended analogy—whether conscious or unconscious on Darwin's part I do not know—to the laissez faire economics of Adam Smith. The essence of Smith's argument is a paradox of sorts: if you want an ordered economy providing maximal benefits to all, then let individuals compete and struggle for their own advantages. The result, after appropriate sorting and elimination of the inefficient, will be a stable and harmonious polity. Apparent order arises naturally from the struggle among individuals, not from predestined principles or higher control. Dugald Stewart epitomized Smith's system in the book Darwin read:

> The most effective plan for advancing a people…is by allowing every man, as long as he observes the rules of justice, to pursue his own interest in his own way, and to bring both his industry and his capital into the freest competition with those of his fellow citizens. Every system of policy which endeavors…to draw towards a particular species of industry a greater share of the capital of the society than would naturally go to it…is, in reality, subversive of the great purpose which it means to promote.

As Schweber states: "The Scottish analysis of society contends that the combined effect of individual actions results in the institutions upon which society is based, and that such a society is a stable and evolving one and functions without a designing and directing mind."

We know that Darwin's uniqueness does not reside in his support for the idea of evolution—scores of scientists had preceded him in this. His special contribution rests upon his documentation and upon the novel character of his theory about how evolution operates. Previous evolutionists had proposed unworkable schemes based on internal perfecting tendencies and inherent directions. Darwin advocated a natural and testable theory based on immediate interaction among individuals (his opponents considered it heartlessly mechanistic). The theory of natural selection is a creative transfer to biology of Adam Smith's basic argument for a rational economy: the balance and order of nature does not arise from a higher, external (divine) control, or from the existence of laws operating directly upon the whole, but from struggle among individuals for their own benefits (in modern terms, for the transmission of their genes to future generations through differential success in reproduction).

Many people are distressed to hear such an argument. Does it not compromise the integrity of science if some of its primary conclusions originate by analogy from contemporary politics and culture rather than from data of the discipline itself? In a famous letter to Engels, Karl Marx identified the similarities between natural selection and the English social scene:

> **It** is remarkable how Darwin recognizes among beasts and plants his English society with its division of labor, competition, opening up of new markets, 'invention,' and the Malthnsian 'struggle for existence.' It is Hobbes' *bellum omnium contra omnes* (the war of all against all).[5]

Yet Marx was a great admirer of Darwin—and in this apparent paradox lies resolution. For reasons involving all the themes I have emphasized here that inductivism is inadequate, that creativity demands breadth, and that analogy is a profound source of insight—great thinkers cannot be divorced from their social background. But the source of an idea is one thing; its truth or fruitfulness is another. The psychology and utility of discovery arc very different subjects indeed. Darwin may have cribbed the idea of natural selection from economics, but it may still be right. As the German socialist Karl Kautsky wrote in 1902: 'The fact that an idea emanates from a particular class, or accords with their interests, of course proves nothing as to its truth or falsity." In this case, it is ironic that Adam Smith's system of laissez faire does not work in his own domain of economics, for it leads to oligopoly and revolution, rather than to order and harmony. Struggle among individuals does, however, seem to be the law of nature.

Many people use such arguments about social context to ascribe great insights primarily to the indefinable phenomenon of good luck. Thus, Darwin was lucky to be born rich, lucky to be on the *Beagle,* lucky to live amidst the ideas of his age, lucky to trip over Parson Malthus—essentially little more than a man in the right place at the right time. Yet, when we read of his personal struggle to understand, the breadth of his concerns and study, and the directedness of his search for a mechanism of evolution, we understand why Pasteur made his famous quip that fortune favors the prepared mind.[6]

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[5] From *Leviathan* (1651), by the English philosopher Thomas Hobbcs.

[6] Louis Pasteur (1822-1895), French chemist and microbiologist.