On the death of paleontologist Stephen Jay Gould

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Stephen Jay Gould, the well-known Harvard paleontologist and noted defender of the theory of evolution, died last month from the effects of cancer, at the age of 60. Throughout much of his adult life, Gould has had an intimate association with this dreaded disease.

Twenty years earlier, he had triumphed over a particularly virulent form of cancer—abdominal mesothelioma—a struggle that became the subject of a memorable essay, "The median is not the message," in which he explained how a particular statistic, in this case the grim prognosis that the median survival time for his type of cancer was eight months, was subject to more than one interpretation.

For more than 30 years, Gould had been a major figure in American scientific thought, as well as in the popular perception of science. His views on the process of evolution, on the conflict between science and religion and on the nature of human history—views that often received considerable attention—deserve a careful and critical examination.

Gould achieved stature as an outspoken critic of creationism, and fought attempts by religious conservatives to remove the teaching of the theory of evolution from the public school science curriculum. During the 1990s, the paleontologist was instrumental in defeating an attempt by Christian fundamentalists in Arkansas to bar the teaching of evolution, and spoke out against a similar ruling by the Kansas Board of Education, whose members were subsequently removed from office in an ensuing election. Flabbergasted by the ignorance exhibited by the Kansas board, Gould observed that the teaching of biology without evolution was tantamount to "teaching English but making grammar optional."

With the Ohio state legislature currently moving to enact House Bill 48—a bill that would establish a nebulous course called "Origins Science," forcing teachers to teach biological evolution alongside the thinly veiled theological conception masquerading as science, the "intelligent design" hypothesis—Gould's voice of opposition will be missed.

Gould was particularly adept at demolishing the usual creationist arguments against evolution, like the claim that the fossil record contains no "transitional" forms that would indicate that a particular group of organisms, amphibians, for example, gave rise to a totally new group, such as reptiles. He was also crystal clear on the question of what constitutes a scientific theory, as opposed to the vulgar use of the term. This explanation would often segue into a discourse on why evolution by natural selection is the theory, but the knowledge that descent through modification has occurred throughout the history of life constitutes a fact.

Gould will be remembered primarily as a popularizer, as well as a prolific writer. He wrote more than 20 books, countless essays, and lectured on topics ranging from Darwinism and natural history to the sport of baseball, for which he held a lifelong passion. Gould also maintained a regular column in the journal *Natural History*, and had been the chairman of the American Association for the Advancement of Science.

Some of his most important books included *The Mismeasure of Man* (1981), a scathing critique of the use of anthropometrics and intelligence tests in the categorizing of humans as being either "superior" or "inferior" according to race, and *Ontogeny and Phylogeny* (1977), an examination of the relationship between evolution and the development of the individual organism—a sympathetic reconsideration of the "biogenetic law" of the nineteenth century German zoologist Ernst Haeckel, whose famous aphorism, "ontogeny recapitulates phylogeny," is largely dismissed today. Haeckel maintained that the development of the individual organism from conception to birth (ontogeny) "recapitulates" the evolutionary history of that organism (phylogeny).

Shortly before his death, Gould completed his magnum opus, *The Structure of Evolutionary Theory*, a final compilation of his thoughts on the theory of evolution, in which he sought to synthesize Darwinism with his own explanation for the tempo of the evolutionary transformation of life that has become known as "punctuated equilibrium."

Yet despite these accomplishments, and his undeniable brilliance, Gould was an enigmatic figure in the natural sciences. While he appeared to many as the authoritative spokesperson for the theory of biological evolution as it is presently understood, he had increasingly become the target of criticism from colleagues who disagreed with his interpretation of the evolutionary process. The controversy swirled around his explanation of punctuated equilibrium, and involved fundamental questions of science and philosophy.

The concept of punctuated equilibrium actually originated with Gould's mentor, the great evolutionary biologist Ernst Mayr. The theory, as it was originally formulated, combined gradualism with sudden and relatively rapid bursts of evolutionary change. Gould, however, increasingly counterpoised punctuated equilibrium to the gradualism advanced by Darwin, and associated rapid evolutionary transformations with catastrophic events—the impact of a comet or asteroid, for example. For Gould, gradualism became a kind of stasis in which very little of consequence was occurring.

Gould concluded that the sudden accelerations of evolutionary change that have certainly manifested themselves throughout the earth's history were the result of events in which chance played the preponderant role. For Gould, the determinism in nature that is contained within the blind process of natural selection was increasingly deemphasized in his writings, in favor of the purely accidental. Gould's "radical" contingency even excluded any notion of direction, such as evolution from the simple to the complex, for example.

It should be noted, however, that Darwinian natural selection doesn't simply appear following a catastrophe, but rages continuously during these allegedly static periods. In other words, species are engaged in an ongoing struggle simply to stay where they are with regard to their environment.

In a recent book, Ernst Mayr criticized Gould's interpretation of punctuated equilibrium. Mayr stated: "The claim has been made by some authors (Gould, 1971) that the occurrence of punctuated equilibria is in conflict with gradual Darwinian evolution. This is not correct. Even punctuated equilibria, which, at first sight, seems to support saltationism

and discontinuity, are in fact strictly populational phenomena, and therefore gradual. They are in no respect whatsoever in conflict with the evolutionary synthesis."

Mayr is not saying, in answer to Gould, that there can be no sudden evolutionary leaps (saltationism). There are many examples of rapid evolutionary change, the evolution of humans being one example. Rather, Mayr is making the point that evolution is a populational phenomenon occurring at the species level.

But it was the publication of *Wonderful Life: the Burgess Shale and the Nature of History* in 1989, Gould's engaging but flawed analysis of the fossils of that famous site in the Canadian Rockies, that created the most controversy. *Wonderful Life* analyzed the remarkable assemblage of organisms that exploded onto the scene 570 million years ago—a time marking the boundary between the Pre-Cambrian—a vast segment of the earth's history dominated by soft-bodied unicellular and multi-cellular organisms—and the Cambrian periods, characterized by the relatively sudden appearance of the major animal phyla that are represented today.

With *Wonderful Life*, Gould solidified his argument in favor of the preponderant role of chance in the evolutionary process. Gould reexamined the unusual creatures that contributed to the richness of the marine life at the Pre-Cambrian/Cambrian boundary that had previously been discovered and analyzed by Charles Doolittle Walcott nearly a century earlier. Gould marveled at the unique body plans of some of the Burgess Shale fossils—morphologies that seemed at first glance to be so unlike anything alive today.

In *Wonderful Life* Gould criticized Walcott's "linear" approach to evolution, in which the old paleontologist simply assumed that the creatures that left their impressions in the Burgess Shale evolved with Darwinian gradualism toward the animal phyla of today. Instead, basing himself on some recent analyses by three paleontologists from Britain and Ireland, Gould concluded that many of the extinct marine organisms were actually of a body type distinct from that of the global fauna of today, and, moreover, had left no descendants.

Thus Gould reasoned that the continuation of only one of the many body types that once populated the shallow seas of the Cambrian period was an event governed purely by chance—caused by whatever precipitated the mass extinction that is known to have occurred shortly after the 570 million year boundary. Roll the clock back 570 million years, Gould explained, and the outcome would be entirely different. Propelled by his analysis of the Burgess Shale fossils, Gould ended his book with a kind of counterfactual binge regarding human evolution and human history, in which the operating concept is the dominance of the contingent.

Counterfactuals, or "what if" scenarios, are certainly important analytical tools for both science and history. There are plenty of examples in history, where accident has played an enormous role in altering the course of events. But there is a complex interconnection between chance and necessity in both nature and human history, as was stressed by the philosopher Hegel, and the great Marxist thinkers, particularly Engels, with whose discourse on the subject Gould was certainly familiar.

After the publication of *Wonderful Life*, Gould's interpretation of the Burgess Shale fossils came under criticism from paleontologists, and he had since altered his views somewhat. But the issues that the late paleontologist raised are complex and significant. What is the relationship between chance and necessity in nature? Can one speak of progress from lower to higher forms in the evolution of life? Is the evolution of consciousness merely accidental, or is it a tendency immanent to nature?

Gould wrote: "Am I really arguing that nothing about life's history could be predicted, or might follow directly from general laws of nature? Of course not: the question that we face is one of scale, or level of focus. Life exhibits a structure obedient to physical principles. We do not live amidst a chaos of historical circumstance unaffected by anything accessible to the "scientific method" as traditionally conceived.... But these phenomena, rich and extensive though they are, lie too far from the details that interest us about life's history. Invariant laws of nature impact the general forms and functions of organisms; they set the channels in which organic design must evolve. But the channels are so broad relative to the details that fascinate us.... Charles Darwin recognized this central distinction between laws in the background and contingency in the details in a celebrated exchange of letters with the devout Christian evolutionist Asa Gray."

So, with this "god is in the details' approach, Gould added: "This means—and we must face the implication squarely—that the origin of Homo sapiens, as a tiny twig on an improbable branch of a contingent limb on a fortunate tree, lies well below the boundary [the boundary between law and contingency, WG] ... Homo sapiens, I fear is a 'thing so small' in a vast universe, a wildly improbable evolutionary event well within the realm of contingency."

Gould is not necessarily wrong in noting that our species, so early in its development when compared with the evolutionary timelines for most organisms, may in fact be a tiny evolutionary twig. Where Gould erred is in his denial of the growing potentiality in human evolution, and in his attributing this development—this "detail"—to the workings of chance only, with necessity, determinism and direction so far off in the distance as to have no impact.

While it is true that our species, Homo sapiens, was not preordained to arise from Australopithecus, the potential for further development along pathways cleared by the evolution of erect posture and bipedal locomotion were certainly present. Moreover, the great leap from Australopithecus to Homo erectus, no doubt triggered by the complex interplay of biology and the first stirrings of a truly human culture, gave to the prospects for the emergence of anatomically modern humans an extraordinarily high probability.

The biochemist and Nobel laureate Christian de Duve put it succinctly in his wonderful book, *Vital Dust: Life as a Cosmic Imperative*. De Duve, a specialist in the chemical composition of life, argues that natural selection operated at the macro-molecular level before living systems evolved, and that the chemical reactions that ultimately coalesced to form these living systems conformed to a strict determinism, which combined both chance and necessity. De Duve writes: "Mutations are chance events, which fact it is often claimed, implies a view of evolution as being ruled by chance. While not denying the role of contingency in evolution, I point out that chance operates within constraints—physical, chemical, biological, environmental—that limit its free play."

De Duve continues: "This evolution seems dominated by biodiversity, a profusion of species, products of chance mutations that happen to confer an advantage in a particular environment. With this variability, however, there is a trend toward complexification. The two features explain the structure of the "tree of life." First, there is the trunk, shaped by a series of "fork organisms," each affected by a mutation that significantly changed the body plan in the direction of greater complexity. Then there is the system of ramified branches, expressing increasingly trivial alterations of established body plans [what interests Gould, WG], the main source of diversity within each major group. This distinction reconciles two views of life that have often been opposed to one another in the past; it puts chance and necessity in correct perspective."

There is another major characteristic of evolution that refutes Gould's rigid separation of chance and necessity—convergence. Despite catastrophes, despite nature's capriciousness, certain tendencies developed not once but several times in the course of life's history, and their development was clearly in the direction of greater complexity. Two prominent examples are the evolution of flight and the evolution of the eye.

Convergent evolution occurs when two or more organisms, often with widely disparate evolutionary histories, independently develop similar

adaptations to problems posed by the environment. In the case of the evolution of flight, bats and birds express this tendency. Regarding sight, the incomparable eye of the eagle, the complex eye of the octopus (not even a vertebrate!) and the human eye show a convergence in the direction of visual acuity and complexity.

Yes, these developments involve accidents in the form of mutations, periodic chance alterations in the DNA molecule. But through these seeming accidents, determinism operates. Life moves to occupy all habitable niches—the niche of flight, the niche requiring acute color vision, and the niche requiring the evolution of consciousness. Thus human consciousness, far from having arisen through happy circumstance, represented the realization of directional tendencies in the evolution of life toward more complex sensory abilities and bigger and better brains.

Gould's interpretation of evolution, in which necessity in nature is debased in favor of the unbridled operation of contingency, ultimately revealed a deep pessimism about the human prospect. This pessimism informed his outlook on the conflict between science and religion, to the point where Gould's position with regard to the relentless onslaught against evolutionary theory by Christian fundamentalists and the Catholic Church became increasingly tentative and conciliatory.

It is no accident that the "intelligent design" hypothesis, the new strategy for insinuating religion into the public schools, seizes upon the notion that the defense of Darwinian evolution through natural selection means accepting of the operation of overwhelming contingency, with no direction or "purpose." In an essay, "The accidental creationist: Why Stephen Jay Gould is bad for evolution ," first published in the *New Yorker* magazine in 1999, science writer Robert Wright commented:

"Over the past three decades ... Gould has advanced a distinctive view of evolution. He stresses its flukier aspects—freak environmental catastrophes, and the like—and downplays natural selection's power to design complex life forms. In fact, if you really pay attention to what he is saying, and accept it, you might start to wonder how evolution could have created anything as intricate as a human being. As it happens, creationists have been wondering the very same thing, and they're delighted to have a Harvard paleontologist who will nourish their doubts."

While Gould always maintained that religion, as opposed to science, constituted a patently false view of the world, he increasingly denied that the two were in conflict. Gould welcomed the Pope's extremely qualified acceptance in 1996 of Darwinian evolution, even though the Vatican's "Message to Pontifical Academy of Sciences" made clear its belief that any consideration of the origins of the universe, life and human consciousness is a matter of epistemology, rather than a science.

However, it must be said that in raising the question to the level of epistemology the Vatican is throwing down the gauntlet and, in essence, declaring what most scientists and clerics recognize but will not admit: that the theory of evolution—nay, all scientific theory really—and religion are based upon two irreconcilably opposed views of the world. Gould makes an accommodation to religion by claiming that both it and science occupy separate "magesteria." The religious magesterium is concerned with morals and ethics, while the science magesterium deals with the world of nature.

Gould's peace offering has not been reciprocated in kind, however. Neither the Vatican nor the Christian fundamentalists are interested in a "live and let live" approach to the promulgation of scientific evolution as the explanation for the origin of life and humankind. No one knew this better than Gould.

So how is it that a scientist, who had dedicated his entire adult life to explaining life's origin and evolution from a scientific standpoint, ends that life with a pall cast over his scientific achievements and philosophy?

There is a wonderful quotation in Karl Marx's *Introduction to the Critique of Hegel's Philosophy of Right*, in which he explains the importance of the critique of religion: "The task of history, therefore, once the world beyond the truth has disappeared, is to establish the truth of this world. The immediate task of philosophy, which is at the service of history, once the saintly form of human self-alienation has been unmasked, is to unmask self-alienation in its unholy forms. Thus the criticism of heaven turns into the criticism of the earth, the criticism of religion into the criticism of right, and the criticism of theology into the criticism of politics."

Perhaps Gould found, in opposing the religious right in Arkansas and elsewhere, these retrograde elements had a wider political agenda. Rather than confronting religious ideology head-on, Gould increasingly sought an accommodation with it. In this regard, it is entirely appropriate to compare Gould's outlook with that of the other great popularizer of science and the scientific worldview, the late Carl Sagan.

Stephen Jay Gould considered himself an agnostic, while Sagan, although not admittedly an atheist, made no accommodation to religion, a fact made clear in his writings. In *The Demon-Haunted World*, Sagan wrote: "Think of how many religions attempt to validate themselves with prophecy. Think of how many people rely on these prophecies, however vague, however unfulfilled, to support or prop up their beliefs. Yet has there ever been a religion with the prophetic accuracy and reliability of science? No other human institution comes close."

Gould's agnosticism, taking into account his familial and scientific background, may have come as a surprise to some. But agnosticism is consistent with a worldview that is skeptical about the objectivity of human knowledge. The term originates from the great nineteenth century biologist T.H. Huxley, who, seeking to counter accusations by the emerging British capitalist class that he was an atheist, proposed that there were unanswerable questions—the existence or nonexistence of god, for example. Moreover, Gould, with his overemphasis of the role of contingency in nature, placed severe limits on the predictive ability of science.

Unfortunately, both Stephen Jay Gould and Carl Sagan are gone. Both died prematurely, and in the prime of their intellectual powers. It is hoped that in their absence, other scientists will come forward to champion science against religious obscurantism before masses of people.