



Essay Review

Grappling with the Ghost of Gould

by David P. Barash

A review of *The Structure of Evolutionary Theory*
By Stephen Jay Gould, 1433 pp, Harvard University Press, 2002.

Some time ago - during the Precambrian era, as I recall - a televised advertisement (subsequently famous) for Alka-Seltzer showed a postprandial over-indulger announcing amidst groans of indigestion: "I can't believe I ate the whole thing!" Well, I can't believe I read the whole of Stephen Jay Gould's *The Structure of Evolutionary Theory*. But I really did! And having done so, I also can't believe that those reviewers who have enthusiastically endorsed this Brobdignagian tome actually suffered through the whole thing. It is nearly inedible, so if this review seems dyspeptic, it is for good reason: I could use some Alka-Seltzer.

Before going on, let's confront the most difficult aspect of this review (aside from the problem of digesting the book itself); namely, the fact that Stephen Jay Gould died two months after it was published. The problem is that although I admired much in Gould's work - especially his persistence and panache - and agreed with his politics, I disputed, consistently, his science. Now he is deceased, and of course, we are abjured to speak only good of the dead ... or as Steve would doubtless have

insisted on putting it, *de mortuis nil nisi bonum*. And it is tempting to do just that, to let bygones be bygones, and pass indulgently and in silence over areas of disagreement. After all, Steve Gould cannot now defend himself, a situation that most assuredly did not obtain while he lived! But in fact, he has numerous acolytes today, and moreover, any such cowardly pussy-footing on my part would be unworthy of Gould's memory. Of all the things he loved - baseball, church architecture, chorale music, Gilbert and Sullivan operettas, fossil mollusks, left-wing politics - Steve loved intellectual disputation above all, enjoyed picking scholarly fights, and never ran from one. So I won't degrade his legacy and refrain from telling you what I think of this, his final book.

First of all, it is not for the faint of heart (1433 pages), or for anyone with anything else to do with his or her life. And second, the writing is so inflated, both polysyllabically and by median sentence length that the dutiful reader cannot help feeling that he or she has been sentenced indeed. Here is a sample outpouring, masquerading as a single sentence:

On the second branch of full efficacy for natural selection as an externalist and functionalist process, the stunning discoveries of extensive deep homologies across phyla separated by more than 500 million years (particularly the vertebrate homologs of arthropod Hox genes) – against explicit statements by architects of the Modern Synthesis (see p. 539) that such homologies could not exist in principle, in a world dominated by their conception of natural selection – forced a rebalancing or leavening of Darwinian functionalism with previously neglected, or even vilified, formalist perspectives based on the role of historical and structural constraints in channeling directions of evolutionary change, and causing the great clumpings and inhomogeneities of morphospace – phenomena that had previously been attributed almost exclusively to functionalist forces of natural selection. [pg. 26]

Such billowing clouds of verbal flatulence herald a new phenomenon – the literate bio-terrorist – or maybe a biologically literate deconstructionist, more interested in generating complex clauses than in communicating anything. In any event, here is another outpouring, from the same page (and, once again, masquerading as a single sentence):

Following the Kantian dictum that percepts without concepts are blind but concepts without percepts empty, these two categories interpenetrate as “pure” data suggest novel ideas (how can one *not* rethink the causes of mass extinction when evidence surfaces for a bolide, 7-10 km in diameter, and packing 10^4 the megatonnage of all the earth’s nuclear weapons combined), whereas “abstract” concepts then taxonomize the natural world in different ways, often “creating” data that had never been granted enough previous

intellectual space even to be conceived (as when punctuated equilibrium made stasis a theoretically meaningful and interesting phenomenon, and not just an embarrassing failure to detect “evolution,” in its traditional definition of gradual change – and paleontologists then began active studies of a subject that had previously been ignored as uninteresting, if conceptualized at all).

Had enough? Don’t despair: there are only 1432 pages left! (Actually, this is, thankfully, an over-estimate, since most readers won’t assiduously peruse the index or list of references. They will likely be too exhausted.) There is an old joke in which a dissatisfied customer complains about a restaurant meal: “The food was terrible. And the portions were too small.” Well, *The Structure of Evolutionary Theory* is too verbose, too densely written, too bombastic and self-referential ... and too long. One searches in vain for a simple sentence, clearly expressed.

In this age of do-it-yourself Internet “publishing,” much of the web’s downside – as well as its charm – is attributable to its lack of editorial oversight. So it is with *The Structure of Evolutionary Theory* (henceforth, *TSET*). It stands as a monument to good, professional editing ... which it didn’t receive. Gould – who famously refused to allow any modification of his unique prose – got his way at the end, and his book is the worse for it. On several occasions (e.g., pp. 147 and 254, and again on 256 and 1023), we even get the same story, repeated in precisely the same words, like an old man who has forgotten that he already told us that one. Even Professor Gould, notoriously enamored of his own prose, would, I suspect, have forborne to repeat himself – at length and *verbatim* – (and, moreover, in the same book!) if only he had known the good grace to accept the suggestions of a professional wordsmith. (By the way, readers of this review may well notice the “Gould Effect” in action: after consuming

more than a thousand pages of Gould's prose, one is inclined to write at least somewhat similarly. It's contagious.)

Stephen Jay Gould was a remarkably intelligent, learned and effective scientist/writer, but let's face it: he wasn't Moses, bearing the imperishable word of god, marmoreally inscribed (look it up) upon stone, generously carried down from Sinai for the edification of us mortals. The atheist within me suspects that even The Ten Commandments were self-published; despite bearing the doughty imprimatur of Harvard University Press, *TSET* reads as though it, too, came from a vanity press. Maybe, as a paleontologist, the author was so accustomed to dealing with fossilized material buried beneath layers of encrusted sediment that he simply assumed most readers would approach his book armed with a rock hammer. It might help.

On the other hand, even Gould's persistent logorrhea has some redeeming consequences. One must admire a writer who comes up with "chameleonic" (as a description of George Cuvier's habit of adapting his beliefs to fit the changing ideologies of 19th century France), or "symposiast," referring to a symposium participant. But what in Darwin's name is an "autapomorphy"? It doesn't even appear in my beloved, unabridged Oxford English Dictionary (along with several other Gouldisms). *TSET* is a platitudinous parcel of impenetrable ponderosity, regrettably but manifestly lacking in clarifying conciseness or concatenated cogency; in short, too many big words.

It is also replete with smug self-congratulation, including the author's repetitive public preening about his "300 consecutive monthly essays" appearing in *Natural History* magazine and terminated only shortly before his death. Throughout *TSET*, Gould is nothing if not self-referential, and sometimes this rebounds advantageously, even humorously. Thus, after complaining of being misappropriated by creationists and in the process misnamed "Dr. Jay Gould," our author adds this:

On the same theme of shoddiness in supposed creationist "scholarship," I was quite struck by a photograph, supposedly of me, that appeared in M. Bailey's creationist book for children. ... The gentleman depicted sports a flowing beard and bald pate – while my head hair has a precisely opposite distribution. He is also considerably older (and, I fancy, a good deal uglier) than I. I finally realized that he is the 19th century robber-baron Jay Gould (no relation, by the way). [pg. 988].

I agree with Gould, by the way, that he is not to be blamed for the lamentable fact that some of his work was misappropriated by creationists ... just as sociobiology should not be excoriated for its misappropriation by a small number of racists and rightwing nuts.

The reality, however, is that for more than two decades, Steve Gould had the unenviable task of navigating between the Scylla of giving aid and comfort to creationists (who eagerly seized on many of his pronouncements as "proof" that Darwinism is in trouble) and the Charybdis of his own personal ambition. No shrinking violet, Gould was not about to refrain from trumpeting what he clearly believed – and wanted others to believe – was a genuine revolution in evolutionary thought. So he wound up doing both, providing ammunition for creationists while also engaging in an extraordinary orgy of bombastic self-promotion. (In the process, it must be noted, he also came up with more than his share of good ideas.)

Much of Gould's success derived from his skill as a phrase-maker, in this way resembling Richard Dawkins, not to mention a certain Mr. C. Darwin. "Exaptation" and "spandrel" (the former a genuine neologism and the latter long existing in architecture but until Gould's notable manuscript co-authored with Richard Lewontin, unknown as an evolutionary term) have already made it into the biological lexicon, and deservedly so. In *TSET*, Gould proposes

adding some others, including “Cordelia’s dilemma,” based on the refusal of King Lear’s daughter to enter into a battle of competitive proclamations of love. Cordelia, you may recall, preferred to say nothing, whereupon Lear warned her that “nothing [i.e., no inheritance] will come from nothing.” Gould’s point is that much research has been stymied by fear that a finding of “no evolutionary change” (that is, stasis) would be construed as “nothing,” and thus, unworthy of being reported, or of scholarly reward. He also suggests the terms “franklin” and “milton” for potential (the former) and actual physical traits (the latter) that reveal adaptive significance only after they have appeared, and have been retained for other reasons. Don’t bet on their lexicographic fitness.

But what is *TSET* about? It is *not* about the structure of evolutionary theory. At least, it is not a portrayal of the current state of evolutionary theory in the sense of a disinterested textbook account, or even a summarizing monograph. It presents, instead, *the structure of Stephen Jay Gould’s evolutionary theory*, which is a very different creature. Or species. Or more accurately, in the phrase once coined by maverick geneticist Richard Goldschmidt, who tried to persuade his colleagues about the potential evolutionary viability of a dramatically discontinuous saltation: a “hopeful monster.”

Gould proclaims his monstrous book to be part of a Hegelian dialectic, in which traditional Darwinism (the Modern Synthesis) has become the thesis, with Gould’s own ideas as antithesis, and a future synthesis waiting to be born. Quoting Ariel in Shakespeare’s *The Tempest*, Gould looks ahead to a forthcoming “sea change, into something rich and strange.” This something is never made clear, but whatever it is, it presumably involves “causative pluralism,” hierarchies of selection, and a lot of verbiage.

Nonetheless, for all this supposed intellectual heterogeneity, in which a thousand theoretical flowers will presumably thrive, “socio-

biology” doesn’t even appear in the index, although the word shows up at least twice in the text, on pages 43 and 136. “Evolutionary psychology” emerges only briefly, on pages 1263-1266. Robert Trivers is ignored (although reciprocal altruism creeps in, on pg. 134, unattributed); William D. Hamilton barely makes it. E. O. Wilson shows up only once, courtesy of his multi-authored textbook, nearly 30 years old – and then, only to be criticized for what Gould sees as the short shrift it gives to macroevolution.

Why, then, should readers interested in sociobiology, evolutionary psychology or a biological “take” on human nature even bother with *TSET* at all? Because Gould’s ideas matter, if only because the nonprofessional American public takes him so seriously, as the major modern avatar of evolutionary wisdom. (Biologists are typically surprised to learn the reverence with which Gould is treated by many lay-persons, who, in turn, are equally surprised to find that most professionals – far from sharing their giddy adoration – consider Gould’s ideas, in the words of John Maynard Smith, “so confused as to be not worth bothering with.”)

For decades, Stephen Jay Gould became the late-20th century incarnation of Soapy Sam Wilberforce, arguing that evolution had almost nothing to do with human behavior (although unlike Wilberforce, he at least accepted *Homo sapiens*’s phyletic connectedness to the rest of life). A brilliant polemicist, Gould also carried the torch for several idiosyncratic revisions of evolutionary theory, wherein lies the rationale for his book. In brief, he argues that Darwinian theory rests on three conceptual legs, each of which needs revision. And Stephen Jay Gould, reviser *extraordinaire*, has the answers. In Gould’s terminology, those legs are “agency” (the level at which selection occurs), “efficacy” (the extent to which natural selection – regardless of level - is responsible for evolutionary change), and “scope” (gradualism versus discontinuity). Neo-Darwinism used to argue that the organism was the effective level at which

natural selection operates; in current vogue, selection at the level of the gene is seen as paramount. The current Darwinian consensus also maintains that natural selection is highly efficacious, responsible for nearly all evolutionary processes. And it embraces “phyletic gradualism,” Darwin’s biologizing of Lyell’s geological uniformitarianism, proclaiming that evolution ultimately involves the gradual accumulation of microevolutionary events.

Gould argues, by contrast, for a “hierarchical” pattern of selection, in which differential reproduction occurs at the level of species, as well as of the individual (and, curiously, not at all at the gene level), that historical and structural constraints supplement and in some cases overpower selection, and that “punctuated equilibria” rather than phyletic gradualism characterize the fossil record, and thus, the evolution of life. The result, he claims, will be “a fundamentally revised evolutionary theory with a retained Darwinian core.” [pg. 61]

Part I of *TSET* – titled “The History of Darwinian Logic and Debate” – does not accomplish what it purports. Nor does it even try. Rather, it displays nearly 600 pages of highly selective reconstructions, all skewed toward reinforcing Gould’s claim that his proposed modification of Darwinian concepts of “agency,” “efficacy,” and “scope” were prefigured in the work of various pre- and post-Darwinians. In this regard, I had hoped to profit from Gould’s remarkably wide-ranging historical scholarship, but was disappointed.

Gould is so eager to beat his own drums that objectivity is lost altogether. The interested reader will find essentially no Haeckel or Spencer, a smattering of Cuvier, Geoffroy Saint-Hilaire and Owen, lots of Paley and Weismann, snatches of Goethe (Gould is fond of archetypes, leading to his soft spot for Goethe’s claim that all plant parts are modified leaves), and then: 11 pp (355-365) on Theodor Eimer’s theory of orthogenesis, 18 pp (365-383) on Alpheus Hyatt’s ideas of phyletic life cycles and ontogeny, 12 pp (383-395) on C. O.

Whitman’s orthogenetic analysis of pigeons (from which Gould quotes approvingly that “natural selection waits for opportunities to be supplied, not by multifarious variation or orderless mutation, but by continuous evolutionary processes advancing in definite directions”), 19 pp (396-415) on William Bateson’s search for the causes of discontinuous variation, 38 pp (413-451) on Hugo De Vries’s “mutation theory,” as well as 15 pp (451-466) on Goldschmidt’s now discredited “systemic mutations” and “hopeful monsters.” Of such stuff are 1400-page tomes created, not evolved.

What, then, is one to think of a book purporting to review evolutionary history that allots, by contrast, only six pages to R. A. Fisher, and two pages to J. B. S. Haldane? And in which Dobzhansky, Mayr and Simpson make only ceremonial appearances to reveal how they purportedly chanted “amen” to the Modern Synthesis, all the while subliminally gesturing toward the true Promised Land of Gouldian Truth? To be sure, Gould is an effective propagandist in his own cause, but he doth rely too heavily upon rhetoric. For example, after accurately attributing the “first phase” of the Modern Synthesis to the integration (by Fisher, Haldane and Wright) of Mendelian genetics and Darwinism, Gould describes the “second phase” (Mayr, Dobzhansky, Simpson, Rensch and Stebbins) as a “hardening” wherein selection is seen as the overwhelming engine of evolution, the organism (rather than any higher level) is identified as the relevant selective agent, and gradualism is perceived to be the primary mode of change.

Gould traces a transition in the work of Dobzhansky, Simpson and Mayr from the early 1940s to the late 1950s, with all the satisfaction of a conspiracy theorist, showing how these three giants of evolutionary theory moved from a more pluralist position to one firmly committed to “strict adaptationism.” As he trots out examples in which the canonical texts by these “second phase” giants gradually morphed into greater solidarity regarding the effective level at

which selection operates, its overall efficacy, and the mounting evidence for evolutionary gradualism, it never occurs to Gould that this shift – which was genuine – reflected an accurate perception of what really mattered rather than a malevolent “adaptationist hardening ... ultimately inadaptive for the broadest goal of understanding evolution aright.” [pg. 543]

Rather, as he builds his case, each example seems to contribute toward a growing pyramid of paranoid triumphalism, as though by revealing this pattern of increasing conceptual uniformity, Gould has uncovered a kind of atherosclerotic conspiracy, a hardening of the categories. But what if, instead of “hardening,” we perceive the second phase as one of “consolidation,” based not on rigid intellectual conformity but on shared recognition of explanations that work?

Gould’s rhetoric is nonetheless seductive, especially for those of us inclined to resist authority. Thus, in describing the tone of the influential 1959 Chicago symposium, held in commemoration of *The Origin’s* centennial, Gould writes that “Sweetness surely triumphed in Chicago, but perhaps at the expense of light. The panel discussions ended in a virtual orgy of agreement, with Darwin as hero and adaptation as king. Even Sewall Wright, who had approached selection with ambiguity for years ... had finally made his peace with the hardened consensus ...” [pg. 574]. More likely, agreement was achieved because the consensus was valid, one not so much hardened as consolidated.

Let us consider what Gould identifies as the three legs of the Darwinian Modern Synthesis, each of which he sees as needing repair. First, levels of selection. Darwin maintained that the individual organism was paramount. Recent neo-Darwinians (especially sociobiologists such as Dawkins, Trivers, and George C. Williams, with crucial technical underpinning from William D. Hamilton) have modified this to emphasize selection at the gene level, based principally on the fact that genes – unlike spe-

cies, groups, or even individuals - are persistent “replicators,” which selection can maintain, promote, or extinguish over time. Gould demurs. He argues for a hierarchical structure of selection, incorporating “gene, cell lineage, organism, deme, species and clade.” But why stop there? What about selection among communities, ecosystems, biomes, planets, star systems, galaxies?

To some degree, it is much ado about nothing, since even arch-reductionists acknowledge that selection operates at many different levels simultaneously, just as the gravitational effects of a falling cantaloupe and of the sun operate upon the orbit of Mars. But the resulting “cantaloupe effect” can effectively be ignored, even though it is not only theoretically defensible, but indisputable. Gould argues that hierarchies are unavoidable (in evolution, mind you, not human society!) and although he labors mightily – and, in my mind, unsuccessfully – for rehabilitating the species as a key level of selection, he disavows any *downward* hierarchy, notably selection at the level of genes, where in fact it is most cogent. He even speaks of gene selection in the past tense, as though it has somehow been disproved; e.g., “Nevertheless, the theory could not work. However stubborn and heroic the attempt, explanations inevitably faltered upon the central logical error – especially when selection had clearly worked upon emergent properties of higher-level individuals, and no verbal legerdemain could recast the story in terms of genes as causal agents.” [pg. 614]

Au contraire, Gould’s verbal legerdemain cannot cast this story *other* than in terms of genes as causal units. “The ‘goal’ of a unit of selection,” he writes, “is concentration by plurification – that is, the differential passage of ‘youness’ into the next generation, an increase in relative representation of your heritable attributes (whether you pass yourself on as a whole, or in disaggregated form, into the future of your lineage).” [pg. 621] Leave aside such Gouldisms as “plurification” and “youness.”

And grant Gould's insistence that organisms, not genes, operate in the real world as the immediate locus of differential reproduction (something that no gene selectionist would deny). There can be no doubt that such differential reproduction results in a difference among alternative alleles respecting their representation in future generations. This difference is natural selection.

"An entity must be able to reproduce," he writes

to be defined as an evolutionary individual, but this entity need not replicate faithful copies of itself. Rather, it needs to be able to plurify – that is, to increase, relative to other individuals, the representation of its hereditary contribution to the next generation. Integral 'you' may be disaggregated in the process, but so long as you operated as an active causal agent of the Darwinian struggle while you lived, then you qualify as a unit of selection ... [pg. 622]

But what is it that makes up one's "contributions"? Genes, that's what. How can genes *not* be a unit of selection? Maybe even *the* unit.

But according to Gould, any such focus on gene selection involves a crucial error: "mistaking bookkeeping for causation." Indeed, he likes this phrase so much that he says it over and over, as though such mantric repetition will make it so. His point is that differential reproduction (of organisms, and – his particular hobby-horse – of species) changes the distribution of genes, but that this is *consequence* of selection, not a cause: "Organisms 'struggle' as agents or efficient causes; their 'reward' may be measured by greater representation of their genes, or material legacies, in future generations. Genes represent the product, not the agent – the stuff of continuity, not the cause of throughput." [pg. 627] For Gould, genes evidently don't *do* anything; they're just along for the ride. They are "products," not "agents."

One cannot help wondering where he has been the last few decades.

Significantly, Gould all but ignores Hamilton's revolutionary insights regarding inclusive fitness. In a tome of such dimensions, he could hardly claim – the usual dodge – that attending to this matter would be "beyond the scope of this book." Ignoring sociobiology with its attendant insights into altruism, male-female differences, parent-offspring conflict, or the game theoretic components of behavior, is certainly regrettable, but tolerable in a book devoted to evolutionary theory *per se*. But leaving out inclusive fitness is something else again. It can only be an intentional sin of omission, brought on by the simple fact that inclusive fitness has effectively focussed the attention of biologists precisely where natural selection finds itself focussed, long before theorists pointed it out: at the level of genes. The striking "fitness" of this conceptual breakthrough must have been a major inconvenience for author Gould, focussed as he was on putting together a work of advocacy, rather than disinterested reportage.

In his effort to downplay gene selection, Gould claims that nonlinearity in the connection between genotype and phenotype makes it impossible to speak meaningfully about the effect of a single gene. Here, one can sense a not-so-faint whiff of postmodernist nonsense, with the impending assertion that because things are complex, we cannot speak of them meaningfully, and that reality itself is therefore somehow called into question. Yet I daresay that a postmodernist with appendicitis consults a surgeon, not a semiotician, and an evolutionary biologist who denies the primacy of genes is – like a Christian Scientist with a compound fracture – in no small difficulty.

The world of molecular biology – translating between DNA and phenotypes – is devilishly complex, but it is a connected, coherent world. And no matter how elaborate the interactions, it remains true that the substitution of one allele for another must have a mean arith-

metic effect on fitness, which will in turn convey a differential evolutionary advantage upon different alleles, depending on the environment (both internal and external) that they experience.

Moreover, Gould has his “bookkeeping-causation” mantra precisely backwards. It is species, not genes, that are units of bookkeeping, and genes - not species - that are units of causation. Species, unlike genes, have no existence independent of our identification of them. They simply comprise the sum total of what we choose to call its members; namely, all individuals (and, of course, their genes) that we recognize as capable of exchanging component genes with each other. Not only that, but I suggest that macroevolution, too, is an artifact of bookkeeping, neither more nor less than the accumulated consequence of numerous microevolutionary episodes, occurring as alleles are substituted for each other, often with the benefit of various isolating mechanisms, be they genetic, geographic, or behavioral.

Despite the unsupported nature of its many conjectures, much of *TSET* reads as though Gould’s points are already established: that selection occurs, co-equally, at many levels (and especially that of the species), that selection is only one among many forces responsible for evolution, and that punctuated equilibrium is an acknowledged fact (and a revolutionary one, to boot). Only rarely does he reveal the tentativeness of his propositions, notably in this passage concerning species selection.

I freely admit that well-documented cases of species selection do not permeate the literature. But I regard this infrequency as a great opportunity, rather than a restrictive limitation or an indication that the phenomenon scarcely exists. We have barely begun to acknowledge (much less to define or operationalize) this process, and we have still not entirely agreed upon criteria for recognition. We face the tradition of a full century spent *not* con-

sidering causes at this level (indeed, actively denying the existence of such levels at all). We are just learning how to look – or, to state the issue more incisively, we have just begun to recognize *that* we should be looking at all! We face all the promise of a rich but unploughed field – and (to commit two literary barbarisms of mixed metaphors and parodied quotations at the same time), we should summon up the courage of John Paul Jones and recognize that we have not yet begun to think. [pg. 710]

Next, the matter of catastrophism versus gradualism. Gould stakes much of his claim to fame upon his “discovery” of so-called “punctuated equilibrium,” shared with Niles Eldredge. His Chapter 8, “Punctuated equilibrium and the validation of macroevolutionary theory,” is nearly 300 pages in length, and warrants being a book by itself. Its title communicates the annoying arrogance and premature certainty that characterizes much of *TSET*, never more so than when “punk ek” rears its unlovely head.

Nearly 700 pages earlier, Gould had already tipped his hand, revealing the kind of selective argumentation that is to characterize most of *TSET*. Thus, in his interminable introductory chapter (“Defining and revising the structure of evolutionary theory”), Gould falsely claimed that the “subject of stasis had never been subjected to quantitative empirical study, a situation that has changed dramatically during the last 25 years” [pg. 75], that correction being due, of course, to the good offices of none other than Gould himself. But in fact, there have been numerous studies of evolutionary stasis, and not only by paleontologists. One thinks, for example, of the now-classic research by H. C. Bumpus on stabilizing selection among English sparrows, or the multitude of studies detailing various patterns of normalizing selection in many other taxa.

In my judgment, punctuated equilibrium isn't nearly the revolutionary approach

that Gould claims. Even those biologists most committed to a "gradualist" perspective never seriously considered that evolutionary change occurs at an unvarying rate, reflecting the slow, steady grinding of some great cosmic mill. *Of course* there have been periods of relative "stasis," punctuated by comparatively rapid changes. Environments change irregularly and unevenly; hence, evolution, too, is bound to be irregular and uneven. The point is that even times of galloping evolutionary change involved tens of thousands, even hundreds of thousands of years, and when they occurred, perfectly normal Darwinian processes - notably natural selection - were responsible.

In his book, *The Blind Watchmaker*, Richard Dawkins provided a devastatingly critical analogy for the gradualist-punctuationalist debate, and one that - not surprisingly - goes unmentioned in *TSET*. Dawkins noted that according to *Exodus*, the children of Israel wandered in the wilderness for 40 years before they came to their promised land, traversing in the process approximately 200 miles. This means that their average speed was about 5 miles per year, or 24 yards per day, or one yard per hour. This is much slower than the average snail, and is in fact, a pace that is nearly impossible for any human being to maintain.

Let us now imagine that two Biblical revisionist-minded scholars, troubled with the one-yard-per-hour dogma, come up with a different interpretation, claiming a crashing new insight: the prevailing "gradualist" analysis is wrong! The Israelites didn't really move this way at all! Instead - wonder of wonders - they traveled in fits and starts, likely camping in the same location for days, weeks, perhaps months, with such "equilibria" punctuated by sudden spurts of several miles in just a day or so. Next step: legions of atheists, eager to highlight dissension in the ranks of Old Testament historians, publicize the new view as proof that the legitimacy of Biblical scholarship, and thus, somehow, the Bible itself, is in doubt. (Actu-

ally, I can empathize with Steve Gould: if I had come up with something that might appear to be a dramatic reworking of the most important theory in science, evolution by natural selection, I too would probably have been tempted to trumpet it as a major modification, even if - or rather, especially if - it seemed to give Darwin a black eye and thereby elevated my own contribution.)

But, *contra* Gould, gradualism (à la Lyell, Darwin, and the Modern Synthesis), does not deny that catastrophes sometimes happen. The crucial point is simply that after catastrophes, plain old natural selection takes up where it left off. Selection continues to operate among the survivors, just as it does after a population passes through a genetic bottleneck, or after a major episode of random, nonselective mortality such as a tornado, or a blue whale passing through a cloud of plankton. The "theory of punctuated equilibria" simply does not qualify as a Kuhnian scientific revolution; it is barely a skirmish. Or, to change the metaphor, Gould and his acolytes have been pushing against an open door.

When it comes to the third major evolutionary principle, Gould's challenge to the exclusivity of natural selection as a mechanism of genetic change, I believe that the author of *TSET* is on firmer ground. He points, effectively, to recent findings in "Hoxology" and the truly astounding discovery of deep homologies between arthropods and chordates in the strange new world of homeobox genes. Gould makes a strong case for the importance of recasting much of what had until recently been seen as convergence as parallelism, instead. (Convergence speaks to the potency of selection alone, whereas parallelism implies the power of shared biological constraints, even when the homologous DNA patterns must go back literally hundreds of millions of years.) In a familiar but important argument, Gould urges the value of "formalism" - constraints imposed by phylogenetic history as well as by structural, engineering considerations - as against "func-

tionalism,” or straight-forward, unvarnished adaptationism.

Gould’s attempted resurrection of D’Arcy Thompson is, in my mind, suitable and overdue, especially for biologists – unlike most of the readers of this journal – with particular interest in morphology. It is nonetheless illuminating and regrettable that in his effort to make a case for nonselective factors, Gould makes it appear as though natural selection has already been dethroned; one searches in vain, for example, for the path-breaking work of John Endler, or numerous other successful toilers in the vineyards of dear old natural selection.

Let me end this review (yes, unlike Gould’s book, it will end!), by acknowledging some of *TSET*’s strengths, because it does have some. As a massive compendium of its author’s thoughts, it will be useful for a long time to come. Ditto as a compilation of numerous obscure and arcane historical references, as well as more information on fossil mollusks than I, at least, can ever absorb. Stephen Jay Gould remains, on the strength of this book alone, one of the greatest polemicists in the history of biology. Consider, as a final extended quotation, this marvelous rhetorical flourish against the polyphyletic theory of human origins:

How could a new species evolve in lock-step parallelism from three ancestral populations spread over more than half the globe? Three groups, each moving in the same direction, and all still able to interbreed and constitute a single species after more than a million years of change? (I know that multiregionalists posit limited gene flow to circumvent this problem, but can such a claim represent more than necessary special pleading in the face of a disabling theoretical difficulty?) Do we advocate such a scenario

for the evolution of any other global species? Do we ever suspect that rats evolved on several continents, with each subgroup moving in the same manner towards greater ratitude? Do pigeons trend globally towards increased pigeonosity? When we restate the thesis in terms of non-human species, the absurdity becomes apparent. When, then, did our media not grasp the singular oddity of multiregionalism and recognize out-of-Africa – especially given the cascade of supporting evidence in its favor – as the most ordinary of evolutionary propositions? [pg. 912]

And what a shame that the author of such fine rhetoric isn’t available to dispute the many silly ideas promulgated in *The Structure of Evolutionary Theory*!

In several places throughout this remarkable and infuriating book, Stephen Jay Gould refers, unblushingly, to his own immodesty. In an unforgettable put-down, Winston Churchill once spoke of his political rival, Clement Atlee, as “a modest man, with much to be modest about.” Steve Gould was an arrogant man, with much to be arrogant about. He was also a brilliant, aggravating gadfly (all the more aggravating because of his brilliance), an intellectually stimulating iconoclast ... in short, the kind of trouble-maker that every discipline needs but too few actually experience. Even if he had not written *The Structure of Evolutionary Theory* – and for the sake of his own reputation, I almost wish he hadn’t – Stephen Jay Gould will remain a “presence” and a force to contend with for many years to come.

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