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The Punctuated Politics of Stephen Jay Gould: Science and Culture in Evolutionary Theory

Michael Shermer

We live in the Age of Science. *Scientism* is our world-view, our mythic story about who we are, where we came from, and where we are going. As such, scientists are our preeminent storytellers, the mythmakers of our epoch. Prominent among them are such cosmologists and evolutionary theorists as Carl Sagan, Stephen Hawking, Edward O. Wilson, and Richard Dawkins, whose books are read by professionals and the public alike, with spectacular advances and (publishers hope) matching sales that reflect the rise of a scientistic literati, where it is now chic to have read (or at least to have on your coffee table) their works.

Stephen Jay Gould has been a highly successful product and producer of this salubrious arrangement between scientists, agents, publishers, and readers. When Gould died on 20 May 2002, it was something of a cultural anomaly in that it was marked by a level of media coverage atypical for scientists. But Gould was no typical scientist. Indeed, in many respects his life was bigger than life. In only six decades he penned twenty-three books, published over five hundred scientific papers, wrote over one hundred book reviews, produced three hundred consecutive *Natural History* essays, and composed countless op-ed pieces and letters to the editor. Along the journey he accumulated copious awards, including a National Book Award for *The Panda's Thumb,* a National Book Critics Circle Award for *The Mismeasure of Man*, and the Phi Beta Kappa Book Award for *Hen's Teeth and Horse's Toes,* while he was a Pulitzer Prize Finalist for *Wonderful Life* (on which Gould commented "close but, as they say, no cigar"). Forty-four honorary degrees and sixty-six major fellowships, medals, and awards bear witness to the depth and scope of his accomplishments in both the sciences and humanities: Member of the National Academy of Sciences, President and Fellow of AAAS, MacArthur Foundation "genius" Fellowship (in the first group of awardees), Humanist Laureate from the Academy of Humanism, Fellow of the Linnean Society of London, Fellow of the Royal Society of Edinburgh, Fellow of the American Academy of Arts and Sciences, Fellow of the European Union of Geosciences, Associate of the Musée National D'Histoire Naturelle Paris, the Schuchert Award for excellence in paleontological research, Scientist of the Year from *Discover* magazine, the Silver Medal from the Zoological Society of London, the

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Gold Medal for Service to Zoology from the Linnean Society of London, the Edinburgh Medal from the City of Edinburgh, the Britannica Award and Gold Medal for dissemination of public knowledge, Public Service Award from the Geological Society of America, Anthropology in Media Award from the American Anthropological Association, Distinguished Service Award from the National Association of Biology Teachers, Distinguished Scientist Award from the University of California at Los Angeles, Skeptic of the Year from the Skeptics Society, and a Festschrift in his honor at Caltech. He even has a Jupiter-crossing asteroid named after him ("Stephengould," as by IAU convention), discovered by Gene Shoemaker in 1992.[1]

Like other popular scientists who have become notable science popularizers, Gould did not shy away from expanding his thinking and writing into nonscientific spheres, most notably social and cultural commentary. This paper presents a brief synopsis of the structure of Gould's evolutionary theorizing, outlines in depth the theory of punctuated equilibrium in the context of its scientific validity and possible political or ideological biases, and presents some results from an extensive quantitative and qualitative content analysis of Gould's books, reviews, papers, and essays in terms of their specific subject matter and general themes. Special emphasis is placed on how Gould used the history of science to reinforce his evolutionary theory (and vice versa), and how his philosophy of science influenced both his evolutionary thinking and his historiography. That philosophy can best be summed up in a quotation from Charles Darwin, frequently cited by Gould: "All observation must be for or against some view if it is to be of any service." Gould followed Darwin's advice throughout his career, including his extensive writings on the history and philosophy of science.

Darwin's Duomo and Gould's Pinnacle

Stephen Jay Gould's last book, *The Structure of Evolutionary Theory* (at 1,433 pages a magnum opus in every sense of the term), is a comprehensive blend of science and history that thoroughly encapsulates his scientific world-view. *The Structure* at its core is a revisionist work, in which Gould revises both Darwin's original nineteenth-century theory and the neo-Darwinian synthesis of the mid-twentieth century. Over the past four decades Gould had systematically built upon Darwin's cathedral, an apt metaphor as his tome begins with an architectural analysis of the *Duomo* (Cathedral) of Milan, showing how the original fourteenth-century foundational structure was appended over the centuries with spires and pinnacles, such that we can legitimately say a core structure remains intact while the finished building represents a far richer compendium of historical additions. Gould's mission is not to raze the Darwinian Gothic structure or to tear down the neo-Darwinian Baroque facades, but to revise, refine, reinforce, and reconstruct those portions of Darwin's Duomo that have begun to crumble under the weathering effects of a century and a half of scientific research (Gould 2002).

The foundation of Darwin's Duomo rests upon the following three theoretical

1. Awards and citations are taken from Gould's curriculum vitae dated September 2000.

pillars, all of which are needed to prevent the theory from toppling over, which it might do, says Gould, unless necessary retrofittings and revisions are implemented.

Agency, or the level at which evolutionary change occurs. For Darwin, it is individual organisms alone that are being selected for or against. Gould proposes a multitiered theory of evolution where change (and selection) occurs at a number of different levels—genes, cell lineages, organisms, demes, species, and clades.

Efficacy, or the mechanism of evolutionary change. For Darwin it was natural selection (and its handmaiden sexual selection) alone that drove organisms to evolve. Gould does not deny the power of natural selection, but wishes to emphasize that in the three-billion-year history of the earth's rich panoply of life, there is so much more to the story. On top of the substratum of microevolution Gould adds macroevolution: long-term changes caused by mass extinctions and other large-scale forces of change. To the bottom floor of adaptationism Gould attaches exaptationism: structures subsumed for later uses and whose original adaptive purposes are now lost to history.

Scope, or the range of effects wrought by natural selection. For Darwin, gradual and systematic change extrapolated over geological expanses of time is all that is needed to account for life's diversity. For Gould, slow and steady sometimes wins the race, but more often than not life is punctuated with catastrophic contingencies that fall in the realm of unique historical narratives rather than predictable natural laws. History, not physics, should be evolutionary theory's model of science.

Revisions to these three branches (while the main Darwinian trunk retains its theoretical power), says Gould, produces a "distinct theoretical architecture, offering renewed pride in Darwin's vision and in the power of persistent critiques—a reconstitution and an improvement" (Gould 2002, 8). Some of those critiques, however, have been aimed not at Darwin's Duomo, but at Gould's Pinnacles. And of the many aspects of Gould's evolutionary theory, punctuated equilibrium has been a favorite target of critics.

Punctuated Paradigms

One persistent misunderstanding about Gould's remodeling of Darwin's Duomo stems from what I call the "paradigm paradox" (Shermer 2001, 97–126). How can the paradigms of Darwinism, neo-Darwinism, and Gouldian Darwinism coexist peacefully? Doesn't one paradigm displace another in a way that makes them incompatible? Not always. Paradigms can build upon one another and cohabit the same scientific, adaptive space. Just as the Newtonian paradigm has been reconstituted to include the paradigms of relativity and quantum mechanics, the overarching Darwinian paradigm has been improved by, for example, the subsidiary punctuated equilibrium paradigm.

Tom Schopf, who in 1971 organized a symposium integrating evolutionary biology with paleontology, stimulated the development of the theory of punctuated equilibrium. The goal was to apply theories of modern biological change to the history of life. Eldredge had already done this with a 1971 paper in the prestigious journal *Evolution*, under the title "The Allopatric Model and Phylogeny in Paleozoic

Invertebrates" (Eldredge 1971). Schopf then directed Gould and Eldredge to collaborate on a paper applying theories of speciation to the fossil record, and this resulted in a paper entitled "Punctuated Equilibria: An Alternative to Phyletic Gradualism," published in 1972 (Eldredge and Gould 1972). Gould explained that he coined the term but "the ideas came mostly from Niles, with yours truly acting as a sounding board and eventual scribe" (Gould 1991). In brief, they argued that Darwin's linear model of change could not account for the apparent lack of transitional species in the fossil record. Darwin himself was acutely aware of this problem, and ever since the missing transitional forms have vexed paleontologists and evolutionary biologists (to the delight of creationists). Collectively both groups have tended to ignore the problem, usually dismissing it as an artifact of a spotty fossil record. Eldredge and Gould, however, saw the gaps in the fossil record not as missing evidence of gradualism but as extant evidence of punctuation. Stability of species is so enduring that they leave plenty of fossils (comparatively speaking) in the strata while in their stable state. The change from one species to another, however, happens relatively quickly (on a geological time scale) in "a small sub-population of the ancestral form," and occurs "in an isolated area at the periphery of the range," thus leaving behind few fossils. Therefore, the authors conclude, "breaks in the fossil record are real; they express the way in which evolution occurs, not the fragments of an imperfect record" (Eldredge and Gould 1972, 205).

Punctuated equilibrium is primarily the application of Ernst Mayr's theory of allopatric speciation to the history of life. Mayr's theory states that living species most commonly give rise to a new species when a small group breaks away (the "founder" population) and becomes geographically (and thus reproductively) isolated from the ancestral group. This new founder group (the "peripheral isolate"), as long as it remains small and detached, may experience relatively rapid change (large populations tend to sustain genetic homogeneity). The speciational change happens so rapidly that few fossils are left to record it. But once changed into a new species they will retain their phenotype for a considerable time, living in relatively large populations and leaving behind many well-preserved fossils. Millions of years later this process results in a fossil record that records mostly the equilibrium. The punctuation is there in the blanks.

The reaction to the theory, in Gould's words, "provoked a major brouhaha, still continuing" (Gould 1991, 16), although initially paleontologists missed the connection with allopatric speciation because "they had not studied evolutionary theory . . . or had not considered its translation to geological time." Evolutionary biologists "also failed to grasp the implication, primarily because they did not think at geological scales" (Gould 1991). Personal attacks also ensued, including association with creationists who misrepresented the theory as spelling the demise of Darwinism and, "this is harder to say but cannot be ignored, a few colleagues allowed personal jealousy to cloud their judgment" (Gould 1991). Some critics derisively called punctuated equilibrium "evolution by jerks." Eldredge and Gould rejoined by calling proponents of gradualism "evolution by creeps."

Is punctuated equilibrium a new paradigm and was there a paradigm shift? To answer these questions we must define a paradigm and a paradigm shift. I define a paradigm as *a framework shared by most members of a scientific community, to*

describe and interpret observed or inferred phenomena, past or present, aimed at building a testable body of knowledge open to rejection or confirmation (Shermer 2001, 101). The modifier "shared by most" is included to allow for competing paradigms to coexist, compete with, and sometimes displace old paradigms, and to show that a paradigm may exist even if all scientists working in the field do not accept it. When paradigms shift scientists do not necessarily abandon the entire paradigm any more than a new species is begun from scratch. Rather, what remains useful in the paradigm is retained, as new features are added and new interpretations given, just as in homologous features of organisms the basic structures remain the same while new changes are constructed around it. Thus, *a paradigm shift is a new cognitive framework, shared by a minority in the early stages and a majority in the later, that significantly changes the description and interpretation of observed or inferred phenomena, past or present, aimed at improving the testable body of knowledge open to rejection or confirmation.*

Using this language, we can ask a series of questions about the scientific validity of punctuated equilibrium.

1. Was punctuated equilibrium a new cognitive framework? Yes and no. Yes, says paleontologist Don Prothero, who writes that before punctuated equilibrium, "Virtually all the paleontology textbooks of the time were simply compendia of fossils. The meetings of the Paleontological Society at the Geological Society of America convention were dominated by descriptive papers." After the introduction of the theory, new theoretical journals sprang up, old journals changed their emphasis from description to theory, and paleontological conferences were "packed with mind-boggling theoretical papers" (Prothero 1992). No, says Ernst Mayr, who makes it clear that he "was the first author to develop a detailed model of the connection between speciation, evolutionary rates, and macroevolution" and thus he finds it curious "that the theory was completely ignored by paleontologists until brought to light by Eldredge and Gould" (Mayr 1992). Mayr recalls: "In 1954 I was already fully aware of the macroevolutionary consequences of my theory," quoting himself as saying that "rapidly evolving peripherally isolated populations may be the place of origin of many evolutionary novelties. Their isolation and comparatively small size may explain phenomena of rapid evolution and lack of documentation in the fossil record, hitherto puzzling to the palaeontologist" (Mayr 1954). In a 1999 interview with Mayr he clarified for me the proper priority for the paradigm of punctuated equilibrium: "Gould was for three years my course assistant at Harvard where I presented this theory again and again, so he thoroughly knew it, so did Eldredge. In fact, Eldredge in his 1971 paper credited me with it. But that was lost over time" (Shermer and Sulloway 2000).

2. Was punctuated equilibrium shared by a minority in the early stages and by a majority in the later? Again, we must answer yes and no. Yes, says Prothero, and the "young Turks" who cut their paleontological teeth on the theory "are now middle-aged" and their influence "dominates the profession" (Prothero 1992, 42). No, say Daniel Dennett, Richard Dawkins, and Michael Ruse, philosopher, zoologist, and philosopher, respectively. Dennett calls Gould "the boy who cried wolf," a "failed revolutionary," and "Refuter of Orthodox Darwinism" (Dennett 1995). Dawkins calls punctuated equilibrium a "tempest in a teapot" and "bad poetic science," saying that Gould unfairly downplays the differences between rapid

gradualism and macromutational saltation which "depend upon totally different mechanisms and they have radically different implications for Darwinian controversy" (Dawkins 1998). Michael Ruse believes that one reason for the confusion on this point is that punctuated equilibrium has gone through three phases, from a modest new description of the fossil record in the 1970s, to a radical new theory about evolutionary change in the 1980s, back to a more reserved tier of a multitiered, hierarchical model of evolutionary change that incorporates both gradualism and punctuation (Ruse 1996, 1999).

3. Did punctuated equilibrium significantly change the description and interpretation of observed or inferred phenomena? This is the most important component of the sociological aspects of paradigms, but at this point in its history the answer could only be a provisional one. Prothero certainly thinks so, and most of his paleontological colleagues seem to agree. But without a formal survey of working paleontologists, and a quantitative comparison with other paradigms, a comparison baseline, and preset operational definitions of judging criteria, there is no way to answer this question.

4. As a new paradigm, did punctuated equilibrium improve the testable body of knowledge that was open to rejection or confirmation? Again we are forced to offer a maximally equivocating "it depends." Prothero's extensive search through the empirical literature leads him to conclude that "among microscopic protistans, gradualism does seem to prevail," but "among more complex organisms . . . the opposite consensus had developed." In hundreds of studies, including his own examination of "all the mammals with a reasonably complete record from the Eocene-Oligocene beds of the Big Badlands of South Dakota and related areas in Wyoming and Nebraska," Prothero concludes, "all of the Badlands mammals were static through millions of years, or speciated abruptly" (1992, 43). My own informal survey of paleontologists and evolutionary biologists leads me to conclude that punctuated equilibrium applies to some fossil lineages but not others. It is an accurate description of some specific evolutionary processes, but it is not universal. I asked Gould if he thought punctuated equilibrium constituted a paradigm shift. "No, but we are forcing selection to be considered at the level of the species and the explanation of trends, which is very different from Darwin's insistence that the individual is the proper level of evolutionary causation" (quoted in Shermer 1996, 89).

Punctuated Politics

Why didn't Ernst Mayr's 1954 paper trigger a paradigm shift? The short answer is that he was the wrong trigger man. As a fifty-year-old biologist, Ernst was not the "young Turk" needed to lead a paleontological revolution. The longer answer is found in the man who did champion punctuated equilibrium—Stephen Jay Gould, arguably the most prominent expositor of evolution of the past thirty years (and dubbed America's "Evolution Laureate"[2]). Whether it was Mayr's idea or Eldredge's, it was, by his own

2. The reference first appears in Robert Wright's highly critical review of Gould's *Wonderful Life*, in *The New Republic*, January 29, 1990. He meant it sarcastically, but it has been adopted since in praise.

admission, not Gould's idea, and yet it is his name most noticeably attached to it. As much as scientists may harbor a distaste for the social nature of science, the fact is: who is doing the saying sometimes matters as much as what is being said.

Thus it is with the theory of punctuated equilibrium that we encounter some of the strongest charges of personal and political bias. Gould, according to some commentators, has imposed upon science a Marxist theory of change. The source of the charge is a 1977 paper on punctuated equilibrium by Gould and Eldredge that began, as so many Gouldian analyses do, with a discussion of the personal and social nature of science. "The general preference that so many of us hold for gradualism is a metaphysical stance embedded in the modern history of Western cultures: it is not a high-order empirical observation, induced from the objective study of nature." Of course, the same charge could be made against punctuated equilibrium, so the authors considered why it is that they originated this theory instead of other paleontologists, with the now famous admission: "It may also not be irrelevant to our personal preferences that one of us learned his Marxism, literally at his daddy's knee" (Gould and Eldredge 1977). The comment is quoted in virtually every discussion of the social aspects of Gould's science. At a symposium on punctuated equilibrium at the British Museum (Natural History), for example, the curator Beverly Halstead, in Gould's words, "accused—and I swear that I do not exaggerate—the British Museum of foisting Marxism upon an unwitting public in this new exhibit, because cladism can be equated with punctuated equilibrium, and everyone knows that punctuated equilibrium, by advocating the orthodoxy of revolutionary change, represents a Marxist plot" (Gould 2002, 984). What are we to make of such charges?

1. Gould was not a Marxist. Note that Gould said he learned his Marxism at his daddy's knee. Learning is clearly different from believing. As he explained in *The Structure of Evolutionary Theory* (in a three-hundred-page chapter on punctuated equilibrium!), "I spoke only about a fact of my intellectual ontogeny; I said nothing about my political beliefs (very different from my father's, by the way)." So why put it in there? "I included this line within a discussion of personal and cultural reasons that might predispose certain scientists towards consideration of punctuational models—just as I had identified similar contexts behind more conventional preferences for gradualism" (Gould 2002, 1018).

2. Niles Eldredge was not a Marxist. Even if Gould was a Marxist the theory was primarily Niles Eldredge's, heavily influenced by Ernst Mayr, neither one of whom was a Marxist. In an interview with Gould, I asked him about Dan Dennett's charge that punctuated equilibrium is analogous to dialectical materialism and that his Marxist background had led him to invent (not discover) a dialectical theory of nature. Gould responded: "Tell him to talk to Eldredge. It's true, my father was a Marxist so I had that background. But, in fact, the idea of punctuated equilibrium was more Niles' than mine, and he never had that background at all" (quoted in Shermer 1996, 90).

3. We must separate the sociological aspects of science from its empirical nature. It is good to know if a theory has sociopolitical origins and implications, but that is orthogonal to the matter of its validity (although this statement applies more to the physical and biological sciences and less to the social sciences, where determining

scientific validity can be far more problematic). The British evolutionary biologist John Maynard Smith once observed: "By and large, those who held that selection played a major role in evolution were English country gentlemen, but . . . those who were not have largely been urban Jews . . . I mean urban intellectuals, people like Stu Kauffman and Steve Gould. It's the search for universal truths. They seem to say, if there are not universal truths, how can you do science?" Gould responded to this charge: "that doesn't make sense because he's the guy—it is the older Darwinians—who want natural selection to be the one exclusive principle. It is we who are seeking a more pluralistic explanation. Stu Kauffman and I have very different views on things. Stu may be looking for an overarching set of universal, timeless, structural principles. I'm basically looking for the operation of contingency" (quoted in Shermer 1996, 88).

4. Gould's emphasis on contingency in evolution is anti-Marxist. Gould's belief in the powerful role of chance and contingency in the history of life—an integral part of the structure of his evolutionary theory—would seem to undermine his critics' charges that his Marxist background has shaped his evolutionary thinking. Contingency not only subverts evolutionary determinism but negates economic determinism, the very foundation of Marxist ideology. As Gould writes in *Wonderful Life*: "When we realize that the actual outcome did not have to be, that any alteration in any step along the way would have unleashed a cascade down a different channel, we grasp the causal power of individual events. We can argue, lament, or exult over each detail—because each holds the power of transformation. Contingency is the affirmation of control by immediate events over destiny" (1989, 284).

5. Metaphors of change do not necessarily translate across disciplines. Charles Darwin openly adopted Adam Smith's metaphor of the invisible hand to describe the workings of natural selection: just as the apparent design in the economy comes not from top-down planners but from bottom-up consumers struggling to make a profit, the apparent design in nature comes not from a top-down designer but from bottom-up organisms struggling to make a living. Gould has repeatedly stated that the irony of Darwin's metaphorical stratagem is that it works in nature but not in the economy (Gould 1989, 124). Does this mean that Gould rejected laissez-faire economics in favor of Marxist (or socialist) principles of state-controlled economics? And if so, does this mean he rejected Darwinian gradualism not because of its empirical shortcomings but because of its political implications? Is punctuated equilibrium a Marxist interpretation of nature? Maybe, but I don't think so. Metaphors are heuristic tools for conceptual explanation, not precise descriptions of actual events in nature. Natural selection is *like* an invisible hand, which in any case is itself just a metaphor, so at best this is a metaphor of a metaphor. Punctuated equilibrium is rapid change relative only to the glacially slow pace of gradualism; to equate a description of biological change with one of social change—in essence confusing Darwinian with Lamarckian evolution—is to reach beyond reason across interdisciplinary boundaries. There are only so many ways to describe the world. Change may be thought of as rapid and revolutionary or slow and gradual. The fact that theories from two different disciplines vaguely resemble one another tells us little about the internal workings of the theories (or theorists) themselves.

Gould's Themata

This is not to deny that there is a strong interaction between Gould's science and his personal and professional philosophy. How that interaction plays out can be seen in the results of an extensive quantitative and qualitative content analysis that I conducted of Gould's 23 books, 101 book reviews, 479 scientific papers, and 300 *Natural History* essays (Shermer 2002). There is no denying that Gould's leftist upbringing influenced his style of thought, as evidenced by the fact that Karl Marx makes frequent appearances in his writings. For example, I found Marx's famous opening from *The Eighteenth Brumaire* quoted no less than seven times: "Hegel remarks somewhere that all great, world-historical facts and personages occur, as it were, twice. He has forgotten to add: the first time as tragedy, the second as farce." The context in which these quotations appear reveal, in fact, that Marx is used by Gould not for any political or ideological purpose, but directly to bolster his philosophy of science and to reinforce two themata that appear throughout his works: the interaction between contingencies and necessities, and the nonrepeatability of historical systems (time's arrow versus time's cycle).

"Karl Marx captured this essential property of history as a dynamic balance between the inexorability of forces and the power of individuals," Gould notes. Even Marx's title, he continues, "is, itself, a commentary on the unique and the repetitive in history. The original Napoleon staged his coup d'état against the Directory on November 9–10, 1799, then called the eighteenth day of Brumaire, Year VIII, by the revolutionary calendar adopted in 1793 and used until Napoleon crowned himself emperor and returned to the old forms. But Marx's book traces the rise of Louis-Napoleon, nephew of the emperor, from the presidency of France following the revolution of 1848, through his own coup d'état of December 1851, to his crowning as Napoleon III. Marx seeks lessons from repetition, but continually stresses the individuality of each cycle, portraying the second in this case as a mockery of the first." To drive home the point, Gould finishes this thought with a recommendation for scientists to heed the lesson: "This essential tension between the influence of individuals and the power of predictable forces has been well appreciated by historians, but remains foreign to the thoughts and procedures of most scientists" (1989, 18).

This literary vignette offers a glimpse into Gould's deeper purpose, which can also be gleaned in fig. 1, which presents the results of a complete classification of all 300 essays into primary, secondary, and tertiary subjects in thirteen different categories.[3]

3. I began reading Gould's essays in 1985 starting with the essay collections. After that I read most of the essays in their original publication in *Natural History*, and reread many of them when they were republished in book form. In late 2000, I went through all three hundred essays in chronological order, page by page, in order to classify them in this taxonomic scheme. It soon became clear that for most of the essays there were multiple layers of literary, scientific, and philosophical complexity, so I developed this three-tiered system to discern the larger patterns. When it became apparent that in most of the essays there was also a strong historical element, I added another three-tiered division to classify the relevant essays by their historical subject or theme. My coding scheme was developed on a handful of randomly selected essays to the point where it became relatively obvious what the primary, secondary, and tertiary themes were in each. I then went through the entire corpus sequentially.

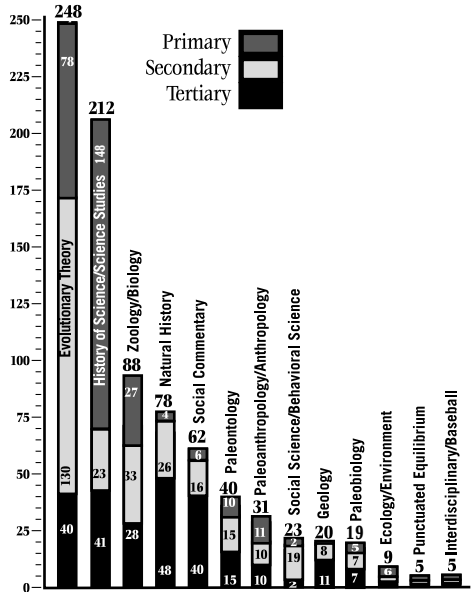

Fig. 1 Gould's Essay Subjects

Starting with the lowest figures we see that Gould almost completely neglects to include both his personal hobbies such as baseball and music, as well as his intellectual child, punctuated equilibrium. He dabbles in ecology and environmental issues, touches on geology and the social and behavioral sciences, and, of course, cannot ignore (but does not dwell on) his own trade of paleontology (and its relations paleobiology and paleoanthropology). Obviously—considering the publication in which the essays are found—natural history, zoology, and biology are regularly featured, even if only on the secondary or tertiary level, and since the essay genre is, by definition, personal, Gould does produce a fair amount of social commentary but predominantly at the tertiary level. What is surprising in this graph is the overwhelming dominance of evolutionary theory and the history of science/science studies, comprising 55 percent of the total. It would seem from this graph that Gould is, first and foremost, an evolutionary theorist. Or is he? To explore this question further, fig. 2 shows the thirteen subject categories collapsed into five, highlighting only the primary subjects.

While evolutionary theory and the history and philosophy of science once again dominate (comprising 75 percent of the total), they have flip-flopped in dominance from the totals in fig. 1. That is, the history of science and science studies (which includes philosophy of science) now overwhelm all other subjects, nearly doubling evolutionary theory and almost totaling more than all other categories combined. What is going on here? What is Gould up to when he blends the history and philosophy of science and science studies with evolutionary theory?

Part of an answer can be found in fig. 3, which presents a breakdown of Gould's

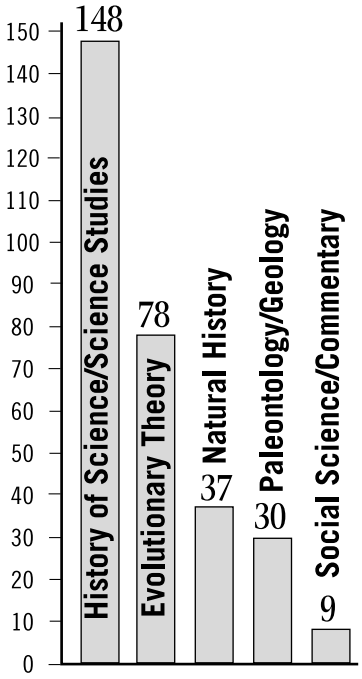

Fig. 2 Gould's Primary Essay Subjects

essays on the history and philosophy of science by primary, secondary, and tertiary emphasis.[4]

Out of the 300 essays, a remarkable 220 (73 percent) contain a significant historical element, with half (109) in the nineteenth century and nearly a third (64) in the twentieth. It is also important to note that the history of evolutionary theory is bracketed in fig. 3 by the philosophy of science on the right and the relationship between culture and science on the left. All other interests pale by comparison, revealing Gould's intense interest in the interaction of history, theory, philosophy, and culture. For Gould they are inseparable. Doing science also means doing the history and philosophy of science and, as a historian and philosopher of science, Gould is intensely interested in the interaction between individual scientists and their culture. This is why there are in these 220 historical essays, no less than 76 significant biographical portraits, a number of which include original contributions to the historical record.

Even more important than the history of science in Gould's writings is his philosophy of science, as evidenced in five thematic pairs representing some of the deepest themes in Western thought that appear in every one of the 300 essays.

4. Frank Sulloway was invaluable in helping to classify Gould's essays in this complex network of literary taxonomy, particularly with regard to the relationship of the history and philosophy of science in Gould's work.

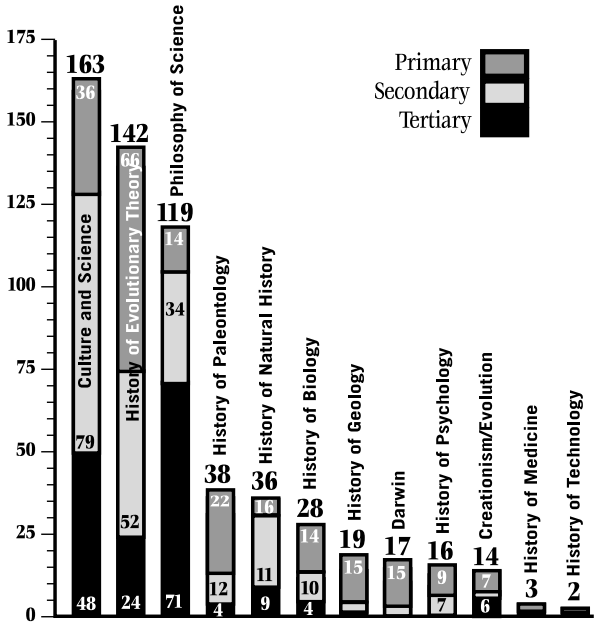

Fig. 3 Gould's History of Science

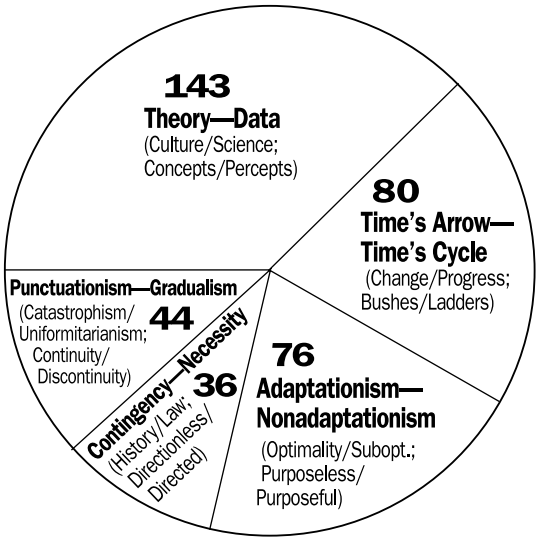

Fig. 4

Classifying Gould's essays (fig. 4) into one of five different thematic pairs reveals how inseparable are history, theory, philosophy, and science.

These thematic pairs also help illuminate what is really going on in the so-called evolution wars (Ruse 2000; Segerstråle 2000; Morris 2001). When Gould is pitted

against his critics, it is almost always along a spectrum of one of these five themata. His longstanding debate with Richard Dawkins, for example, reveals a difference along the adaptationism/nonadaptationism theme. Dawkins is a vocal defender of the adaptationist program in evolutionary theory whereas Gould prefers to focus on the nonadaptive qualities of organisms. One wonders, in fact, if both sides in these various debates do not lean too close to the termini of each thematic pair as a corrective to the perceived exaggerated emphasis of the opponent on the other end of the spectrum. For example, Gould does not deny that natural selection creates well-adapted organisms. His point is that not everything in nature can be explained through the adaptationist paradigm: "Darwinian theory is fundamentally about natural selection. I do not challenge this emphasis but believe that we have become overzealous about the power and range of selection by trying to attribute every significant form and behavior to its direct action" (Gould 1984). What is remarkable in the evolution wars, in fact, is just how consistent the various players are in their declared positions along each thematic pairing.

Darwin's Dictum and Gould's Purpose

In 1861, less than two years after publication of *The Origin of Species*, in a session before the British Association for the Advancement of Science, a critic claimed that Darwin's book was too theoretical and that he should have just "put his facts before us and let them rest." In a letter to his friend Henry Fawcett, who was in attendance in his defense, Darwin explained the proper relationship between theory and data: "About thirty years ago there was much talk that geologists ought only to observe and not theorize; and I well remember someone saying that at this rate a man might as well go into a gravel-pit and count the pebbles and describe the colours. How odd it is that anyone should not see that all observation must be for or against some view if it is to be of any service!"[5]

This quotation is a favorite of Gould's, cited often in defense of his own philosophy of science that closely parallels that of Darwin. Gould's science, as well as his philosophy of science, history of science, and popular science, is driven by this philosophy, best captured in the final clause of what I call Darwin's Dictum: all observation must be for or against some view if it is to be of any service (Shermer 2001). Darwin's Dictum is the key to understanding Gould's purpose. Rethinking Gould's purpose in the context of the philosophical and historical themata that have guided his work leads us to realize that we need both data and theory, that science does not operate in a social vacuum, and that the past's great value lies primarily in its service to the present.

Stephen Jay Gould made his own history, but he did not make it just as he pleased. . . .

5. Darwin to Henry Fawcett, 18 September 1861 (Darwin 1903). Of the final clause of the line, "if it is to be of any service," Gould commented lightheartedly: "It tickles me that the quote has six words in a row with only two letters each. Now this must be rare! (but how to measure it?)" (personal communication, 15 May 2001).

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