From Smiling Birds to Dancing Gods: A View of Evolution

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The Flamingo's Smile
Stephen Jay Gould
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"The vision of one man lends not its wings to another", says the prophet in Kahlil Gibran's eponymous book, and this is, by and large, true. A few people, however, are gifted with a power of expression so remarkable that they can give their readers or listeners at least a few glimpses into their vision. A century and a half ago, the urdu poet Ghalib claimed that he possessed a unique and beautiful way of putting things (*kahtey hain ke Ghalib ka hai andaaz-e-bayaan aur*), and no one has yet disagreed with this somewhat grandiose but nonetheless accurate self-assessment. Among the science writers of the last hundred years or so, Stephen Jay Gould was one for whom a similar Ghalibian claim to uniqueness and beauty in writing would have been very apt. I first came across Gould's writings in 1987, when a collection of his essays, *Ever Since Darwin*, was prescribed as supplementary reading for a course on evolutionary biology being taught by John Thompson. We students were required to write critiques of some of the chapters, in addition to discussing the book. I thoroughly enjoyed reading the book, and since then I have read almost every book Gould wrote. As time went by, and my own views on evolutionary processes and patterns matured, I began to find much in Gould's writings with which I disagreed as an evolutionary biologist. My appreciation for Gould as a writer and historian of evolutionary biology, however, remained very high and, if anything, rose higher with time.

In an era when terseness seems to have replaced elegance as the desideratum of writing style, and in a nation not particularly noted for classical essay writing, Gould wrote expansively, passionately and beautifully on a variety of topics and themes revolving around an exposition of basic ideas in evolutionary biology and their implications for humankind, both intellectual and socio-political. His most popular and, in my opinion, best writings were the 300 essays he wrote for the column 'This View of Life' in the *Natural History* magazine between 1974 and 2001. In these essays, Gould explored myriad examples of what he once referred to as the "duality of natural history – richness in particularities and potential union in underlying explanation". With Gould, a simple observation about how a giant panda eats bamboo could lead to a delightful exposition of how the best evidence for evolution through natural selection comes not from seemingly perfect adaptations but from the odd and incongruous ways in which some organisms seem to deal with challenges posed by nature. Even items from outside the living world were used to great effect by Gould in explaining evolutionary ideas: neoteny discussed through Walt Disney cartoons, and the layout of typewriter (and computer) keyboards being the result of historical contingency are just two examples that come to mind. Several volumes of lightly edited collections of Gould's essays in the *Natural History* magazine have been published as books, and *The Flamingo's Smile*, first released in 1985, is one of them. All of these compilations are recommended most strongly to the readers of *Resonance*.

The first of the thirty essays that make up *The Flamingo's Smile* is the one that gives the book its title, and deals with the peculiar posture that flamingos adopt while feeding. Flamingos are filter feeders, taking out small animals from water in shallow hypersaline lakes. Their thick fleshy tongues, much in demand as a delicacy in Roman feasts, pump water into and out of their beaks which are lined with filters. While feeding, the heads of flamingos are upside down such that the anatomically upper bill is actually below the lower bill and functions as though it were the lower jaw. Till the description of the flamingos beak, the essay is classic descriptive natural history; thereafter it becomes evolutionary biology. If adaptive evolution indeed proceeds via natural selection, then we should expect form to follow function. The question that Gould goes on to ask is whether the flamingo's upper bill, functioning as a lower bill would, has evolved any similarities to the typical lower bill of other birds. The answer, perhaps not surprisingly for those who think Darwin got it right, is yes. In most birds, a smaller lower bill moves against a larger upper bill, whereas in flamingos the situation is reversed with a small upper bill actually dropping and rising against a stationary large lower bill during feeding. The theme of this essay is one to which Gould turned frequently in his writings – natural selection is a tinkerer, not an engineer. It is the odd adaptations, therefore, that provide the best evidence for evolution through natural selection. As Gould writes at the end of the second essay on sexual cannibalism, "Our world is not an optimal place, fine tuned by omnipotent forces of selection. It is a quirky mass of imperfections, working well enough (often admirably); a jury-rigged set of adaptations built of curious parts made available by past histories in different contexts. Darwin, who was a keen student of history, not just a devotee of selection, understood this principle as the primary proof of evolution itself. A world optimally adapted to current environments is a world without history, and a world without history might have been created as we find it. History matters; it confounds perfection and proves that current life transformed its own past."

Other essays in the first section of the book deal with a fundamental, and somewhat philosophical, question in biology: how do we decide what is an individual and what is not. When we think of animals such as ourselves, it seems a ridiculous question. However, as Gould shows through discussions of conjoint twins and Portuguese-men-of-war, the boundaries between individuals and colonies (aggregates of individuals) are not always as clear as we may think. The next series of essays moves on to another one of Gould's favourite themes, the issue of creation as described in the *Book of Genesis versus* evolution. Here Gould is writing as historian of science rather than naturalist but, once again, there is more to these essays than just a description of some interesting historical episode in this major argument about how to explain the diversity of life. Using these historical vignettes, Gould tries to highlight the essence of science and the scientific method as one in which ideas are laid out carefully and precisely as testable predictions, subjected to testing and, if found inadequate, rejected without prejudice.

In the essay 'The Freezing of Noah', Gould tells the tale of the Rev. William Buckland, a geologist, who tried to relate geological facts about caves with the biblical story of the flood. As we now realize, Buckland mistook geological relics of retreating glaciers for the signs of an ancient flood. However, in the 1820s, the notion of continental ice sheets had not yet been proposed, and one can hardly blame Buckland for not having considered it as a possible explanation of the observed geological data. Yet, as more data came in, it became increasingly clear that Buckland's explanation would not hold. Geologists realized that the different sites studied by Buckley were not from the same period, thus making it impossible to correlate widespread geological data with a single inundation. Moreover, no human remains were found at any of the sites, suggesting that the various inundations would have had to have preceded the biblical flood. The point that Gould stresses is that once the data that failed to support Buckland's ideas began coming in, he realized his theory could not stand and yet retained his interest in the issue and worked to find new, more appropriate, explanations. Indeed, once the theory of ice ages was put forward in the 1830s by Louis Agassiz, Buckland became one of the main people arguing in its favour in England. "Thus", as Gould puts it, "Buckland not only promptly abandoned his flood theory when it failed the test; he also led the search for new explanations and rejoiced in their discovery." Such is, or should be, the nature of scientific endeavour!

Another historical story related by Gould in this volume is that of Pierre-Louis Moreau de Maupertuis, who in a book published in 1745 attempted to provide a mechanistic explanation for development and differentiation, one of the great biological mysteries of that time. The development of a complex animal with differentiated tissues and parts from a rather formless fertilized egg was the subject of major debate among biologists in the 18th century. The preformationists held the view that development was primarily a process of unfolding and enlargement of pre-existing structures already present in the egg or sperm. The epigeneticists, on the other hand, believed that development actually involved the differentiation of varied complex parts from an original simplicity. Most epigeneticists were also vitalists, invoking some 'vital' non-material force that could impose a complicated structure on an initially homogeneous fertilized egg. The preformationists held a more mechanistic worldview and argued that the stunning complexity of an animal could not possibly arise from a formless nothingness. Maupertuis, as Gould shows, was a bit of an oddball in this debate: an epigeneticist in the sense of being opposed to the presence of pre-existing structures already in the egg and sperm before fertilization, but also committed to a mechanistic view that sought an explanation other than recourse to a "vital" force for the process of development and differentiation. Eventually, Maupertuis's convoluted theory involving gravity like forces between different disaggregated parts that cause them to combine into a developing body was completely rejected. Today we can see that Maupertuis had the correct insight that structural complexity cannot arise from mere formless potential. Yet, he lacked the right metaphor of programmed instructions, a metaphor that we living in a computer age are very comfortable with. As Gould writes in the concluding paragraph of the essay, "We must have access to the right metaphor, not only to the requisite information. Revolutionary thinkers are not, primarily, gatherers of facts, but weavers of new intellectual structures. Ultimately, Maupertuis failed because his age had not yet developed a dominant metaphor of our own time – coded instructions as the precursor to material complexity."

Other essays in the collection meander through topics and issues that Gould returned to repeatedly in his writings over the years. Five essays deal with the varied misunderstandings of evolution over the years and the equally longstanding abuse of evolutionary ideas as justification for chauvinistic and racist policies. Evolutionary biology, uniquely among scientific bodies of thought, has often been used to justify all kinds of socio-political agendas, and Gould, a strongly left-of-centre liberal, was always vocal about such abuse. Another issue that Gould wrote about often was our tendency to create and disseminate 'heroic' stories of how certain scientific advancements came about. In one of the essays in this volume, he explodes the myth that Darwin had a magical moment of insight into evolution by adaptive radiation upon seeing the various species of finches on the Galápagos Islands, many of which had bills very different from what would be normal for a finch. We learn, instead, that Darwin did not even recognize many of these birds as finches at all and it took John Gould, a British ornithologist and, ironically, a staunch creationist, to point out to Darwin that the various species from the Galápagos were actually an assemblage of thirteen closely related congeneric species among which bill morphology happened to vary considerably.

The final section of three essays deals with the notion that the extinction of dinosaurs, and of many other groups of organisms, was due to the fallout of the impact of a large asteroid that hit the earth about 650 million years ago. This theory was proposed in 1979 by Luis and Walter Alvarez to explain the Cretaceous mass extinction in which dinosaurs, many families of marine invertebrates, and most marine plankton went extinct in a geologically rather short time span. It was after this mass extinction that a major adaptive radiation of mammals – hitherto small nocturnal creatures crawling around in a landscape dominated by dinosaurs – into new ecological niches took place. The asteroid impact theory suggests that the dust cloud raised by a large asteroid hitting the Earth would cause photosynthesis to cease and would lower temperatures drastically. This theory was actually proposed after it was found that rocks from the time of the Cretaceous extinction were relatively rich in iridium, a rare metal that is almost absent in terrestrial rocks, and is usually found on extraterrestrial objects that strike the Earth. The story then gets more interesting. The Cretaceous mass extinction is one among several other episodes of mass extinction that have befallen the Earth and its flora and fauna. Scientists now recognize at least five episodes of mass extinction in the history of our Earth wherein the rate of species going extinct within a relatively short span of geological time was well above the average background level of extinction. Interestingly, these episodes seem to have occurred with a periodicity of about 26 million years. Higher than usual levels of iridium are also found in rocks dating to the times that other mass extinctions than that of the Cretaceous took place. There also appears to be a somewhat similar periodicity of occurrence ($\sim$28 million years) of impact craters on Earth that are over 10 kilometres in diameter. Based on these observations, a theory developed that the extraterrestrial bodies involved in these collisions that seem to accompany mass extinction episodes may have been comets rather than asteroids. This view was based on the periodic nature of these impacts: asteroid hits tend to occur at random, whereas comets tend to come near the Earth in a periodic manner.

In the final essay in the book, '*The Cosmic Dance of Siva*', Gould discusses a speculative theory about why comets should have hit the Earth with a periodicity of about 26 million years. There are vast numbers of comets circling our Sun in an envelope known as the Oort cloud that is well beyond the orbit of Pluto. One suggestion that was advanced in the mid 1980s was that our Sun had a hitherto unrecognized companion star, revolving in an eccentric orbit of maximal distance of about two light years from the Sun. If this star perturbed the Oort cloud only at its closest approach, it could in principle explain the 26 million year periodicity in major comet hits. This putative and undiscovered companion was tentatively named Nemesis by the propounders of the theory. Gould makes a plea – one that would surely resonate with Indian readers – that, if found, the companion star be named Siva rather than Nemesis. "Mass extinctions," he writes "are not unswervingly destructive in the history of life. They represent a source of creation as well...Mass extinction may be the primary and indispensable seed of major changes and shifts in life's history. Destruction and creation are locked in a dialectic of interaction... (Mass extinction) strikes at random or by rules that transcend the plans and purposes of any victim. May we not name the Sun's potential companion for a figure who embodies these central features of creativity in destruction and 'neutrality' toward the evolutionary struggles of creatures in preceding normal times?".

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