I Have Landed

IHL 1. I Have Landed

This, Gould tells us, is the 300th and final essay written for his monthly column *This View of Life*, which has appeared in *Natural History* magazine since 1974. The essay appears in the December 2000 / January 2001 issue, concluding a run in which he never missed a column deadline. He compares his personal 300-essay streak, over 27 years, to another continuous, unbroken chain of events more than a billion times longer – the natural history of life on earth. During this enormous period, life suffered several mass extinctions, but never went out completely; thus, we are the direct biological descendents

of an unbroken chain of life dating back more than 3.5 billion years. Infinite space and eternal time may be beyond our grasp, but life on earth – while extraordinarily vast – is both finite and, at least to a degree, comprehensible. He expresses his joy in being able to be a part of it, even if only for a geological moment. Writing these monthly essays has played a major role in his life, he adds, and he thanks all of the readers who made this journey with him. He closes this essay, and the series, with two additional stories on the theme of continuity.

The first story involves Henrietta Heathorn Huxley, the wife of Thomas Henry Huxley and grandmother of both Aldus Huxley (the author) and Julian Huxley (the biologist). She was born and raised in Australia, and as a young woman met "Hal" when he visited there as an assistant surgeon (in practice, a naturalist) on the 1846-1850 mission of the *H.M.S. Rattlesnake*. He was then in his early twenties, and was using some of his time at sea to learn Italian. "Nettie" gave him a parting gift of a five-volume set of Italian poetry by a Renaissance poet named Tassi; she signed it to him, in part, "in remembrance." After five years of separation, she sailed to England and married him; they lived happily and had six children that lived to adulthood. Much later, the very same Tassi collection came up for auction, and Gould successfully acquired it. He tells us in the preface that he was moved to tears by what he found. As an old woman, Nettie passed the same collection from the library of her deceased husband to her grandson Julian, with the same inscription written above the first: "In remembrance." Continuity, across a lifetime.

The second story is that of his maternal grandfather, who arrived at Ellis Island with his mother and sisters (his father had arrived a year earlier) from Hungary as a 14-year-old in 1901. Gould tells the story of how this young man grew up, met his wife, had children – one of whom was his mother – and worked his way into the middle class. Gould is the proud owner of what is apparently the first book his grandfather bought after arriving in his new native land: an 1892 edition of *Studies in English Grammar* by J. M. Greenwood. In it, written in pencil and unsure English, are the words "I have landed – September 11, 1901." (He mentioned this story in an earlier essay, and expresses gratitude to a reader – a professional genealogist – who sent him copies of his father's name on the ship's manifest stored in the Ellis Island archives.) Connecting the legacy of what his grandfather began almost exactly a century ago with his own sequence of essays, he ends his run with the following paragraph, a letter written to the memory of his grandfather:

> Dear Papa Joe, I have been faithful to your dream of persistence, and attentive to a hope that the increments of each worthy generation may buttress the continuity of evolution. You could speak those wondrous words right at the joy of terror and inception. I dared not repeat them until I could fulfill my own childhood dream – something that once seemed so mysteriously beyond any hope of realization to an insecure little boy in a garden apartment in Queens – to become a scientist and to make, by my own effort, even the tiniest addition to human knowledge of evolution and the history of life. But now, with my step 300, so fortuitously coincident with the world's new 1,000 and your won 100 [since arriving at Ellis Island], perhaps I have finally won the right to restate your noble words, and to

> tell you that their inspiration still lights my journey: I have landed. But I also can't help wondering what comes next!

IHL 2. No Science Without Fancy, No Art Without Facts: The Lepidoptery of Vladimir Nabokov

Vladimir Nabokov (1899-1977) is considered to be one of the most important literary figures of the twentieth century. His most famous work is the novel *Lolita*, published in 1955. Nabokov is noted for his detailed descriptions and his literary style, which involves anagrams other forms of wordplay. As it happens, he was also a professional lepidopterist: one who studies butterflies. More specifically, he was a taxonomist specializing in Central American "blues," and was a full-time Research Fellow and butterfly curator at Harvard University's Museum of Comparative Zoology for six years (1942-1948). This "dual citizenship" in the scientific and literary communities attracted Gould's attention. He has argued in several essays [e.g., LMC 2] that science and art both draw on man's unique creativity, despite the more common view that they are largely distinct. He writes:

> A set of stereotypes still rules perceptions of "otherness" in these two domains [the sciences and the arts] . . . . Scientists are soulless dial-twirlers; artists are arrogant, illogical, self-absorbed blowhards. . . . I do not wish to forge a false union in an artificial love feast. The two domains differ, truly and distinctly, in their chosen subject matter and established modes of validation. The magisterium (teaching authority) of science extends over the factual status of the natural world, and to the development of theories proposed to explain why these facts, and not others, characterize our universe. The magisteria of the arts and humanities treat ethical and aesthetic questions about morality, style, and beauty. . . . But many of us who labor in both domains (if only as an amateur in one) strongly feel that an overarching mental unity builds a deeper similarity than disparate subject matter can divide. Human creativity seems to work much as a coordinated and complex piece, whatever the different emphases demanded by disparate subjects. . . .

To Gould, Nabokov represents an excellent example of how the two worlds can exist in a single mind, without conflict. He wrote this essay as part of a catalog on antiquarian books, as opposed to his usual forum of *Natural History* magazine, in order to target a more humanities-oriented audience. He draws on books by B. Boyd and D. E. Zimmer for details.

He begins with a description of the problem, which he calls "the paradox of intellectual promiscuity." This phrase reflects a common lament among fans of specific artists and scientists who dedicate significant resources to other interests. The world lost something when Mozart died before his time; perhaps, others argue, it also lost something when Newton spent years analyzing the prophetic books of the Bible, or (in this case) when Nabokov studied butterflies when he could have been writing more novels. Gould's view is that there is nothing to be done about this; individuals make choices, and one's output is unquestionably affected by it. Gould adds that Nabokov was no dilettante, that is,

someone who worked on butterflies only in his spare time; he was a full-time professional in the field for many years, and this work absorbed vast amounts of his energy.

Perhaps, some have argued (he offers references), fans of Nabokov's writing can take solace in knowing that he made contributions to lepidoptery that were as great as those to literature. Gould analyzes some arguments along these lines and concludes that none of them are truly valid. Nabokov was a good descriptive taxonomist, and had "a good eye" – a complement of great prestige in the field. However, he had little interest in overarching theory, and those views that he did express were considered both fairly mainstream at the time, and recognized as incorrect today. He was a good, solid scientist, but not a great one. Another line of solace-searching involves the view (or hope) that the effort Nabokov put into studying butterflies fed back into his writing, making him a better novelist. This type of cross-pollination can occur; he references the work of Alfred Kinsey [TFS 10], who credits the methodology he developed in studying wasps to that of studying human sexuality. However, Gould concludes, this is probably not the case here. Nabokov was always very detailed and accurate in his descriptions of butterflies whenever they appeared in his stories, but he never made allegorical allusions to them, and they were never central to any particular storyline. However, Gould concludes, neither of these "failed solutions" is really an issue, because (he argues) Nabokov's "intellectual promiscuity" is not really a problem. It is just what he did.

So what, if anything, is the connection between art and science within Nabokov's mind? As Nabokov himself stated, the obvious answer is an almost obsessive attention to detail. This is virtually required for his taxonomic descriptions of the anatomical details of butterflies, but is less common in literature (and thus helped define his style). Other reviewers have, of course noticed this – it is difficult not to. However, some scholars in the humanities suggest this characteristic would be an impediment in the world of science, reducing the host "a laboratory drudge," as one writer put it. Gould counters that this is a bit unfair to the science community; many of the truly great scientists have also been highly detailed-oriented, from Kepler (who used the details of Tycho's observations to show that planets traveled in ellipses, rather than circles) to Darwin (who spent 20 years amassing a set of detailed examples in support of evolution).

In closing, Gould argues that Nabokov was one man, with one source of creativity, who developed two professional outlets. While many people in each field consider the other activity to be very different, Nabokov did not. The essay closes with a quote from a 1966 interview: "There is no science without fancy, and no art without facts."

IHL 3. Jim Bowie's Letter and Bill Buckner's Legs

At a functional level, one thing that all vertebrate brains seem to do is to identify *patterns* in data received via the senses. It is common to miss real patterns, but it is also important to note that humans, at least, are capable of identifying patterns where none exist; one obvious example is constellations. Humans add another layer to this function by creating *stories* to explain many of these patterns [a theme that Gould discusses in DIH 27].

Stories are defined by certain characteristics. First, they tend to be directional: they have a beginning, a middle, and an end. We like to find "the story" in everything from an individual baseball game to the rise and fall of civilizations. Second, the characters in these tales usually have a motivation of some sort that propels the story forward. Even if the story involves non-human or inanimate characters, it is common to associate *causes*, including themes that involve valor and integrity (or their opposites). This inescapable process, as Gould has discussed in other essays, is part of the "filtering" process between an external reality and our perception of it. It helps us make sense of an incredibly complex universe, although it can naturally lead to oversimplification. In this essay, Gould focuses on a related but nonetheless distinct problem with this approach to modeling reality: the number of stories in our repertoire is rather limited. This means that we tend to force the real world into a limited number of pathways, and this can lead us astray – leading us to "not see" relevant, available information, and to misconstrue some of the observations that we do make. Gould illustrates this point with two purely human examples, and then briefly discusses how the same phenomenon can impact our understanding of natural history. An awareness of this phenomenon can help us mitigate our biases. Gould suggests that an increase in the number of "canonical stories," as he refers to them, would also prove useful.

Gould names the first of the two types of canonical stories discussed here as "*All the brothers were valiant, and all the sisters virtuous*," which refers to fighting to the end for deeply held beliefs. The specific example he selects is the famous battle of the Alamo that took place on March 6, 1836. The canonical tale is that the 180 Texians (as they called themselves, with the "i"), under the dual command of the 40-year-old Jim Bowie (leader of the "militia" forces) and the 26-year-old William Travis (commander of the regular army troops) chose martyrdom over surrender to the vastly superior forces of Santa Anna. Their motivation was a valiant and total commitment to independence from Mexico, and, by inference, to freedom. Actual politics aside, one problem that puzzled Gould for 20 years is the existence of a letter from Jim Bowie to Santa Anna dated two weeks before the battle – "hiding in plain sight" in the Alamo museum itself – that offers to parlay and to find an honorable way out of the impasse without loss of life. Whether anything would have come from this had Bowie not fallen terminally ill with pneumonia is something we cannot know; but it does challenge the notion that everyone on the Texian side was committed to certain death and martyrdom. Perhaps the real story is simply that cooler heads did not prevail and events spiraled out of control, with tragic, rather than glorious, results. Gould's point is that the existence of Jim Bowie's letter has not been suppressed; it is, in fact, prominently displayed behind a glass case. Rather, he argues, most people simply do not know what to make of it, because it does not fit within the canonical tale of "all the brothers were valiant," and so filter it out. [Interestingly, a 2004 movie about the Alamo (of that title) re-told the story largely along the lines that Gould suggests here. It bombed at the box office; evidence, perhaps, that we indeed like our canonical stories!]

A second canonical story involves the famous 6th game of the 1986 World Series that the Boston Red Sox lost to the New York Mets, when a weakly-hit ground ball dribbled under the glove and then *between the legs* of first baseman Bill Buckner, perhaps the

most famous error in baseball history. Gould uses this example to illustrate a class of tales that he calls "*But for this*." It was true that, going into the game, the Red Sox were up three games to two, and on the verge of winning their first World Series championship since 1918 – with numerous soul-searing seasons in between. (The Boston fans believed, only half-jokingly, that the team was cursed.) Tied at the end of nine innings, the Red Sox scored two runs in the top of the tenth, and then got the first two outs in the bottom of the inning. Then things fell apart, the final play being Buckner's error and the loss of the game. "But for this," Boston would have broken the curse and won the Series. What this canonical version of the tale leaves out is that the Mets had already tied the score when the error occurred, so that even if Buckner had made the play, the game would have continued – with the outcome uncertain. Further, there was still a seventh game to play; had the Red Sox won that game, Buckner's error would only have been a footnote. Gould kept a file of press clippings about that game, all presumably written by people who watched it, and most tell the story as Buckner's error costing Boston a championship. This, he argues, tells us something important about how our minds work; we can and do reshape even our direct experiences with reality to fit our canonical stories.

This same phenomenon shapes both our understanding of human history and natural history, he claims. We see a (progressive, virtuous) increase in the complexity of life over time, including "the conquest of the land" and "the rise of mammals." We ignore the significance of bacteria in recent natural history, even though we know that their biomass exceeds all other forms of life combined; we downplay the well-established fact that more than three-quarters of all animal species on earth are insects. As a result of our story-oriented mode of thinking, we can misunderstand the true nature of life on earth, even when we have the facts.

IHL 4. The True Embodiment of Everything That's Excellent

Regular readers of Gould's essays know that he was a big fan of Gilbert and Sullivan. This essay, which appeared in *The American Scholar*, was written partially in response to the release of a movie about these historic figures in late 1999 entitled "Topsy Turvy." However, the essay is not a film review, but rather an inquiry into what made Gilbert and Sullivan's relatively "lowbrow" Victorian work not just good, but *excellent*. For a work of art (in the more general sense) to be truly excellent, Gould argues, it has to work well on two levels: it has to be accessible and enjoyable to people during the initial presentation, and it has to possess a more analytical, rational brilliance upon extended, detailed examination. It must be both superficially pretty and subtly, intricately clever. Gould discovered Gilbert and Sullivan at about age ten, and so loved the sound of the words and music that he was effortlessly able to memorize all thirteen surviving operas. Yet, even years later as an adult and Harvard professor, he would continue to discover new and unexpected twists. He gives several examples of both Sullivan's music and Gilbert's lyrics where he came to appreciate their work even more as he aged, an uncommon trend with regard to childhood passions. He presents some other examples of work that he feels works on multiple levels, from watching Joe DiMaggio play center field to some of the classic Disney movies (*Pinocchio* from 1940, and, interestingly, *Toy*

Story 2 from 1999) to Darwin's book *Origin of Species*. [The essay contains a few hints that he hopes his own "popular" writing will be found to qualify for this term as well.]

IHL 5. Art Meets Science in *The Heart of the Andes*: Church Paints, Humboldt Dies, Darwin Writes, and Nature Blinks in the Fateful Year of 1859

Gould identifies Alexander von Humboldt (1769-1859) as one of the great naturalists and intellectuals of the Enlightenment; he was one of the most famous men in Europe during his lifetime, even though he is not widely known today. A Prussian, he spent five years (1799 – 1804) exploring the geology and biology of South America, making numerous maps and describing the continent in a "modern" scientific way for the first time. (He visited President Jefferson, a fellow aficionado of science, while on his journey home). He produced a series of narratives of his journeys over the next two decades, which both sold very well and motivated the entire generation of naturalists that followed. In 1845 and 1847, he produced the first two volumes of his five-volume work *Kosmos*; Gould argues that this work "might well be ranked as the most important work of popular science ever published." The first volume tries to discuss the entirety of the external physical universe, from rocks to stars, fusing geography with all of the physical sciences. The second volume focused on the mechanisms by which the human mind *interpreted* this external reality, and illustrated his Enlightenment worldview.

The nature of Humboldt's worldview is at the heart of this essay. "The Enlightenment" was a very broad movement, or (some would say) a collection of movements. The political aspect challenged and, to a large degree, helped overthrow the centuries-old power triumvirate of kings, an established church, and the bible as mutually-reinforcing buttresses. A central part of the Enlightenment's underlying mechanism was (in Gould's words) its "faith that human history moved toward progress and harmony based on the increasing spread of intellect" which was, in turn, powered by the revolutionary techniques of mathematically-based, observation-driven *science* (as opposed to references to the established sources of Aristotle and the Bible). In *Kosmos*, Humboldt beautifully expresses the paradigm of natural harmony; this worldview postulated literal analogies between the machinery developed in the past few centuries (from timepieces to early steam engines) and living organisms, and – just as importantly – ecosystems and the universe in general. Newton had proven that three laws of motion, combined with the universal force of gravity, could explain many aspects of the universe, from the motions of celestial objects to apples falling and arrows flying on earth. A good part of the Enlightenment involved trying to expand this philosophical approach to everything else in nature as well.

Gould focuses on two of Humboldt's themes in this essay, both of which involve the concept of unity or holism. The first is that the universe is an integrated whole – a single, vast, interoperating machine. He and many other Enlightenment writers use the term *harmony* when discussing this concept. Gould quotes from Humboldt's preface to *Kosmos*, Volume I:

> The principal impulse by which I was directed was the earnest endeavor to comprehend the phenomena of physical objects in their general connection, and to represent nature as one great whole, moved and animated by internal forces. . . . Nature is a unity in diversity of phenomena; a harmony, blending together all created things, however dissimilar in form and attributes; one great whole animated by the breath of life."

Humboldt's second theme involves the human mind's subjective interpretation, or modeling, of this objective universe. The key inference is that all aspects of human creativity – including both science and art, but also music, poetry, and spirituality – all have the same source, and all help humans to perceive different aspects of this single but incredibly complex external world. (This view, claiming the unity of "emotional" art and "rational" science, differed from other views of the time. Edmund Burke, for example, considered the two to be completely separate – and argued that the rationally-oriented upper class, who were capable of rejecting the emotions found so commonly in the lower classes, were alone fit to rule. The Romantic school of thought also argued that the emotional and rational were separate, but that the rational, "scientific" part should be rejected by most people because [proponents claimed] the perceived beauty of the natural world was lost whenever one came to understand it rationally. Humboldt felt strongly that the emotional and the rational *reinforced* each other.)

Of the many people Humboldt influenced with his travel narratives and *Kosmos*, one was a scientifically-minded American painter named Frederick Edwin Church (1826 – 1900), one of the most famous landscape painters of all time. Church was inspired by Humboldt's writings to go to the Amazon basin himself and paint what he saw. He visited and stayed in many of the same places, using Humboldt's journals as a guidebook. Church is famous for his huge canvases with phenomenal detail – of icebergs in the arctic, of Niagara Falls, of mountains in the Andes. *The Heart of the Andes*, first exhibited in New York in 1859, was ten feet wide by five feet high surrounded by an enormous frame. Per Humboldt's vision, it designed to awe while being technically accurate in the geology and the flora it depicted – emotional *and* rational. It indeed caused quite a sensation, and in this pre-photographic age, people lined up to pay to see it. Church then had the painting shipped for display to Berlin, where Humboldt was still living. However, Humboldt died that same year (1859), before the painting arrived.

Another avid follower of Humboldt's was a young Charles Darwin. In his autobiography, written late in life, Darwin stated that two books that he read in his youth – J.F.W. Herschel's *Preliminary Discourse on the Study of Natural History* and Humboldt's *Personal Narrative* – influenced him to become a naturalist more than any others. Darwin was sufficiently inspired by Humboldt to plan a trip to the Canary Islands, and involved his mentor, J.S. Henslow. Later, when Henslow was approached to suggest someone suitable to accompany Capt FitzRoy on his upcoming five-year voyage in command of the H.M.S. *Beagle*, he suggested his young protégé. Thus Humboldt played an indirect role in getting Darwin to South America and the Galapagos Islands.

Darwin brought some of Humboldt's books with him on the voyage, and his letters (which Gould quotes) are full of admiration for him.

The essay's title reflects three events from 1859: the presentation of Church's *The Heart of the Andes* in New York and Europe, the death of the seminal Humboldt, and the publication of Darwin's *Origin of Species*. There is a large measure of irony in this, because Darwin's theory of natural selection (not the idea of evolution itself) demolishes three key parts of Humboldt's philosophy. First, it destroys the notion that nature is a unified whole; instead, it only involves individuals striving to survive and reproduce. Further, nature is not "kind" (nor is it cruel; in Darwin's world, it is simply indifferent). Gould quotes one of his favorite Darwin metaphors, "the face of nature" [see DIH 34]:

> We behold the face of nature bright with gladness, we often see superabundance of food; we do not see, or we forget, that the birds which are idly singing round us mostly live on insects or seeds, and are thus constantly destroying life; or we forget how largely these songsters, or their eggs, or their nestlings, are destroyed by birds and beasts of prey.

Secondly, in Darwin's world, evolutionary changes are not progressive, but only reflect adaptation to the current local environment. Species do not move toward higher or more unified states. Third and finally, life in general (and evolution in particular) is not driven by harmonious forces, but rather by internal and external mechanisms that contain a significant degree of randomness.

Many followers of Humboldt and his worldview were profoundly dismayed by Darwin's theory. Gould concludes, however, that all is not lost for this intellectual tradition. First, he states, Enlightenment views always acknowledge that something gained when the truth is learned, even if it is not the truth we had hoped for. Also, if one can get past the loss of a caring universe, many people – including Darwin, Gould notes – can still find spiritual joy in the beauty of nature, even if it does not "love us back." Second, the common creative origin of both science and art remains. While tensions between the magisteria of art and science sometimes dominate scholarly discussion, he stands by his view that Humboldt was essentially correct: the two can and should go hand in hand.

IHL 6. The Darwinian Gentleman at Marx's Funeral: Resolving Evolution's Oddest Coupling

Karl Marx (1818 – 1883) is buried in Highgate Cemetery in London, one of the most "fashionable" cemeteries in Victorian England. (Marx was a German, but moved to London in 1848 at age 31, after becoming *persona non grata* on the Continent for his radical writings and his agitation during the Revolutions of 1848. He lived in England for the rest of his life.) Despite his fame, his funeral in 1883 was not well-attended; there were less than a dozen mourners. Half of these were family members, and most of the rest were representatives of "worker's movements" that he had known since his youth.

There was, however one exception to this mix: the British biologist and Darwin supporter E. Ray Lankester (1847-1929), apparently a genuine friend. A scientist by training and a contrarian by nature, he was an established member of British Society, and politically quite conservative. He became a member of the Royal Society, and finally the Director of the British Museum (Natural History) from 1898 to 1907, the highest post in his profession. He produced a solid body of work "mopping up" after the first wave of Darwinism but before the rediscovery of Mendel's laws of genetics; he is also credited with establishing Darwinism at Oxford. The question, which Gould states has bothered him for 25 years, is what such a conservative member of the British establishment was doing at the funeral of the author of *The Communist Manifesto*? Gould draws on a 1995 book by Joseph Lester, *E. Ray Lankester and the Making of British Biology*, as well as two professional articles by Lewis S. Feuer and Diane B. Paul, for some answers.

Gould starts by rejecting two "obvious" hypotheses. Perhaps, some have speculated, Lankester harbored some socialist political leanings in his youth. This is undermined in part by the conditions in which they met in 1880 (when Lankester was in his 30's and Marx was an old man). It was Marx that approached Lankester, not the other way around; and the purpose was to seek the influential Lankester's assistance in finding a good physician for his wife, who was dying from breast cancer. Perhaps, others have proposed, Marx sought out Lankester because of the latter's support of Darwinism, something that "Marxists" of all types found interesting and supportive of their goals [see BFB 22 for more on Darwin's later influence in Russia]. This also does not pan out; unlike his colleague Engel, Marx did not remain actively interested in evolution. Further, Marx wrote explicitly and astutely (but also politely) that Darwin's vision of the struggle of all against all did not fit well with his own ideas of class struggle, and that Darwin's obvious references to Adam Smith's "invisible hand" [ELP 9] suggested a connection between natural selection and capitalist market economics that was also unhelpful.

So why were Lankester and Marx friends? The answer that Gould comes up with, on the surface, is anticlimactic. Marx in his old age had built up a series of resentments toward his contemporaries, but had a number of younger friends to whom he was a brilliant sage, well-versed in many forms of knowledge, including art and literature. One young man in particular, Charles Waldstein (who was some ten years younger than Lankester), received a letter from Marx that Gould had only recently come across. In the letter, Marx proposes that the two become *Dutz-freunde*, a German term in which the familiar "du" is used instead of the formal "Sie" as a form of address. (English has lost its version of the familiar form, "thou.") This was a rare honor, and it illustrates that Marx considered at least one young man to be a genuinely close friend. Waldstein and Lankester knew each other well, and Feuer (whom Gould references) suggests that this could easily explain how they met and the initial basis for their friendship.

If the solution is so straightforward, Gould asks himself, then why did he have such trouble in recognizing it? He finally realized that he was confusing the Karl Marx who died in 1883 with the Karl Marx of the Russian revolutions (1905 and 1917) and of Stalin. All of this was far in the future in 1883; communism was not yet *Communism*, with its implications of totalitarianism and mass murder. It would have been impossible

for Lankester to know how Marx's theories would be used in the future; he relates this via analogy to predictions some being might have made about the future of a species of primate on earth ten million years ago.

IHL 7. The Pre-Adamite in a Nutshell

British historian of geology M. J. S. Rudwick published a book in 1992 entitled *Scenes from Deep Time*; the subject is "the development of conventions for illustrating extinct faunas of the geological past." One of Rudwick's key figures is from an 1860 book that sold quite well in its time, entitled *Pre-Adamite Man: The Story of Our Old Planet and Its Inhabitants*. The book did not state the author, but others had determined it to be a woman named Isabelle Duncan. Gould is sorry, but not surprised, that he can find out almost nothing else about her. (In an extended footnote, he thanks one reader in particular for sending him a recent dissertation on Ms. Duncan. He has lamented the lack of opportunity and exposure for 19th century women in the sciences in DIH 15.) The book contains an important illustration as a fold-out; it depicts three ages of life on earth in three horizontal bands, the uppermost containing modern animals and even pyramids in the background. According to Rudwick, this figure "broke the standard mold by suggesting a sequence in deep time." Gould continues: "Previously, most authors had presented only one or two reconstructions of particular past moments or intervals – with Mesozoic dinosaurs and large Cenozoic mammals already emerging as "industry standards." [James Hutton's Theory of the Earth, often credited as announcing the discovery of "deep time," was published in 1795 (HTHT 6); the bones of certain large mammals were formally recognized as "extinct," with the implication of a different set of European fauna in the past, at about the same time (HTHT 7); and dinosaurs were recognized as a distinct and older group in 1842 (LSM 9).] Gould notes an odd feature of the drawing: the bottom two layers are connected, suggesting a continuum, but the middle and upper bands are separated by lifeless band of icy mountains. It is this discontinuity that leads to the second and main part of the essay, which involves Duncan's worldview.

What is Pre-Adamism, the concept behind Duncan's book and illustration? Gould backs up another step and tells us that it belongs to one subset of the larger paradigm of *exegesis*. Exegesis is a school of thought that postulates that human understanding of reality comes, not directly from divine revelation or from observation and experiments, but by critically interpreting ancient texts, including the Bible, but often others as well – including those of the Greeks, Romans, and other past civilizations. When it comes to scientific discoveries, some Biblical exegetes fall into the category of contrarian: if science and the Bible disagree, science must be wrong. But most exegetes were (and are) reconciliationists, meaning that they are generally willing to consider different *interpretations* of the text – including the authors' use of metaphors, and general incompleteness – to fit with more modern discoveries, such as deep time, although the text itself was (by postulate) inerrant. Exegetes trying to glean the origin of the earth and man from both the Bible and early science first had to reconcile the biblical six days of creation with what they accepted as an earth that was significantly older than 6000 years. They fell largely into three categories: one that believed that there was an enormous

temporal gap between the time God created heaven and earth, and everything else; the "day-age" group that interpreted each of the six days of creation as a metaphor for a much longer period of time; and a third group that, in addition to one or both of the above, also believed that the story of Genesis only tells the creation of the Jewish people, and deals with only local events. Most Pre-Adamites fell into this third category; such an approach solved certain problems, such as where the North American "Indians" came from, and how the enormous number of species being discovered in tropical environments could all have fit on Noah's ark. The flowering of this family of worldviews lasted for about 200 years, and drew the attention of many notable thinkers. It helped stimulate the larger field of Biblical studies (at least in Christendom), where the text can be examined critically for details, including errors and internal contradictions. As a method for learning about reality, exegesis is almost extinct today, but it does occasionally pop up in popular literature. [Gould attacked Immanuel Velikovsky as an exegete, although he did not use that term, in one of his earliest essays – ESD 19.]

By 1655, some scholars (and, no doubt, even a few ordinary people) had recognized certain problems with the story of Genesis; for example, who was available to marry Cain, and thereby produce the rest of us? (One commonly hinted-at solution was an unnamed sister or two, but this raises other problems.) Also, after the former killed Abel, God branded him with "the Mark of Cain"; but if there were no non-family members on earth to see it, what was the point? The formal idea that there were men (and women) on earth before Adam and Eve was first proposed by Isaac La Peyrère (1596 – 1676), a French protestant intellectual, in his widely-read 1655 book *Men Before Adam*. (Gould draws on R. H. Popkin's 1987 book about La Peyrère for details.) La Peyrère became convinced that a passage from Romans 5 (which he misinterpreted, according to most biblical scholars today) "proved" that men must have existed before Adam, and thus Genesis refers only to the creation of the Jews and related groups. (La Peyrère believed, nonetheless, that all humans – not just the Jews and their Christian "descendents" – were all equal in the eyes of God, and would be judged appropriately. Others, however, used this concept to produce the concept of polygenesis [discussed in TPT 16 and TFS 12]; in this view, only Caucasians were descended from Adam and Eve, and other races were separately created (and, almost inevitably, therefore inferior). Gould is also fascinated by the timing; the year 1655 was just eleven years before Isaac Newton published *Principia*, a date which is often associated with the founding of science. These two approaches for understanding the world coexisted on parallel tracks, he writes, for two centuries.

Pre-Adamism came in a number of variants. Isabelle Duncan developed a strikingly original version in her 1860 book. Rather than focusing on Romans as La Peyrère had done, she instead turned to Genesis 1 and 2. Virtually all biblical scholars today agree that, despite claims that the first five books were all written by Moses, they were in fact assembled from a number of sources. This is especially clear in the original Hebrew: Genesis 1 refers to God as Yahweh (Jehovah in King James English), while Genesis 2 calls God Elohim. Duncan recognized this, but this was not her objection; what bothered her was that Genesis 1 and 2 tell *different stories*. Specifically, Genesis 1 states that plants and animals were created before man (with man and woman being created together), while Genesis 2 creates man first, and then plants and animals, and then finally

woman. It was the *internal inconsistency* that was the problem for her; how could both stories be true, as was required by her religious faith and her exegetic paradigm? Her solution was to interpret Genesis as the story of two separate creations, with the Hebrew word "Adam" used generically for "man" instead of specifically for one man. The dinosaurs and Cenozoic mammals were associated with the earlier creation. So far, Gould writes, this is a consistent theory, given the constraints of her sources and her exegetic methodology.

But Duncan went further. She drew in a problem from the realm of science: artifacts of early man (arrowheads, stone axes, and so on) were turning up in recent geologic strata, but human skeletons were not. [A few Neanderthal bones had been discovered by 1860, but their age had not yet been determined. Java Man, today recognized as *Homo erectus*, was not discovered until 1891.] Where were the bones of these men of the first creation? At this point, she filled in the blanks via the familiar mechanisms of reading the Bible and reflecting; in the process, she made up a story, *without realizing that this was what she was doing*. She determined that the only possible answer was that these men and women had been wiped out completely by an angry God; not via the local mechanism of Noah's flood, but via what she believed was a worldwide ice age, the evidence of which had been offered by Luis Agassiz in 1837. Then, their bodies had been resurrected, leaving tools but no bones. The only thing that could make God so angry, she continued, had to be a rebellion by a portion of the population. The guilty were resurrected as followers of Lucifer, while the innocent became the angles that the Bible states have visited the members of the second creation on occasion. This worldwide layer of ice is depicted as the lifeless boundary in the key illustration from her book.

Besides the entertainment value of her model and the historical artifact of an utterly false model, is there anything we can learn from Duncan's exegetic views? Yes, replies Gould: we can learn that the mind is capable of filling in large gaps between constraints, even when those constraints are not accurate. Further, it is often very difficult for us to realize that we are speculating, rather than extrapolating. He also writes: "We can learn something important from Isabelle Duncan because her blazingly obvious restrictions may help us to analyze our own, more subtle, limitations – for we always view the natural world within a blinkered mental compass, and we usually don't know how to see beyond our presuppositions (the reason, of course, why many false views of indubitable past geniuses seem so strange to us today.)" He then offers a quote from Hamlet, illustrating this point and giving the essay its title:

> Oh God I could be bounded in a nutshell, and could count myself a king of infinite space, were it not that I have bad dreams.

"I'm afraid," he concludes, "that we must pay the price in scary thoughts if we wish to fracture the confines of our mental comfort."

IHL 8. Freud's Evolutionary Fantasy

Sigmund Freud (1856 – 1939) was one of the most influential thinkers of the 20th century, and the theory and techniques of his psychoanalysis live on today, albeit in modified forms. His supporters, Gould states, usually argue that Freud's worldview was almost completely original, and tend to downplay the role of earlier ideas on his thinking. However, he continues, few scholars of Freud have studied biology in detail, and almost none have studied a rejected and largely-forgotten paradigm that did, in fact, heavily influence him: recapitulation. As a result, Freud's theories are often implied to be more abstract, metaphorical, and almost mystical than they really are. (Gould draws on Frank Sulloway's 1979 book *Freud: Biologist of the Mind*, and his own 1977 technical book *Ontogeny and Phylogeny* for details in what follows.)

Freud was formally trained in biology in the 19th century, when recapitulation was at the center of biological and evolutionary thinking. As a biological theory [described in the most detail in these essays in TPT 24 and IHL 22], recapitulationism argues that the development of an individual organism, from fertilized egg to adult ("ontogeny"), repeats – or recapitulates – the evolutionary development of that individual's ancestry over perhaps hundreds of millions of years ("phylogeny"), thus yielding the eponymous catchphrase "ontogeny recapitulates phylogeny." While there are in fact some interesting correlations between the two, even in its heyday it proved to be unhelpful to those who tried to use it to solve real biological problems, and it faded quickly after the rediscovery of Mendel's genetics in 1900. Before it did, however, some versions of this theory that focused on human evolution manifested themselves in the mainstream of society. Humans, it was argued, continually "progress" toward higher states of intelligence and behavior [ESD 7]; but not all races have progressed equally. Caucasians, of course, had progressed the farthest (this was rationalized in a number of ways, often geographically), followed by the Orientals, and then finally the Africans. In what was known as the three-fold parallelism, Caucasian children were argued to be analogous to both ancient Caucasian ancestors (from hunter-gatherers of 10,000 years ago to *Homo erectus* of a million years ago and beyond, depending on the version) and, importantly, to the adults of modern "primitive" cultures. The correlation between modern European children and the adults of those peoples that the Europeans were running into during the age of imperialism was widely used to justify racist and colonialist policies [ESD 27, TPT 15, and his books *Ontogeny and Phylogeny* and *The Mismeasure of Man*]. (Gould quotes a line from Rudyard Kipling's famous poem, "The White Man's Burdon.")

Also important was the perspective that today's children are mentally and emotionally similar to the adults of our ancient ancestors, the "cave men." An essential component of this view was that these behaviors were *selective adaptations* for life in those times; that is, cave men were not behaving "childishly," according to this version of recapitulationism; rather, they were behaving *like proper adults* for the world that they lived in. (Even if recapitulationism were valid, Gould notes, he would still object to the view that human behaviors are entirely shaped by selective processes, and that they are therefore all "adaptive.") This view made it into the educational process of American elementary schools in the late 19th century, and was also responsible for a view of criminal behavior as a "throwback" to acceptable behavior in an earlier world [ESD 28].

It was in this environment that Freud developed his theory of psychoanalysis. (Gould points out that Freud studied biology in college, and – as noted in the title of Sulloway's book – thought of himself as a "biologist of the mind"). In essence, Gould states, Freud was trying to add a fourth parallel to the three-fold parallelism: one in which neuroses and psychoses were interpreted as interruptions in the proper developmental ontogeny of the afflicted individuals. That is, he argued that neuroses reflected the subject becoming stuck, or "fixated," in a developmental state that corresponded to an earlier *phyletic*, or evolutionary, state. Gould quotes Freud from 1905, regarding his famed oral and anal psychosexual stages, that "[it] almost seems as though they were harking back to early animal forms of life." He continues with several quotes over Freud's career to illustrate that recapitulation was fundamental to his thinking, and was in fact the central concept of his 1919 book *Totem and Taboo, or Some Points of Agreement between the Mental Life of Savages and Neurotics* (1913 – the subtitle makes the point) and his 1937 book, *Moses and Monotheism*. His view was that obsessions, compulsions, repression, and even psychoses were not (say) the result of disruptive brain chemistry, but rather *appropriate behavior* for some of our ancestors, who faced different challenges, or – one of Freud's recurring themes – reflect ancient traumas. Freud believed that it was possible to read human psychological history in the development of children and the neuroses of adults, just as geologists could read the history of earth by examining strata and lava fields. (To make this work, Freud needed the second now-discarded paradigm: the Lamarckian view of evolution, with its catchphrase "the inheritance of acquired characteristics." In our modern view of evolution, one generation's psychological trauma cannot affect the *genome* of those that follow, and so cannot *biologically* influence their behavior. Freud, Gould shows, was deeply committed to Lamarckism.)

Many scholars believed that Freud was speaking allegorically when he argued that, for example, manic-depression in a patient today reflects the emotional range of emotions that one of our ancestors felt when he killed his father, the king (joy at the accomplishment at achieving power, along with the intense guilt at the act itself). However, a fascinating lost paper of his was rediscovered in 1983, and published four years later by Harvard University Press under a translation of Freud's own title, *A Phylogenetic Fantasy*, challenges this. Actually a handwritten draft, it explicitly discusses Freud's self-admittedly speculative reading of mankind's history in terms of modern neuroses. In this work, Freud emphasizes a correlation between the typical age of an individual when certain mental problems tend to first appear, and his view of traumas faced by early man from the advance and then retreat of the ice age glaciers.

Freud discusses six neuroses in these chronological terms. The first three, which he calls "transference neuroses," are anxiety, conversion, and obsession, and in his view reflect appropriate responses in our ancestors. Anxiety, which can appear in young children, reflects our adult ancestor's reaction to the coming of the great ice sheets themselves. Conversion hysteria is associated with psychologically-induced physical symptoms such as numbness, paralysis, or fits, and Freud attributes these as an appropriate psycho-sexual response to limit population in hard times by limiting the libido. Obsession reflects a formerly-appropriate behavior of working compulsively to collect the food and firewood, or maintain other resources necessary for survival in the harsh environment. The second

set of three, which he calls narcissistic neuroses – schizophrenia, paranoia, and depression or manic depression – record events that occur after the ice sheets have retreated. Schizophrenia, he argues, reflects the father's castration of his older sons who challenged his authority (Freud drew on his belief that patients suffering from schizophrenia behaved as though they had been castrated, in terms of their withdrawal from society. His book *Totem and Taboo* elaborates on these views.) Paranoia reflects what he considered to be the legitimate concerns of young men in all-male packs exiled from the tribe by the father-king to the problem of warding off inevitable homosexual advances. Finally, manic depression reflects the reaction to the murder of the father-king (and perhaps marrying his wife, their mother) by the triumphal sons.

There is so much wrong with this paradigm that it is difficult to know where to begin. Gould notes, almost in passing, that most of *our* ancestors were living in Africa during the ice ages, and that we have no evidence that the Neanderthals who did face the ice sheets suffered from a lack of resources during this period. Freud himself recognized how speculative it was (hence the essay's name), and after a period of early enthusiasm never returned to it; he never tried to publish it. Freud also recognized that the Lamarckian version of evolution that this theory depended on was rapidly fading in the scientific community. Gould closes by stating that he dislikes Freud's highly speculative approach, on the grounds that often results in giving the historical sciences an underserved bad name. However, he continues, he also objects to those who would try to interpret Freud's thinking as ranging from allegorical to mystical; this does neither the man nor his theory the justice it deserves. Freud may have been both overly speculative and simply wrong, but his thinking was not as abstract as many believe.

IHL 9. The Jew and the Jewstone

Gould has always been interested in how people who lived before the scientific revolution viewed the world. In reading a recently-purchased book published in 1677 (in Latin), he came across just such a window into the mind of "pre-scientific" man. The book, *Pharmacopoeia mediocochymica* by Johann Schröder, was a 17th-century desk reference for drugs, medicinal substances, and "curative procedures." The particular procedure that led to his writing of this essay involved the treatment for a wound caused by a thrusting weapon, such as a sword. The issue was not the balm itself, for which a recipe was given, but the fact that the physician was directed to apply the balm to the sword as well as the wound! (Gould had long ago heard that such remedies had been proposed, but had never seen an actual example of it until he examined this purchase.) If we can get to the point where this approach is comprehensible, Gould argues, then we will have gained some insight into how our ancestors thought.

The mainstream views of the world to Europeans of the sixteenth century were heavily based on the concepts of harmony and balance, a creation of God to illustrate His power and goodness. The Earth, at the center of the universe, was recently formed to accent His best creation: the one in his own image. (Gould notes that the difference between the pre- and post-scientific world can be partially summarized in terms of its different views of causality; the older one reflecting a young, static universe with everything at rest or in

equilibrium.) Most physicians of this period had been following a Christianized version of Galen's theory of humors. Galen, a Greek working for the Roman Empire, argued that diseases resulted from imbalances between the levels of the four humors: blood (sanguine), phlegm, yellow bile (choler), and black bile (melancholy). Thus, illness should be treated by adding or subtracting the appropriate humor, usually by purging and/or "bleeding."

The author of the weapon salve in Schröder's book was not a follower of Galen, however, but a follower of the theories of Paracelsus (1493 – 1541). The essay now turns to explore this man and his views. Paracelsus did not believe in humors, or that disease was caused by a lack of balance and harmony amongst them. Rather, he believed that diseases had *external* causes (mostly "poisons" of various types). To cure them, he drew on a different kind of harmony: the one between different realms of nature – animals, plants, and minerals [see LSM 1 & 3]. To correct an illness in a human (that is, in the animal world), one must seek help from the analogous forms in the plant and mineral realms, as well as the relative positions of heavenly bodies. (The fact that some plants did provide real medicinal benefits helped justify this belief.) Paracelsus looked for "signatures": plants that were the same color as the affected organ, or stones that had a shape or perceived origin that was related to an ailment. For example, impotence would be treated by ingesting orchids, a flower which, to some, resembles the male genitalia. Schröder's book also identifies numerous items from the mineral realm that are credited with medical uses. Some of these are: *glossopetra* or "tongue stones," used for treating snakebites, and today recognized as fossil shark teeth; *aetites* or "pregnant stones," believed to be helpful during labor, and today known as geodes (volcanic bubbles that have been filled in by silicate minerals); and *Lapis judaicus*, or "jew stones," used to help with kidney stones and today recognized as fossil sea urchin spines. Jew stones are named for the fact that they were commonly found in Palestine. Their "signature" was that, in addition to a rough resemblance to kidney stones, they had a series of long, parallel grooves that were thought to aid in "flowing" them out of the body. Returning to the original stimulus for this essay, why apply the salve to the sword as well as the wound? Disappointingly, Schröder says little about this, other than the "balsamic" (comforting) spirit exists in both the patient and the blood of his wound, which presumably adheres to the weapon.

Gould has argued in these essays for the importance of not condemning previous generations for what they could not possibly have known. He also resists the urge to dismiss these obsolete paradigms as unimportant, because they give us a priceless perspective on other ways that humans can think. The treatments, especially those involving minerals, are ineffective (other than a possible placebo effect); however, Gould asks, if one grants that genuinely helpful treatments do not yet exist, does the existence of these false cures, and the false paradigms behind them, do any harm? In fact, he concludes with some ambivalence, these pre-scientific worldviews were harmful. First, of course, people are resistant to change, so models that do not accurately reflect nature impede the acceptance of those that are better. A second argument involves the importance of taxonomy. If shark teeth, geodes, and sea urchin spines are grouped together as "objects in the mineral world with therapeutic value," then it is far more

difficult to explore the notion that some of the above are remnants of formerly living organisms, while others are not. The art and science of "grouping things" is important [HTHT 5, DIH 32], and bad choices can preclude further fruitful activity. Gould's third argument that these views are harmful can be extrapolated from a paragraph in Schröder's preface, which reads that the primary cause of the harm and ills that physicians must face are caused by – yes – Jews; Schröder elaborates in ugly detail. Gould acknowledges that post-scientific-revolution humanity is also capable of irrational hatred, including anti-Semitism, but at least now there are arguments and other techniques that can at least attempt to counter these views. Importantly, no such tools exist in this alternative worldview.

IHL 10. When Fossils Were Young

Gould begins by discussing minor changes that make life noticeably better. His first, almost trivial example is the change in listing departing flights on airport screens by destination rather than departure time. This was a simple change that cost virtually nothing to implement, and it made a small but non-negligible improvement in the quality of life of frequent travelers. He observes that the original scheme did not arise capriciously, but made sense an earlier age, dating back to train travel; departures were few and only went in a few directions. He also notes that such schemes have an inertia of sorts, hanging on longer than they should; but when the change does come, it tends to occur fairly rapidly, if in a somewhat piecemeal fashion.

He continues by offering a second example: the organizing of authors in the bibliographies of books. It has always been done alphabetically – but originally, after the printing press was invented, it was by the author's first name. This made sense in the 15th and 16th centuries, since most referenced sources were Greeks and Romans (e.g., Aristotle and Pliny); there were yet to be a significant contribution to any of the technical fields by moderns. By the late 1600's, ordering authors by last name, conducive with the European naming scheme, had become standard, with exceptions granted for the ancients. But in between, there was an extended period in which most of the authors were European, but the ordering was still by first name (like airplane flights listed by departure time). Gould references a 1613 publication by Caspar Bauhin, a great Swiss naturalist of his day, which lists an entire page of authors under "John."

Taxonomies can exhibit this problem as well. Gould defines taxonomies as ". . . classifications of related objects into an order that either helps us to retrieve information (the basic utilitarian reason for erecting taxonomies) or purports to explain the basis of variation (the scientist's more general rationale for devising systems of classification)." He continues:

> . . . [F]alse taxonomies – based on sensible criteria at first but then persisting as traditions that can only be deemed arbitrary (at best) or harmful (at worst) – form a potent category of mental biases that becloud our view of empirical nature and our moral compass as well. My fellow scientists seem particularly subject to this species of blindness because we have been trained to think that we see the world

> objectively. We therefore become specially subject to delusion by taxonomic schemes implanted in our minds by cultural traditions of learning but falsely regarded as expressing an objective natural reality.

He exemplifies this with what he considers to be an exceptionally "clean" case study: the illustration of fossils in early post-Gutenberg books. [Gould discussed the importance of illustrations in understanding old worldviews in several essays, including ELP 30, LMC 3, LSM 3, and IHL 7.] The first "modern" books to describe fossils in a comprehensive way were Agricola's *De natura fossilium* in 1546 and Gesner's *De rerum fossilium* in 1565 [both discussed in LSM 3], but these contained only a handful of drawings; little with which one could infer a taxonomic worldview. It was not until 1598 that Jean Bauhin (1541 – 1613) – brother of Caspar Bauhin (1560 – 1624), almost coincidentally mentioned above – produced a monograph that contained 211 drawings of fossil objects from an area in Germany. Importantly, Bauhin stated that he was presenting the material "objectively," as he wished to avoid falling into any of the debates on the nature of fossils that were then being waged. Since this cannot really be done, Gould argues, this gives us a direct, if limited, window into the worldview of this one talented individual in his time.

Gould identifies three misleading and inappropriate "conventions" that appear in his drawings. All have since been changed, but Gould's point is that they influenced scholars for about 200 years, well past the time when they should have been replaced – analogous to bibliographies listing authors by first name well into the 17th century. The first of these is *the conflation of categories*; Bauhin places drawings of agates and stone-age tools next to those of fossil shells and bones. This false taxonomy [discussed in more detail in LSM 3] helped delay a proper understanding of geology and paleontology. The second is *failure to distinguish accidental resemblance from genuine embodiment*. Bauhin produced a plate containing six drawings of rocks that resemble, to varying degrees, male genitalia. He did not *believe* that these rock formations were in fact remnants of actual organs; however, he did believe in harmonies between the realms of nature [see previous essay]. This view retarded the proper identification of true fossils, those that are remnants of formerly living organisms. The third category is *drawing organic fossils with errors that preclude insight into their origins*. He draws ammonites with the last, outer whorl decreasing rather than increasing in diameter to make the overall object appear more circular; this undoubtedly seemed like a minor detail in a messy real object to the artist, but it would effectively preclude a viewer from considering it to have once housed a living organism.

Gould closes with a general defense of the Bauhin brothers. Jean Bauhin should not be blamed for not being objective (none of us are), nor for what he did not know about fossils; it is up to later generations to correct mistakes and false taxonomies in a timely manner. Further, he notes, each produced a masterpiece of botany: Caspar published *Pinax* in 1623, and Jean developed *Historia plantarum universalis*, published posthumously in 1650. These books use a taxonomic structure that reflects principles intrinsic to the plants themselves, rather than in alphabetical order or grouped in terms of utility to man (as others had done). In this way, they anticipated (and no doubt

influenced) Linnaeus, who developed a similar approach [IHL 21] that is still in use today.

IHL 11. Syphilis and the Shepherd of Atlantis

The sequenced genome of the bacterial spirochete that causes syphilis was published in the journal *Science* in 1998. Partially in response to this event, Gould tracked down the etymology of the word "syphilis" itself, which in turn opens an intellectual window into the world of the 16th century. The term actually refers to the name of a fictional character in a heroic poem written by one of the most remarkable people of that era, Girolamo Fracastoro. The poem itself, originally written in Latin (Gould draws on a 1686 English translation by Nahum Tate), is acknowledged by critics to be highly accomplished, and even "divine." The 1998 biology paper, on the other hand, is virtually unreadable outside of a small professional circle. However, Gould will argue, the scientific paper and the information recorded in it is beautiful in a different way, in that it is another step toward treating and, perhaps someday, even eliminating the disease, something no poem could ever do. Gould loves both the humanities and the sciences, but this essay is a tribute to the truly progressive nature of the latter – even if it takes many wrong and even immoral steps along the way. (Gould draws on details from a 1991 article by R. A. Anselment entitled "Fracastoro's Syphilis: Nahum Tate and the realms of Apollo" in *Bulletin of the John Rylands University Library of Manchester* for some of the details that follow.)

The first major outbreak of what later would be called syphilis took place in Naples in 1498. In a world that was constantly involved in wars and shifting alliances, the French (who occupied Naples at the time) called it the Neapolitan disease, blaming it on Columbus, who had recently returned from what he thought were the East Indies. The Spanish, for whom Columbus sailed, called it the French disease, blaming its spread throughout Europe on the occupying soldiers. Others called it the Spanish disease. The common thread was that the name in any given location was associated with that nation-state's political enemies at the moment. So where, Gould asks rhetorically, did the name "syphilis" come from? Perhaps more to the point, does it matter? Gould argues that it does, for two reasons:

> [F]irst, that apparently foolish concepts of early scientists made sense in their times and can therefore teach us to respect their struggles; and, second, that those older beliefs were truly erroneous, and that science both progresses, in any meaningful sense of the term, and holds immense promise for human benefit through correction of error and discovery of genuine natural trends.

Syphilis – the term – can be definitively traced to Girolamo Fracastoro (1478 – 1553) of Verona, a famous physician who knew Copernicus and had the Pope himself among his clientele. Fracastoro was a Renaissance man, both literally and figuratively, and one of his many talents was writing poetry in the classical style of Virgil. In 1530, he published a 1300-verse epic in Latin entitled "Syphilis, or the French Disease," the subtitle reflecting his political environment. The poem is in three parts, and the first two were

written some ten years earlier; each part is quite different, and apparently serves a different purpose. The name "Syphilis" does not appear until the third part.

The first section discusses the symptoms, and discusses Fracastoro's Renaissance view of the causes. His first task – Gould quotes several passages from the 1686 English translation – is to absolve the nationalities of his patrons and their allies, which include the Germans, Spanish, and Italians. Gould then writes:

> The remainder of part 1 presents Fracastoro's general view of nature as complex and puzzling, but intelligible – thereby giving us fascinating insight into the attitudes of Renaissance humanism, an approach that tried to break through the strictures of scholastic logical analysis to recover the presumed wisdom of classical times (renaissance means "rebirth"), but had not developed the belief in primacy of empirical documentation that would characterize the rise of modern science more than a century later. Fracastoro tells us that we must not view syphilis as divine retribution for human malfeasance (a popular theory at the time), a plague that must be endured but cannot, as a departure from nature's usual course, be comprehended. . . . Rather, syphilis has a natural cause that can, in principle, be understood.

Part 2 of his work continues the theme of the French Disease having a natural cause, and discusses the utility of mercury as a treatment. Perhaps ironically, considering his commitment to Renaissance humanism in part one, his vehicle here follows the tradition of Latin epic poetry: he creates a myth, in which the disease results from a god's anger with man's hubris. Specifically, a hunter named Ilcius kills a deer belonging to the sister of Apollo, who in anger inflicts the pox. Ilcius shows repentance, and another god shows pity and takes Ilcius underground to where the mineral mercury can be found. (Mercury was used for centuries to treat syphilis, and many of the early symptoms did respond to it; but it was not a true cure, and of course it is highly toxic.)

The third part was written ten years later, and is also told as a myth. The plot is similar to the second part, but the characters are different. The purpose, evidently, was to play up what was briefly believed to be a new and far better cure derived from the wood of the guaiacum tree, which is found only in the New World. The offenders of Apollo this time are a group of sailors, who are probably allegorical to Columbus's crew. While they are suffering, some locals appear; they also have the disease, but have found an effective treatment based on the guaiacum tree, which they share. The locals turn out to be descendents of survivors from the lost island of Atlantis, one of whom – a shepherd named Syphilis (or Sypilis) – had also angered Apollo, and was also aided by another god. The sailors bring the guaiacum tree back to Europe (where, not coincidentally, one of Fracastoro's patron's allies has a royal monopoly on them). Unfortunately for all, it became rapidly apparent that guaiacum was not effective against the disease; but by the time this was discovered, the poem and myth had made their way into popular culture, and the name "syphilis" stuck. Fracastoro did go on to learn more about the disease, and acknowledged his earlier mistakes in later writings.

An effective treatment was not found for syphilis until 1909, and a cure did not appear until penicillin appeared in 1943. (Even this would only cure the disease in its early stages.) Yes, Gould acknowledges, it took science 400 years to find an effective treatment, and almost another century to get to the point where we have mapped the disease-producing organism's genome. In the meantime, some horrible "scientific" treatments were prescribed (and, in the case of a "control group" of blacks in the US in the early 20th century, *not* prescribed) to treat it. Nonetheless, it was the methodology of science that finally solved the problem. This makes science different – and, he openly states, better – than the intellectual constructs that it has replaced.

Introduction to essays 12-17

The following six short pieces are from sources other than Gould's monthly column in *Natural History* magazine. Most of them first appeared as op-ed pieces in the New York Times or Time Magazine. They present a mixture of points made in detail elsewhere in his writings.

IHL 12. Darwin and the Munchkins of Kansas

Gould wrote this "viewpoint" piece for *Time Magazine* shortly after the Kansas Board of Education, with several recently-elected members, voted to remove evolution (as well as the "big bang" theory of cosmology) from the state's science curriculum. Since the Supreme Court had declared the explicit teaching of Creationism and, later, Intelligent Design to be unconstitutional, this alternative tactic – not to prohibit the teaching of evolution, but to remove questions about it on statewide tests – reflects yet another approach to achieve the same ends. [Gould discussed in HTHT 21 how the textbook industry's fear of controversy would almost guarantee that the subject would be significantly downplayed, if not "voluntarily" removed; also see IHL 18.] With several references to *The Wizard of Oz*, Gould compares this approach to teaching chemistry without the periodic table, or American history without Lincoln; evolution is the central concept that ties biology together.

People of good will who know little science may legitimately wonder, Gould continues, if evolution is speculative and scientifically in question; or, even if true, is a genuine threat to our national and spiritual values. Gould replies with three points. First, he states, it is important to note that the controversy over teaching evolution exists in no other Western nation; it is a uniquely American phenomenon [see BFB 28 for a discussion of its origins]. Second, we are as certain of the fact that *evolution occurs* as we are that the earth orbits the sun and not vice versa [HTHT 19]. Third, he argues, science and religion represent non-overlapping magisteria (NOMA) [LMC 14]. The biological origins of man are outside the teaching scope of religion, while ethics, morality, and the meaning of life are all questions that are outside of science's purview. "Science and religion should operate as equal, mutually respecting partners, each the master of its own domain, and with each domain vital to human life in a different way."

Finally, he concludes, the teaching of evolution is worth fighting for. In addition to the fact that the fundamentalists who oppose it are not really interested in religion so much as political power [HTHT 20], the fact is that the discovery of evolution is one of the greatest intellectual achievements of mankind.

[Gould adds in a footnote that the next election of the school board voted the fundamentalist members out, and restored evolution to the tested curriculum. However, Patricia H. Kelley notes in Section 5 of *Stephen Jay Gould: Reflections on His View of Life*, edited by W. D. Allmon, et al, 2009, that the Kansas school board membership changed again in both 2004 and 2006, indicating that this battle is not over, and likely to break out elsewhere. She concurs with Gould's view that most mainstream religious figures support the teaching of evolution in schools, offering the example of The Clergy Letter Project that began in 2006. However, she disagrees that modern creationism is a uniquely American phenomenon; it may have started out that way, but it has now spread to several other Western countries. Finally, while she agrees that science and religion can and should peacefully coexist (she identifies herself as a person of faith who teaches science), she notes that many sincere believers would not accept his NOMA concept, which effectively limits religion to questions of morality and ethics. Many people, she states, believe in a God who is willing and able to intervene in their lives.]

IHL 13. Darwin's More Stately Mansion

Gould wrote this editorial for the journal *Science* at about the same time as the previous op-ed piece for *Time*, and in response to the same events in Kansas. The difference between the two articles is primarily one of tone: in the former, he is presenting the case for teaching evolution to an American public with mixed beliefs, while in the latter, he is "preaching to the choir" and trying to rally the troops.

He begins by acknowledging that roughly half of Americans simply do not believe that humans evolved from non-human primates. What can explain the disconnect that allows Americans to believe that science can produce cures for disease, but that it does not understand its own basic principles about how life works? He references an observation by Freud [discussed in DIH 25 and LMC 15] that scientific revolutions are not completed until man comes to accept his reduced, more humble status in the new worldview. Many people – probably most – simply do not *like* the idea that humans are just one species among millions, who will someday pass out of existence like all the rest; they prefer the comfort that comes with believing that we are special, perhaps God's favorites. What can "we" – the scientific community of *Science* readers – do in the face of this situation? First and foremost, he states, we should not denigrate people who believe these things; it wins neither hearts nor minds, in addition to the fact that all peoples' beliefs deserve respect. However, he continues, there are three points that those who accept the full consequences of Darwin's revolution can offer to others. First, evolution is simply true; and people of good faith can and do recognize that "the truth makes us free." Second, the recognition that our existence is due to the uncaring rules of a non-conscious universe relieves us from searching for moral and ethical lessons in nature; we are free to seek these vitally important attributes within and amongst ourselves. Finally, the true story of

the history of life on earth is the most interesting, and most exciting, creation myth people have ever come up with; far superior to anything concerning Zeus or Wotan. As Darwin wrote, "there is grandeur in this view of life."

IHL 14. A Darwin for All Reasons

This is an op-ed piece that appeared in the *New York Times* in May, 1998. In it, Gould references two pieces of politically conservative writing that employ the name of Charles Darwin – for opposite ends. The first, the book *Slouching Toward Gomorrah* by Robert Bork, vilifies Darwin as the last intellectual obstacle that must be removed before another religious revival can sweep America. (The others are Marx and Freud; what they all have in common, Bork writes, is that they lead people to believe that atheism is the only respectable intellectual stance.)

On the other end of the conservative spectrum is an article by John O. McGinnis in *The National Review*, which essentially argues that Darwin's theory *supports* conservative politics. [This was William Jennings Bryan's objection to it at the time of the Scopes "Monkey" Trial in 1925; see BFB 28.] Self-interest, sexual differences, "natural inequality" – all these are examples of right-wing views that can be readily inferred from Darwin's theory of evolution. McGinnis adds additional arguments based on the view [which Gould rejects; see ESD 30] that human behaviors evolved for life as hunter-gatherers, which in turn justifies his anti-libertarian views that the State must be allowed to guide certain aspects of the individual's life, including saving for retirement and channeling sexual passions. Gould adds that liberals as well as conservatives have, over time, sided with or against Darwin for political and ethical reasons as well. His view is that all sides should cease and desist. He writes:

> Perhaps I should be flattered that my own field of evolutionary biology has usurped the position held by cosmology in former centuries – and by Freudianism earlier in our own times – as the science deemed most immediately relevant to deep questions about the meaning of our lives. But we must respect the limits of science if we wish to profit from its genuine insights. . . . Those who would misuse Darwin to advance their own agendas should remember the biblical injunction that provided the title to a great play about the attempted suppression of evolutionary theory in American classrooms: "He that seeketh mischief, it shall come unto him. . . . He that troubleth his own house shall inherit the wind."

IHL 15. When Less Is Truly More

On February 12, 2001, the 192nd birthday of Charles Darwin, two groups of researchers formally announced that they had successfully decoded the entire human genome. Gould states his excitement in this *New York Times* op-ed piece, comparing it as a scientific and technical accomplishment comparable to the first moon landing in 1969. Perhaps the most important "big picture" surprise in the data is that there appear to be "only" some 30 to 40 thousand human genes. This is much smaller than the 140 thousand that had been

predicted, and only about 50% more than *C. elegans*, a roundworm comprised of exactly 959 cells.

How can an organism as complex as a human be created from a set of instructions not much larger than a roundworm? Humans are indeed vastly more complex than roundworms; Gould suggests that it is the underlying assumption that individual genes code for individual features that is the stumbling block. We need to reject the "reductionist" view that each gene controls one trait, that each trait is controlled by one gene, and that an organism can (in principle) be understood as the sum of its genetic parts. The reductionist approach works brilliantly for many physically simple systems, but it is apparent that biology involves the *interaction* of multiple components at multiple levels; and these can only be studied by examining the organism as a whole, rather than in terms of its constituent components [TFS 25]. Further, he adds, the specific interactions of these components owe their current form as much to the contingencies of history than they do to the invariant natural laws of physics and chemistry [ELP 21]. This admittedly makes the problem of understanding life more difficult. However, he writes, "The failure of reductionism doesn't mark the failure of science, but only the replacement of an ultimately unworkable set of assumptions by more-appropriate styles of explanation that study complexity at its own level and respect the influence of unique histories."

IHL 16. Darwin's Cultural Degree

The title of this short piece, originally published in the *New York Times*, is play on words and actually refers to Darwin's statement in *The Decent of Man* that the difference between the mind of man and of higher animals is one of degree, not kind. Over the years, many have tried to identify what Gould calls a "golden barrier" between humans and other animals: use of tools, language, the existence of a moral sense, and others [ESD 5]. Each has come to be seen more in Darwin's terms as a matter of degree than an absolute difference. What stimulated Gould to write this particular piece is the fall of another proposed golden barrier: that of culture. He reports on some long-term studies (including those of Jane Goodall) that clearly show that non-interacting groups of chimpanzees exhibit distinctive behavior that is not shared by other groups. Further, these behaviors are passed from one generation to the next "culturally" – that is, by teaching and learning. Gould does not want to imply that we are not different than chimps; we are. But the difference is due to genealogy and evolution, not to any functional attribute we alone possess.

IHL 17. The Without and Within of Smart Mice

This "viewpoint" piece appeared in *Time Magazine* in September 1999, written as a pre-emptive strike against the interpretation in the media of a recent scientific paper as the discovery of the "gene for intelligence." The paper by Joe Tsien and colleagues, which Gould applauds, describes the process by which mice that were bred with an extra copy of a gene that produces a protein associated with inter-neuron activity. Such activity is believed to be associated with memory. Since memory is an important component in any

working definition of intelligence, can we infer that science has found an intelligence gene? We cannot, Gould states, for several reasons, the first and foremost of which is that genes do not directly "code" for specific features. There is no gene for the big toe, no gene for tallness, and especially no gene for human behaviors or for intelligence [ESD 32, LMC 15, LSM 18]. We cannot make super-athletes, or super-scholars, by tweaking a gene or two. However, and perhaps ironically, while the study does not support arguments for genetic determinism, it does demonstrate the value of environmental enrichment in raising offspring. Gould writes:

> This gene doesn't make a mouse "smart" all by its biochemical self. Rather, the gene's action allows adult mice to retain a neural openness for learning that young mice naturally possess but then lose in aging. . . . Even if Tsien's gene exists [in humans] and maintains the same basic functions . . . we will still need an extensive regimen of learning to potentiate any benefit from its enhanced action. In fact, we try very hard – often without success, in part because false beliefs in genetic determinism discourage our efforts – to institute just such a regimen during a human lifetime. We call this regimen "education."

IHL 18. What Does the Dreaded "E" Word Mean Anyway?

Gould begins this wide-ranging essay by discussing the Kansas school board's vote in 1999 to make evolution an optional subject in public school biology courses in their state [IHL 12 & 13]. Skirmishes are taking place in other states as well, he continues. At least two states "have retained their Darwinian material in official pamphlets and curricula, but have replaced the dreaded 'E'-word with a circumlocution . . . ." Gould is familiar with this tactic; it was used in his high school biology textbook [in relatively liberal New York City in the 1950's; see HTHT 21], where the phrase "the hypothesis of racial development" was used instead. The word "evolution" itself is worth fighting for, because symbols matter in intellectual and conceptual struggles. He writes: "We must not compromise our showcasing of the 'E' word, for we give up the game before we start if we grant our opponents control over defining language."

Having said that, it is somewhat ironic that Darwin himself rarely used the word (he preferred phrases such as "descent with modification). He had a specific and principled reason for this. The word "evolution," which literally means "to unroll" or "to unfold" [see ESD 3], implies two properties that he firmly argued were not part of his mechanism of natural selection: directionality and predictability. The pre-Darwinian views that life had changed over time, and which went by names such as "transmutation," "transformation," and "the development hypothesis," all assumed that life was progressive, in moving from the simple to the complex, from the sea to the land, and so on. But Darwin's mechanism only implied better adaptation to local environments, via a two-stage process that included a random component, and explicitly did not include a directive force. It was Herbert Spencer [LSM 17] who first widely applied the term "evolution" (as well as the phrase "survival of the fittest") to describe Darwin's process, and Spencer's interpretation *did* include the implications of the word that Darwin deliberately left out. Darwin chose not to fight this battle, and accepted the term to

describe his theory, although he continued to use the word only rarely in his writings. Gould states:

> This interesting sift, despite Darwin's own reticence, occurred primarily because a great majority of his contemporaries, while granting the overwhelming evidence for evolution's factuality, could not accept Darwin's radical views about the causes and patterns of biological change. Most important, they could not bear to surrender the comforting and traditional view that human consciousness must represent a predictable (if not divinely intended) summit of biological existence.

Changing gears, Gould notes that there is another scientific community that also uses the word "evolution," but in a significantly different way – one that is, he notes, much more closely aligned with its literal meaning. This is the astronomical community, who study the evolution of stars, galaxies, and the cosmos itself. These systems do exhibit a well-defined directionality, and operate by rules that allow for many accurate predictions (including how long our own sun will last, and how its end-stages will play out); they do "unfold" in a predictable, progressive way. Also interestingly, this community does *not* use evolution to describe the changes that involve unpredictable processes or those that have unique histories, such as the surfaces of planets and moons [ESD 24, BFB 34 & 35]. He does not lament this different meaning of the same word by different communities, but states that it is important to identify and discuss these (legitimate) differences, especially in public forums.

Changing gears again, Gould notes that there are still many people – including many within the professional community itself – who continue to suspect (or at least hope) that biological evolution does contain at least some fragments of the "predictable progress" that astronomers enjoy. He offers two recent papers as further evidence that life does not work this way. The first, *Lower Cambrian Vertebrates from South China* by D. –G. Shu, et al, in the November 14, 1999 issue of the journal *Nature*, discusses the discovery of two genera of vertebrates in the famous Chengjiang Formation. Like the Burgess Shale, the Chengjiang Formation preserves the soft parts of organisms that lived just after the Cambrian explosion, the geologically brief period in which almost all modern phyla appear. Our own phylum, the Chordates, had been found there before [see *Pikaia* in Gould's book *Wonderful Life*]. However, Chordata has three sub-phyla: tunicates, *Amphioxus* and its relatives, and our subphylum, the vertebrates. *Pikaia* belongs to the amphioxus subphylum, not our own; the Burgess shale appears to contains no actual vertebrates. Therefore, those who believed in "progress" in evolution could hold out the hope that vertebrates evolved later, and perhaps therefore required more development, and could therefore be seen as more "advanced." The news from Chengjiang formation, which is slightly older than the Burgess Shale, dashes this hope; vertebrates are present near the beginning of the Cambrian.

The second paper, *Dicyemids Are Higher Animals* by M. Kobayashi et al, published in the October 21, 1999 issue of *Nature*, deals with a group of organisms known as mesozoans. Biologists have traditionally divided animal life into three fundamental groups: Protozoa, Mesozoa, and Metazoa. Protozoa consist of a single cell, and are

therefore no longer considered "animals" in the taxonomic Kingdom sense [see ESD 13]. At the other end, the Metazoa comprise most multicellular organisms in the animal kingdom. They are further divided into those which have two layers of cells (diploblasts, such as corals and jellyfish), and those which have three layers (triploblasts, which include the "major" phyla of annelids, arthropods, echinoderms, mollusks, and vertebrates [see LSM 21]). Mesozoans were long considered to be an intermediate step on the path to true multicellularity, and therefore suggestive of a progressive trend. But it was hard to tell, because most mesozoans live as microscopic, highly simplified parasites. The paper reports that a team of geneticists found a *Hox* gene in a mesozoan species of the *Dicyemid* genus. *Hox* genes never appear in Protozoa. Moreover, they also never appear in diploblastic organisms; they are unique to the more "advanced" triploblasts. The Mesozoa, therefore, are apparently degenerate Metazoans, and do not reflect an intermediate developmental stage between the simple and the complex. He closes by noting that the amount of time it has taken to evolve (in the biological sense) human consciousness is about half of the evolutionary lifetime (in the astronomical sense) of our own star, further suggesting that our self-reflective presence on this planet is not only far from a sure bet, but instead rather improbable.

IHL 19. The First Day of the Rest of Our Life

This essay's title is part of a famous "self-help" quote popular in the 1970's, and Gould uses it because he apparently could not bring himself to draw on an even more hackneyed phrase (although he does so in the text): "What I did on the millennial day of January 1, 2000." In summary form, he tells us: "I sang in a performance of Joseph Hayden's great oratorio *The Creation*, presented by the Boston Cecilia at Jordan Hall." The rest of the essay discusses why he, as a professional scientist, was so pleased to sing this choral music about Genesis.

He begins by summarizing the history of millennial thinking, which for much of Western history has been about more than just the "odometer moment" (as it is today); he references his 1997 book *Questioning the Millennium*. The original, biblical meaning of the term "millennium" referred to the thousand year period of time (not a transitional moment) that would follow the return of Christ, after which the world would end. Many early Christians thought that this would happen in their lifetimes. As the generations and centuries dragged on, some Christian scholars pointed to Biblical passages stating that one day to God was like a thousand years to man; since Genesis refers to God's act of Creation as having lasted six days, then perhaps there would be six thousand years between the moment of creation and Christ's return. If so, the seventh day would equate to the thousand-year reign of Christ. By the 17th century, some scholars had concluded that Jesus was born exactly 4000 years after creation, on the boundary between BC and AD; therefore, He would return and the world as we know it would enter its terminal phase on January 1, 2000.

There are, Gould notes, a few problems with this. First and foremost, the earth really is about 4.7 billion years old, not six thousand. Further, there are inconsistencies within the Biblical story itself. Roman records clearly identify King Herod as dying in what we call

the year 4 BC, and the Bible specifically states that he was alive when Jesus was born. [See ELP 12 for Bishop Ussher's approach to this problem; he identifies 4004 BC as Christ's birth year.] Also, Dionysius Exiguus, the sixth-century monk charged by the Pope with producing a formal Christian chronology, made some mistakes, including leaving no time between 1 BC and 1 AD [see DIH 2]. Nonetheless, the point remains that millennial thinking has traditionally been about the end of the world, which Gould finds depressing; he *likes* the world.

Given all this, as well as his career as a Darwin-loving, creationist-battling agnostic Jew, why (he asks rhetorically) would he be so happy to participate in Hayden's oratorio about Biblical Genesis? First, he acknowledges, the music is lovely; but there are other pieces of music (he identifies J. S. Bach's St. Matthew Passion and St. John Passion) that are even more beautiful musically, but whose texts really do make him uncomfortable with their virulent anti-Semitism. (Gould notes that he would not change a word of the original wording, nor does he hold a grudge against Bach, who – like all of us – was a man of his time, and probably never even met a Jew. He does, however, feel obligated to discuss the history and significance of the wording with his fellow singers before the first rehearsal.) Yes, Hayden's piece calls for him to praise the creation of animals "in perfect forms, and fully grown," but this does not bother him; via his non-overlapping magisteria viewpoint [LMC 14], the words reflects art and spirituality, not science. (Gould notes that Hayden was a devout Catholic, and as such no doubt considered the six days of creation to be metaphorical rather than literal himself.) But Hayden's *The Creation* goes further. Genesis is comprised of two different stories [see IHL 7], and Gould definitely prefers the first to the second; Hayden's work leaves out the second story entirely. In Genesis 1, man and woman are created together on the sixth day. In Genesis 2, Adam is created early on, followed by the rest of creation, and then finally woman out of Adam's rib; this story justified the subjugation of women for centuries. Further, the theme of "forbidden knowledge" – anathema to any scholar – only appears in Genesis 2; Hayden downplays it almost completely. Finally, Hayden leaves out the one part of Genesis 1 that Gould truly dislikes: the passage giving man "dominion . . . over every living thing that moveth upon the earth." In summary, Gould really likes Hayden's *The Creation*, preferring its optimistic, positive view of the world to the more traditional millennial faire that focuses on end times. He considers his participation in performing it to be a fitting and appropriate thing to do on January 1, 2000.

In closing, Gould notes that the piece – first performed in 1798 – really does not seem to fit the mood of the time in which it was written. It feels more like a "the future is bright" work from the height of the Enlightenment in the 1750's and 60's, rather than that of the French Revolution's Reign of Terror and the forming storm clouds of the Napoleonic Wars. Referencing research by other scholars, he notes that Hayden wrote only the music, which was set to an oratorio ("lyrics") that already existed. The origin of these words is apparently a mystery, and he reiterates the theory that it was actually written some 40 years earlier for Handel, who died before he could use it.

IHL 20. The Narthex of San Marco and the Pangenetic Paradigm

About halfway through this essay, Gould reveals the significance of its cryptic title. It is a play on words, he informs us, on the title his second most referenced paper (after the first on punctuated equilibrium), written with his colleague Richard Lewontin and entitled *The Spandrels of San Marco and the Panglossian Paradigm*. The purpose of that 1977 paper was to challenge the professional community's commitment to what the authors considered an over-reliance on adaptationism, as opposed to structuralism or formalism, to explain evolutionary history. [Within this series, see TPT 4 and HTHT 10 on this topic; for a fuller discussion, see his final book, *The Structure of Evolutionary Theory*.] This paper was very controversial, he tells us, and some critics produced papers with parodying titles such as *The Scandals of San Marco* and *The Spaniels of St. Marx*; he is thus taking this opportunity for a little self-parody. Having said that, the essay has nothing whatsoever to do with the adaptationist/structuralist debate; it does draw on the same Cathedral, San Marco in Venice, but refers to different architectural and artistic components.

What this essay *is* about is the channels our minds exhibit, and how these affect the way we *model* the outside world. Humans like to view the world in terms of stories [DIH 27]; this is neither good nor bad, Gould argues, it is just the way we are. Making up stories about the plethora of data we must contend with helps us organize and make sense of it. However, in many cases there are a rather limited number of storylines; the structure of those stories can act as a source of bias in how we view external reality. Understanding that such mental channels exist, and studying their details, he argues, can help us compensate for them. In particular, when viewing information that includes sequential and progressive development, two storylines in particular tend to dominate. Gould calls these "successive addition" and "progressive (or "refining) differentiation."

To illustrate these two storylines, he discusses a famous story of progressive development: Genesis I from the Bible. He originally viewed the story of the six days of creation as a successive-addition story: light created on day one; a firmament separating two types of water on day two; the land and plants on day three; the sun, moon, and stars on day four; animals of the sea and air on day five; and, finally, terrestrial animals and man on day six. But he was always bothered by the second day – the creation of nothing more than a "firmament" (translated as "sky" in many modern versions, he tells us, but closer to a metal plate in the original Hebrew). Does this really compare with the products of the other five days? Then, after a trip to Venice and a tour of the San Marco Cathedral, he suddenly realized that Genesis made more sense in terms of the refining-differentiation storyline; such a version of Genesis was presented visually in the beautiful mosaics on the ceiling dome of the cathedral's narthex ("front porch"). On day one, God *separated* the void into light and darkness, both of which were *already present*. That is, light was not "added"; it was already there, mixed with darkness. Then on the second day, He differentiated the water above from a mixture of land and water below; He did not "add" a firmament, He "separated" a pre-existing mixture. (Gould notes that the ancients did not understand evaporation, and thought in terms of two great bodies of

water – rivers, lakes, and oceans below, and the source of the all-important rain above. Thus, this differentiation was worthy of a full day, making the story more "sensible.") On the third day, two more differentiations occur: the land is separated from the water, and – in Gould's view – plants are differentiated from the land, taxonomically associating plants with lifeless earth rather than living animals. Gould argues that the last three days can also be seen in terms of differentiation rather than addition, although he acknowledges that most Biblical scholars are more reluctant to do so. In the San Marco mosaics, for example, Adam is shown as being the same color of the earth, suggesting that the artist viewed his creation as another act of refining differentiation, separating him from the soil. He notes that Adam literally means "from the earth," that the concept is consistent with the "dust to dust" phrasing found elsewhere. [Gould notes that dueling storylines for Genesis is not new; he discussed a 19th-century occurrence of it in BFB 27.]

Biology includes two extensive areas of study that involve progressive development: embryology and evolution. The history of both fields included pitched battles between competing models – which can be seen in terms of the competing storylines of successive addition and refining differentiation. The early days of embryology saw a battle between the epigenesists and the preformationists [ESD 25, TFS 25]. Supporters of epigenesis – the word literally means "generated upon" – believed that external, formative principles acted upon an originally-homogenous embryo; that is, they were "additionists." Preformationists, on the other hand, believed that all the components required to build a newborn were already present in the fertilized egg, and that embryology involved differentiation and growth. Gould notes that Darwin's own "provisional hypothesis" of inheritance, wrong and almost completely forgotten, was called pangenesis, and clearly seen falls into the "differentiation" storyline category. (This also completes the explanation of the essay's title.) In fact, both the epigenesists and the preformationists were wrong about the nature of reality; but Gould's point is that both models tell us something important about our preferred modes of thinking. Somewhat later, Haeckel's recapitulation theory [TPT 24, IHL 8 and 22] also viewed embryology – and evolution – as a story of addition; meanwhile, von Baer's model [IHL 22] was one of differentiation.

Embryology today is told most successfully in terms of differentiation stories, Gould states; it is genetic instructions, rather than little eyes, noses, and fingers that are present, but differentiation as a general theme works better in situations where the outcome is known or predictable. Regarding the "story" of evolution, Darwin's model falls into the "successive addition" category; first one feature appeared, then another changed, and so on. Gould argues that processes involving progressive development in which the outcome is not known are better suited to this type of story. He notes that there were [and, some would say, there still are] other models of evolution in which the end result is predictable, and supporters tended to discuss them in terms of differentiation.

IHL 21. Linnaeus's Luck?

Gould first and foremost considered himself to be a paleontologist; but this, in his view, is a subset of the larger field of taxonomy. Taxonomy has suffered many attacks over the years from other scientists, who have likened it to stamp collecting, in that it requires

little more from its practitioners than the drudgery of identifying the correct pigeonhole for each object. Gould has written several essays stating his views that taxonomy is far more than this [for example, HTHT 5, DIH 32, and IHL 10]; each taxonomic structure reflects a theory of the origin of patterns, or *causes of order* in nature (his phrase). While an external reality absolutely exists, he continues, our minds can only attempt to *model* it. Taxonomies thus reflect an emergent combination of outside data and internal processing; this is as close to "reality" as we can get. [This is as close as Gould gets to pure philosophy, a subject that – along with geology – was his major in college.] He writes:

> . . . [W]e must begin by refuting [the] assumption that one true order exists "out there," and that correct classifications may be equated with accurate maps. We can best defend the scientific vitality of taxonomy by asserting the opposite premise, that all systems of classification must express theories about the *causes of order* [italics added], and must therefore feature a complex mixture of concepts and percepts – that is, preferences in human thinking combined with observations of nature's often cryptic realities.

He is quick to note, however, the importance of that external universe to our holistic, emergent models:

> This acknowledgement that taxonomies can only express nature's objective realities in terms of theories devised by the human mind should not encourage any trendy postmodern pessimism about the relativity of knowledge. All taxonomies do not become equally valid because each must filter nature's facts through sieves of human thought and perception. Some popular attributions of former centuries may be dismissed as just plain wrong. (Corals, for example, are animals, not plants.) Other common schemes may be rejected as more confusing than helpful in nearly all situations. . . .

Thus, he notes, the *usefulness* of a taxonomy is as important as its accuracy in reflecting nature. Reality can be a tricky thing, and if a certain taxonomy can lead to fruitful progress in understanding it, then it has merit even if it eventually fails. [Gould was always pragmatic, even when it came to philosophy.]

Within this context, Gould turns to the founder of modern biologic taxonomy: Linnaeus (Carl von Linne, 1707 – 1778), the great Swedish naturalist [previously discussed in DIH 32 & 33 and elsewhere]. Linnaeus developed the familiar *Genus species* binomial nomenclature (e.g., *Canis familiaris*, *Homo sapiens*). The "official" year of this taxonomic structure's inauguration is 1758; this was the date of publication of his definitive tenth edition of *Systema Naturae*. (In earlier editions, Linnaeus often used the genus name followed by some descriptive text; it is the tenth edition in which he gives both a genus and species name for every listed organism.) The system has been extensively modified over the years, with additional hierarchical categories added, and organisms re-binned many times as more knowledge has become available. However, the fundamental structure of "rigid hierarchical nesting" has remained beautifully intact

in the two-and-a-half centuries since. This organizing principle, in which all members of a lower group (say, genus) must be in the same higher-level groups (family, class, phylum), works so well because it reflects the external reality of evolutionary development of life through time: a continuous branching of species, with the branches never reconnecting. Two species within the same genus share a common ancestor (otherwise they would be re-categorized), and all members of that genus share a common ancestor with every member of other genera of the same family, order, class, and so on.

But wait, Gould says: *Systema Naturae* was published a century before Darwin's *Origin of Species*; further, Linnaeus himself was a dedicated creationist! How, he asks, could a taxonomic structure based on one view of the "causes of order" in nature survive unscathed when the *causes* that were behind its creation changed completely? Gould discusses some possible explanations. One is that Linnaeus was simply lucky (hence the essay's title), and of all the possible organizing principles for life he just happened to pick one that would turn out to be consistent with evolution. Gould will return to this shortly. A second is that Linnaeus suspected the truth of evolution in some form at this early stage; there were non-Darwinian evolutionary theories floating around in this time. Gould rejects this; Linnaeus clearly believed that had discovered a static and eternal pattern, reflecting the thought process of God [also see DIH 32].

Third, Gould considers the possibility that the "taxonomy-as-stamp-collecting" critics are right: that the external reality of life's current pattern is so obvious that any half-decent observer could recognize it, regardless of how he thought it came to be. On the one hand, he notes, it is true that the nested-hierarchy structure has been around for centuries; his original motivation for writing this essay was his acquisition of a 16th-century book on Aristotelian logic that used this approach to categorize, of all things, ethics. On the other hand, there were many other taxonomic structures at the time for organizing life on earth, and very few of them were hierarchical [see DIH 32, LMC 4, and LSM 4 for examples, as well as IHL 10 for a counterexample]. Gould points out that Linnaeus's hierarchical taxonomy beat out a rival one produced by Buffon [a matrix-type model that identified organisms not only by structural design, but behavior, utility to man, and other factors; see LSM 4] because it was *more useful*, not because it was recognized as more consistent with "reality." (Buffon's model led to endless debates at meetings about where organisms should be placed, while Linnaeus's model usually led to rapid resolution.) In the end, Gould concludes that Linnaeus was more than "just" lucky; he was a brilliant, if sometimes arrogant, observer, and he did correctly see how the world's organisms were organized when others did not, even though he misunderstood the reason behind that organization.

In another twist that further illustrates the complexity of the history of ideas, Gould notes that Linnaeus's reputation as a brilliant "seer of truth" must take a hit: he overreached, and applied his nested hierarchical taxonomy to other categories where it does not work, including types of rocks – he gave genus and species names to types of quartz, for example [also see Mendes da Costa in LMC 4]. He believed that "he had discovered the one true system for all natural objects." Today, we recognize that rocks are formed

almost exclusively by the laws of chemistry and physics, and vary and blend in ways that life does not; the contingencies of history play almost no role. Gould continues:

> Ironically, however, Linnaeus had succeeded (in a truly ample, albeit not universal, domain of nature) precisely because he had constructed a logic that correctly followed the causes of order in the organic world, but could not, for the same reasons, be extended to cover inorganic objects *not* built and interrelated by ties of genealogical continuity and evolutionary transformation. The strength of any great system shines most brightly in the light of limits that give sharp and clear definition to the large domain of its non-universal action! By understanding why the Linnaean system works for organism and *not* for rocks, we gain our best insight into the importance of his achievements in specifying the *varied* nature of *disparate* causes for nature's order among her many realms [his italics].

Gould ends with a final, devastating twist. Based on the accomplishments of genetic sequencing during the 1990's, it had been discovered that prokaryotes – single-celled organisms with no nucleus or other organelles – do not fit into the Linnaean paradigm after all. This is because bacteria can exchange segments of DNA with different kinds of bacteria – including with "species" that are not even closely related to! This process is known as lateral gene transfer, or LGT. The famous *E. coli* bacteria, for example, shows evidence of 234 separate LGT events over the past 100 million years, accounting for 18 per cent of its entire genome. While this event is much less important in multi-cellular organisms, apparently even our own genome has examples of LGT embedded in it. What this means, Gould explains, is that the currently understood causes of Linnaean taxonomy are only *approximately* correct in animals, and that the paradigm may not be applicable at all in our own distant evolutionary past. That is, the "tree of life" model apparently falls apart when we explore our own pre-multicellular ancestry. [In fact, other problems with the "successive branching with no rejoining of limbs" were already known, based on the discovery that eukaryotic cells – those with nuclei and organelles, and the kind all multicellular organisms are comprised of – are apparently amalgamations of different types of prokaryotes. Gould alluded to this issue decades earlier, in TPT 24.]

In a footnote, Gould dedicates essay to Ernst Mayr, "the greatest taxonomist of the twentieth century . . . who taught me . . . the central principle of our science (and this essay): that taxonomies are active theories about the causes of natural order, not objective, unchanging, and preexisting stamp albums for housing nature's obvious facts."

IHL 22. *Abscheulich!* (Atrocious)

This intricate essay involves three important scientific figures from the late 19th century, a discovery by Gould himself in 1979, some contemporary (late 1990's) scholarship by Michael Richardson that identifies an old but chronic problem that was never properly resolved, and, finally, a skirmish with creationism. The three historical scientific figures are Karl Ernst von Baer (1792 – 1876), Louis Agassiz (1807 – 1873), and Ernst Haeckel (1834 – 1919); in the story that emerges, Gould notes the irony that the "bad guy," Haeckel, was the only one who campaigned vigorously *for* the acceptance of evolution.

Haeckel was a German naturalist, biologist, writer, accomplished artist, and professor of comparative anatomy at the University of Jena in Germany. Gould writes:

> No character in the early days of Darwinism can match Haeckel for enigmatic contrast of the admirable and the dubious. No one could equal his energy and the volume of his output – most of high quality, including volumes of technical taxonomic description (concentrating on microscopic radiolarians, and on jellyfishes and their allies), not only theoretical effusions. But no major figure took so much consistent liberty in imposing his theoretical beliefs upon nature's observable factuality.

Haeckel believed in evolution even before *Origin of Species* appeared, and afterwards wrote several popular books that helped turn the tide in evolution's favor. Gould states that "Haeckel's forceful, eminently comprehensible, if not always accurate, books appeared in all major languages and surely exerted more influence than the works of any other scientist, including Darwin and Huxley (by Huxley's own frank admission), in convincing people throughout the world about the validity of evolution." Yet ironically, Haeckel did not believe in Darwin's mechanism of natural selection; instead, he was convinced of a Lamarckian-style mechanism in which an organism's "progress" could be passed to its offspring. An early student of embryology, he became convinced that the developmental process of an embryo re-enacted, or recapitulated, its evolutionary history. This theory, with the eponymous catchphrase "ontogeny recapitulates phylogeny" [ESD 27, TPT 24], was speculative at the time and disproved by about 1910; nonetheless, it made its way into several aspects of popular culture [ESD 28, TPT 15, and IHL 8, and his 1977 book *Ontogeny and Phylogeny*]. Recapitulation theory stemmed from a Romantic view of the world that was widespread in Germany, and it was later used – without Haeckel's consent or support, Gould acknowledges – to justify the extreme racial superiority myths and militarism of Germany in the first half of the 20th century.

Haeckel was a talented artist as well as a naturalist, and drew intricate, beautiful plates of many types of organisms. He blended the two fields of science and art by drawing "idealized" versions of his subjects, reflecting a higher degree of symmetry and aesthetics than were generally present in life; his "Artforms in Nature" and "Artforms from the Ocean," still in print, reflect this. [Gould includes some of Haeckel's beautiful illustrations in TFS 5.] He also crafted his own illustrations for his professional papers and popular books, and again drew "schematics" or idealized forms of his subjects rather than specific examples. Artists can make important and useful points by not drawing literally from nature [a point Gould makes in LMC 2, IHL 5, and elsewhere]. However – and this gets to the heart of the essay – Haeckel's artistic interpretations crossed the line by introducing important inaccuracies and oversimplifications to support his speculative arguments. This was not a major problem in his professional writing, as those familiar with the subject could readily identify such "liberties"; however, it can become a bigger problem when writing for the public. As a writer for popular audiences as well as professional ones himself, Gould detests this [BFB 16].

The specific issue involves Haeckel's drawings of vertebrate embryos in various stages of development. His "additive" model of embryology, reflecting recapitulation, argued that embryological development (ontogeny) could be used as evidence *in support of evolution* by noting how similar vertebrate embryos were early in their development. If one accepts his recapitulation premise and the high degree of similarity of vertebrate embryos (including fish, amphibians, mammals, and humans), then one can infer that all vertebrates shared a common ancestor – thus "proving" that evolution, rather than separate creation, occurred. However, real embryos are far more different than Haeckel's drawings reflect. (As Gould points out, this does not mean that "evolution" is wrong; Darwin and his other supporters never claimed, nor required, the high degree of embryological similarity that Haeckel needed for his recapitulation-based Lamarckian model.)

The professional community was not fooled; several scientists noted the gross inaccuracies in Haeckel's popular books such as *The Evolution of Man* (1903) at the time. (Gould references a paper he wrote some twenty years earlier, based on his discovery in the stacks of Harvard's great library of Louis Agassiz's personally-annotated copy of Haeckel's first edition of *The Natural History of Creation* (1868). Agassiz was one of the last of the greats to hold out against evolution, but – this is Gould's point – he was still a man of enormous integrity. He immediately recognized that Haeckel had used the *same illustration three times*, ostensibly representing three different types of vertebrate embryos (a dog, a chicken, and a tortoise). After explicitly identifying this outrageous action, Agassiz penciled *Abscheulich!*, German for "Atrocious," in the margin, giving the essay its title.) However, several key Haeckel drawings made it into *biology textbooks*, where they were presented uncritically. Then, in a practice that Gould has lamented in other essays [BFB 10 and LMC 16], the drawings and captions were then copied, almost verbatim, from textbook to textbook for the better part of a century.

It was Michael Richardson, a colleague of Gould's of the St. George Hospital Medical School in London, who finally took up this issue. In a 1997 paper with several coauthors, entitled "There is no highly conserved embryonic stage in the vertebrates; implications for current theories of evolution and development" in the journal *Anatomy and Embryology*, he noted all of the points discussed above. The story was picked up, first in the broader professional journals, and then in the popular press; it was here that events took another turn. The journal *Science* headline read, accurately, "Haeckel's embryos: fraud rediscovered." However, beginning with Britain's *New Scientist* (September 6, 1997), a major error crept in: the statement that Richardson had discovered the problems with Haeckel's drawings *himself*. Others in the mainstream press, quickly followed by the creationist community, picked up and amplified the second version: Haeckel was a supporter of Darwin; Haeckel had committed fraud; therefore, Darwinism itself (and evolution in general) had suffered a major blow. Further, the creationist attack continued, no evolutionary biologist had even noticed this error in all this time; how much confidence, therefore, can anyone have in anything they say? It is in this context that Gould suggests that Agassiz, the opponent of evolution, is a "good guy" in this tale, while Haeckel – by taking liberties with the data to make a point, which in turn not only misinformed generations of students, but eventually offered up ammunition to the

modern-day descendents of the very people he opposed – is the "bad guy." But the real villain, Gould continues, is the complacency with which those who knew the drawings were wrong stood idly by and allowed them to persist.

Within the embryology community, with Haeckel long ago rejected, most scientists felt that the similarities that did exist in early embryological development were due to something known as von Baer's law. Gould places Karl Ernst von Baer in his "top three" intellectual heroes, along with Darwin and Antoine Lavoisier [BFB 24, LSM 5]. Huxley, Gould notes, regarded von Baer as the greatest pre-Darwinian naturalist in Europe; he was one of the founders of embryology, and is credited with (among many other things) discovering the mammalian egg cell in 1827. His "law" is expressed in his 1828 masterwork, "The developmental history of animals." In a pre-evolutionary context, he argued that embryological development is a process of *refining differentiation*, rather than one of *successive addition* as Haeckel would later suggest [see IHL 20]. Von Baer's law states that, as a general principle, embryos develop from the general to the specific. Gould writes:

> In other words, you can first tell that an embryo will become a vertebrate rather than an arthropod, then a mammal rather than a fish, then a carnivore rather than a rodent, and finally good old Rover rather than Ms. Tabby. Under von Baer's reading, a human embryo grows gill slits not because we evolved from an adult fish (Haeckel's recapitulatory explanation), but because all vertebrates begin their embryological lives with gills. Fish, as "primitive" vertebrates, depart least from this basic condition in their later development, whereas mammals, as most "advanced," lose their gills and grow lungs during their maximal embryological departure from the initial and most generalized vertebrate form.
>
> Von Baer's Law – as biologists soon christened this principle of differentiation – received an easy and obvious evolutionary interpretation from Darwin's hand. The intricacies of early development, when so many complex organs differentiate and interconnect in so short a time, allow little leeway for substantial change, whereas later stages with fewer crucial connections to the central machinery for organic function permit greater latitude for evolutionary change. . . . The evolutionary version of von Baer's law suggests that embryos may give us better clues about ancestry than adults – not because they represent ancestral adults in miniature, as Haeckel and the recapitulationists believed. Rather, embryos indicate ancestry because generalized features of large groups offer better clues than do specialized traits of more-restricted lineages. [See LMC 19 for the example of *Sacculina*, a parasite whose lineage was finally determined by examining its larval stage.]

Interestingly, it is one of Richardson's points that the general, unquestioning acceptance of the validity of von Baer's law may simply reflect more complacency; he suggests that we should reevaluate it with today's technology. Gould writes:

> Von Baer's law makes good sense – but nothing in Darwinian theory implies or requires its validity, while evolution itself clearly permits embryology to proceed in either direction . . . either from embryonic simplicity to adult discordance (as in groups that follow von Baer's principle), or from larval discordance to adult likeness (as in several invertebrate groups, notably some closely related sea urchin species, where larvae have adapted to highly different lifestyles of planktonic floating versus development from yolk-filled eggs that remain on the sea floor, while the highly similar adults of both species continue to live and function like ordinary sea urchins). . . . The "bottom line". . . may now be simply stated: the validity and relative frequency of von Baer's law remains an open, empirical question within evolutionary theory, an issue that can only be resolved by observational evidence from a wide variety of organisms.

He closes with a rhetorical flourish against professional complacency: "Physician, heal thyself."

IHL 23. Tales of a Feathered Tail

In the previous decades, Gould begins, it has come to the attention of the popular science press, and of people in general, that birds evolved from dinosaurs. This is indeed true; however, he continues, two of the most common misperceptions about how evolution works – branching versus transformation, and a belief in progress over time – have led many people to draw a number of false impressions from this technically valid conclusion. Gould offers a number of points on birds and dinosaurs generally, and on one "feathered dinosaur" discovered in China in particular.

Gould notes that there is less "news" to this story than is commonly appreciated. Ever since *Archaeopteryx* was discovered in the 1860's, it has been known that there was a close relationship between dinosaurs and birds. However, because all birds (including *Archaeopteryx*) have modified clavicles ("wishbones," required to anchor the flight muscles) while dinosaurs generally do not, it was assumed that birds were descended from a closely related group of reptiles. However, in the 1970's, it was found that an important group of dinosaurs did retain clavicles; this group almost certainly is the ancestor of all birds. [Gould discusses this discovery in TPT 26.] But this literal truth has led many people to believe – incorrectly – that sauropods, triceratops, stegosaurs, and tyrannosaurs "evolved" into hawks, penguins, hummingbirds, and ostriches. This extrapolation is factually incorrect: all of the above-mentioned dinosaur groups really did die without offspring, and the diversity of all modern birds stems from a blossoming of a single branching event that probably includes *Archaeopteryx*. This error, in turn, is based on the widespread but false belief that evolution works by linear transformation, rather than by branching – a theme that he has written about many times in these essays [beginning with ESD 6, where the subject in question is *Homo sapiens*]. Part of the question remains, however: are birds "living dinosaurs" [a question he also discussed in TPT 26]? Not in Gould's view, any more than modern whales "are" the shrew-like Jurassic mammals that eventually gave rise to them. Evolution really does mean change.

Gould next turns to the discovery of *Caudipteryx* [literally "feathered tail," hence the essay's title] in China, reported in 1998, by Ji Qiang et al. This was identified as a so-called "feathered dinosaur," probably from the early Cretaceous, and thus somewhat younger than *Archaeopteryx*; it appears certain that the animal was incapable of flight. In a relevant tangent, Gould then references one of the great problems in evolution: how can structures such as feathers and wings be "selected for," when ten percent of a wing is of zero percent utility for flight? Many people, dating back to Darwin himself, suggested that the original function of feathers – recognized today as modified reptilian scales – must have been something other than flight, perhaps thermoregulation [see BFB 9 regarding this topic specifically, and ELP 22 for a more general discussion]. The existence of a non-flying but feathered dinosaur fits directly into this view. However, a challenge to the "*Caudipteryx*-as-intermediate-state" argument soon appeared. In a 2000 article in *Nature*, T. D. Jones, et al make a solid, although not airtight, case that *Caudipteryx* is *secondarily* flightless; that is, it is the descendent of a true, flight-capable bird, rather than a dinosaur that had yet to "evolve" the ability to fly. Gould is surprised, not by the paper itself, but (again) by the reaction to it, which to him seems to include a tone of mild outrage. He concludes that many people, laboring under the false belief that evolution is (or ought to be) progressive, are "disappointed" that *Caudipteryx* has *regressed*. In Gould's view, this is silly; evolution is exclusively about adapting to the local environment.

Gould summarizes this second-to-last essay in his monthly series [the last being IHL 1] with the following words:

> The vigorous branching of life's tree, and not the accumulating valor of mythical marches to progress, lies behind the persistence and expansion of organic diversity in our tough and constantly stressful world. And if we do not grasp the fundamental nature of branching as the key to life's passage across the geological stage, we will never understand evolution aright.

He gives the last word to Darwin, from the end of chapter 4 of *Origin of Species*, which introduces the concept of natural selection.

> As buds give rise by growth to fresh buds and these, if vigorous, branch out and overtop on all sides many a feebler branch, so by generation I believe it has been with the great Tree of Life, which fills with its dead and broken branches the crust of the earth, and covers the surface with its ever branching and beautiful ramifications.

IHL 24. An Evolutionary Perspective on the Concept of Native Plants

This essay is from the proceedings of a conference on landscape gardening, rather than Gould's monthly column in *Natural History*. His stated purpose is to challenge a popularly-held view of his host's community that native plants are preferable to imported or exotic plants for *scientific* reasons, specifically those involving biology and evolution.

In the course of the essay, he expresses his love of the diversity of life on earth, and acknowledges that using native species in landscaping can play an important role in maintaining that diversity. He adds that he considers green lawns in dry areas like Arizona, both inappropriate and "vulgar." However, he continues, these are his personal feelings, and *not* his professional opinion as a scientist. He objects to attempt to employ scientific arguments to justify what he considers to be aesthetic, and sometimes ethical and moral, positions, for two reasons. The first is simply that these arguments are almost always false, elaborating on the two most common categories in what follows. The second is about why it matters; it is not just about the technical accuracy of minor details. Rather, it is because once science is drawn inappropriately into a social issue, even for a "good cause," it opens the door for opponents to do the same. History is filled with examples where science was used to justify social behavior from colonialism and slavery to the holocaust, even when the proponents of the original arguments intended nothing of the sort. (On this last point, he presents several quotes from Nazi authors regarding plants in 1930's Germany; the arguments they use to justify the superiority of local flora are remarkably similar to those used to argue the superiority of the Aryan race, and the inferiority of others. Gould writes:

> How tenuous the space between *genius loci* (and respect for all the other spirits in their proper places as well) – and "my *locus* is best, while others must be uprooted, either as threats or as unredeemable inferiors." How easy the fallacious transition between a biological argument and a political campaign.

He calls the first objectionable scientific argument that touts the superiority of native plants "the functional argument based on adaptation." The thrust is that native plants are better because evolution has optimized them for their current location. This, in turn, reflects an important, widespread misunderstanding about Darwin's theory: that it *optimizes* lineages. The "struggle for existence" implied by natural selection, he points out, is only a "better than" mechanism, and species tend to stabilize for long periods once exclusive niches are established. It is certainly true that many non-native plant species need intensive care to survive. Others, however – for example, kudzu – not only survive independently in their new environment, they force out the indigenous species. The rampant problem of "invasive species" shows with brutal clarity that native plants are not, in general, optimally designed for their habitat. Evolution does not work that way.

Gould refers to the second category of incorrect evolutionary justification as "the geographic argument based on appropriate place." This view draws less on Darwin, but more deeply entrenched in our culture. From the essay:

> This argument holds that plants occupy their natural geographic ranges for reasons of maximal appropriateness. Why, after all, would a plant live only in a particular region of five hundred square kilometers unless this domain constituted its "natural" home – the place where this species, and no other, fits best?

This, Gould states, is actually a version of natural theology [HTHT 2, ELP 9, LMC 15]; that the universe shows evidence of deliberate design, and that God (or some other

spiritual or secular force) made the world in the best of all possible ways. But again, he states, this is not how evolution works; it is driven in large part by contingency. All "native" plants (and animals, and everything more complex than bacteria) are, in almost all cases, simply descendents of those who arrived first, usually by chance. Darwin himself studied how seeds could stay fertile for months at sea, carried about by currents, to wash up almost anywhere.

The arguments about native plants apply to people as well, he notes; "native Americans" are simply an earlier wave of an invasive species. The destruction of their lives and culture is a human tragedy, but it is important not to argue that there are *scientific*, as opposed to *moral*, reasons to consider it as such. This is because – and this is his point – it suggests that science a *role* in such matters, and others can then use it to come to the opposite conclusion – often far more effectively. [This is his NOMA theme; see LMC 14.]

Returning to native plants, he concludes that we should not equate "native" with "good" and "foreign" with "bad." Besides, he notes, some role for humans in shaping nature – in his opinion – can be a good thing. He is a big fan of New York's Central Park.

IHL 25. Age-Old Fallacies of Thinking and Stinking

In 1646, an English physician – Sir Thomas Browne – published a book entitled *Pseudodoxia Epidemica*, or "A Plethora of False Truths." Gould refers to this book as "the granddaddy of a most honorable genre still vigorously pursued – exposés of common errors and popular ignorance. . . ." Browne's 113 chapters discussed a wide range of subjects, from plants and animals to geographical and historical myths. Examples include the notion that elephants have no joints; that beavers castrate themselves, leaving their testicles behind, when pursued; and that men have one less rib than women. In each case, he approaches the issue from three directions. First, he tries to identify the origin of the false belief; next, he counters it with empirical evidence; and finally, he offers arguments based on logic or reason as to why the belief could not be true.

Gould focuses on one particular example: the old, widely-held fallacy that Jews "stink." Browne identifies the origin of this error as a Biblical phrase attacking the villainy of Jews collectively in advocating the crucifixion of Jesus; this phrase, he claims, was taken literally rather than metaphorically. He next presents documentation that Jews as a group are not malodorous, based on visits to synagogues, Jewish marketplaces, and individual homes. Turning to arguments of reason, Browne notes that people can chronically stink if they maintain poor hygiene or unhealthy diets; however, he notes that Jews as a group eat and drink carefully and in moderation, and live cleanly. He also dismisses the idea of a "curse derived upon them" as both intellectually lazy and offensive to the grandeur of God, who would not use His miraculous powers for something so petty. Finally, and most importantly for what is to follow, Browne considers the argument of heredity; that there might be some inherited trait that results in a characteristic smell. To this, he presents an interesting argument: Jews are not really a pure ethnic group. Their members

are widely dispersed, and there has been much interbreeding in most of their communities. Therefore, hereditary-based arguments cannot be valid.

Gould takes this old, specific myth about Jewish odor and generalizes it to a coherent collection of similar problems today, taking a swipe at biological determinism in the process. He writes:

> In many years of pondering over fallacious theories of biological determinism, and noting their extraordinary persistence and tendency to reemerge after presumed extirpation, I have been struck by a property that I call "surrogacy." Specific arguments raise a definite charge against a particular group – that Jews stink, that Irishmen drink, that women love mink, that Africans can't think – but each specific claim acts as a surrogate for any other. The general form of argument remains perennially the same, always permeated by identical fallacies over the centuries. Scratch the argument that women, by their biological nature, cannot be effective as heads of state and you will uncover the same structure of false inference underlying someone else's claim that African Americans will never form a high percentage of the pool of Ph.D. candidates.

Turning specifically to claims about black intelligence, he references studies by Jensen and Shockley in the 1960's [ESD 31] to more recent 1994 book *The Bell Curve* by Murray and Herrnstein. [Gould brought out a second edition of his book *The Mismeasure of Man* in 1996 in response to this publication.] As a counter, he draws on Browne's argument, noting that recent evidence regarding the human genome shows there is more genetic diversity within Africans than in all the rest of the world *combined*. That is, "blacks" are not a distinct ethnic group – not in Africa, and much less so after centuries of intermixing in America – and therefore any claims about their collective intelligence based on genetic arguments must be false. (Gould also notes that this genetic information has finally buried the "multiregional" theory of *H. sapiens* origin, leaving the field to the "out of Africa" model [see TFS 12, DIH 8, LMC 10].)

IHL 26. The Geometer of Race

Why are Europeans and other "white" races called *Caucasians*, a name that stems from the Caucasus Mountains in Russia and western Asia? The quick answer, Gould tells us, is that this name was assigned by the great German Enlightenment naturalist, J. F. Blumenbach (1752 – 1840), in the third edition of his *De generis humani varietate nativa* (*On the Natural Variety of Mankind*), published in 1795. But there is a story behind his choice of terminology, one that reflects a paradigm shift in the way human races were viewed in Western culture. The older way, reflected in his first edition, identifies four major human races, and organizes them primarily by geography. Blumenbach's later, revised geometry shows five races, and the primary organizing principle is one of hierarchy – a "ranking" of races by certain criteria. [Gould uses the term "geometry" in this essay rather than "taxonomy" to describe the organizing principles of these systems, perhaps because it first appeared in *Discover Magazine* rather than in *Natural History*.]

The first man to attempt to organize human races in a modern way was Linnaeus himself [IHL 21], and Blumenbach began as an apostle of his views. Linnaeus considered all humans to be comprised of a single species, *Homo sapiens* [although he did recognize the possible existence of "ape men," occasionally reported, as *Homo troglodytes* – see TFS 17]. Within this species, however, he recognized four varieties: Europeans, Asians, (native) Americans, and Africans. Despite the importance of hierarchy in his taxonomic structure, Linnaeus did not "rank" these groups. Rather, his underlying paradigm was based on the Greek model of four elements (earth, air, fire, and water), and the related idea of four humors (blood / sanguine, phlegm / phlegmatic, yellow bile / choleric, and black bile / melancholic). Linnaeus – and, in his first edition of *Variety of Mankind*, Blumenbach – identified four races in terms of characteristics of location, temperament ("humor"), physical posture, and *regitur* ("ruled," referring to how one's decisions were made). These four varieties were: American, with red skin, choleric temperament, upright posture, and "ruled by habit"; European (white, sanguine, muscular, ruled by custom); Asian (pale yellow, melancholy, stiff, ruled by belief); and African (black, phlegmatic, relaxed, ruled by caprice).

While this categorization is recognized as blatantly racist today, it was liberal for its time. As noted, it did not explicitly rank these varieties, although some of the descriptors are "obviously better" than others. Importantly, Linnaeus and Blumenbach both believed that races were mere varieties, and not separate species ("separately created," in this pre-Darwinian world), as many others did. [Gould discusses the monogenesis versus polygenesis debate in TFS 12.] Further, Gould notes, Blumenbach himself was perhaps "the least racist, most egalitarian, and most genial of all Enlightenment writers on the subject of human diversity." Yet, in his second edition (1781), he introduces a completely different paradigm for organizing human races, one that does draw on hierarchy – a structure readily co-opted by modern racism.

What happened? Blumenbach, in trying to elaborate on his monogenist worldview, argued that all humans had been created in a single region, as a single "race." As they expanded their range, they adapted to their local environment – for example, by developing darker, thicker skin in tropical regions. (Blumenbach did not believe in evolution, in the modern sense of speciation, but did believe that varieties could appear; this was, of course, recognized in domesticated animals and crops.) As people moved, they gradually and continuously transformed into the other varieties over many generations; Blumenbach chose the unfortunate term "degeneration" for this process, but he only meant "farther from the original," not "worse" as the word implies today. Still a product of his culture, he unquestioningly assumed that white Europeans were the group that most closely resembled the original stock, which was also consistent with the location of creation being somewhere in Europe or western Asia. To emphasize the importance of his dispersal model, he abandoned the Linnaean perspective that required exactly four totally distinct races. Instead, he argued for a progressive degeneration model, with indigenous Americans as an intermediate stage between European whites and Asian Orientals. In a separate, second line of transformation, he established a path between Caucasians and black Africans; in support of this perspective, he carved a fifth

race – which he later called the Malay – out of Linnaeus's African group, again as an intermediate stage.

Gould emphasizes that Blumenbach did not consider the non-white groups to be inferior, either intellectually or morally. Blumenbach kept a large collection of books by black authors as evidence of their intellectual equality, and was a staunch opponent of slavery before this movement became popular in Europe. What, then, was his criterion for placing Europeans at the top of his hierarchical structure? It was physical beauty, Gould tells us, although it was apparently the beauty of the skull, rather than the face or body of living specimens, that Blumenbach drew on. The most beautiful skulls in his collection came from the Caucuses; he identified this in his 1781 second edition, but did not officially name this group "Caucasians" until his 1793 third edition. (Blumenbach apparently considered his assessments of attractiveness to be objective rather than subjective, even though he made no attempt to quantify any of his data [as, for example, Petrus Camper tried to do; see BFB 15].) Gould therefore argues that the naming of whites for a particular geographic region, and the addition of a fifth race, were not a minor factual refinement – but rather markers of a major change in the way in which Europeans view human diversity.

Gould closes with a discussion about the irony of Blumenbach's contributions: this profoundly egalitarian scientist created a taxonomic structure for organizing racial information that *promoted* racism. As he has noted elsewhere, academic ideas can have social and political consequences; "Would Hitler have flourished without racism, America without liberty?"

IHL 27. The Great Physiologist of Heidelberg

This essay summarizes the life and work of Friedrich Tiedemann (1781 – 1861), who was professor of anatomy, physiology, and zoology at the University of Heidelberg – the oldest university in Germany – from 1816 until his retirement in 1849. Although almost unknown today, Gould is attracted to him for his iconoclasm: he was perhaps the least racist scientist during the two-century heyday of European colonialism. Gould discusses Tiedemann's 1816 work that compared the embryology of the human brain to the anatomy of adult brains of other vertebrates, laying much of the groundwork for Haeckel's recapitulationism [ESD 27, TPT 24, and IHL 22]. Tiedemann then turned to physiology for the next twenty years of his career, studying the process of digestion with chemist Leopold Gmelin. However, in 1836, he published the paper that is the primary focus of this essay. This paper was written in English – his only such effort – and compares the brain size of different races, a field that had not worked actively in for some time. While Gould credits Tiedemann with sound research and a worthy motivation, as well as the currently appreciated conclusion that there was no intellectual difference between the races, in the end he must conclude that he may have allowed his personal feelings to interfere to a limited degree with his science.

One of the major areas of study in the late 18th and early 19th centuries in biology was the pursuit of a common, universal law of development. Animal embryos, as the newest

microscopes showed, appeared to change from simple, homogenous blobs to complex, differentiated structures as they developed. At the same time, the paradigm of the Great Chain of Being [TFS 17 & 18, LSM 6] implied that animals were "ranked" from, among other things, the simple to the complex. Might there be a connection, which – if identified – could lead to a better understanding of nature and/or the mind of God? Tiedemann worked on this problem, focusing on the brains of humans and other vertebrates. His conclusion, published in his meticulous 1816 treatise, concluded that the chronological development of the human embryonic brain *did* correlate with features present in the adult brains of fish, reptiles, birds, and mammals, in that order. [Gould discusses the problems with both the theory and the analysis of these widely held conclusions in *Ontogeny and Phylogeny*.] What is important about this paper, Gould notes, is what it did *not* include. He writes:

> Yet he never extended this notion, the proudest discovery of his life, to establish a sequence of human races as well – although virtually all other scientists did. Nearly every major defense of conventional racial thinking in the nineteenth century expanded Tiedemann's argument from embryology and comparative anatomy to variation within a sequence of human races as well – by arguing that a supposedly linear order from African to Asian to European expresses the same universal law of progressive development. . . . But Tiedemann himself, the inventor of the basic argument, would not extend his doctrine into a claim that variation within a species . . . must follow the same linear order as differentiation among related species. . . . I can only assume that he demurred . . . because he did not wish to use his argument as a defense for racial ranking.

Gould notes that Richard Owen [LMC 6], another egalitarian scientist of the era, interpreted Tiedemann's silence in the same way, in the process referring to him as "the great physiologist of Heidelberg" – thus giving the essay its title.

In 1836, after working in other areas for an extended period, Tiedemann published a paper entitled "On the Brain of the Negro, compared with that of the European and the Orang-Outang," and published in English in *The Philosophical Transactions of the Royal Society of London*. He used two lines of research to argue that there is no discernable difference between the brains of Africans and Europeans. The first, based on physiology, showed that there was no qualitative difference in structure; every component that existed in one also existed in the other. The second was a statistical comparison of brain sizes among Blumenbach's five racial varieties, with the materialistic supposition that brain size is correlated to intelligence [see TPT 13 and 14 for Gould's criticism of this view, as well as *The Mismeasure of Man*]. Tiedemann's study of brain size (measured from the internal volumes of a collection of skulls) was the largest ever done to that point, encompassing about 300 skulls. His conclusion was that, while all races exhibited a range of brain sizes, these ranges overlapped almost completely; therefore, there was no difference in brain size between races, and therefore (by the standard implication of the time), no difference in intelligence. This was in contrast to the conclusions of many other studies, which often compared a single skull of each race – invariably (although, Gould concludes, probably subconsciously) selecting large Caucasian skulls and smaller non-

Caucasian skulls. As Tiedemann noted in the paper itself, he was motivated to do this research, and to publish the results in a British journal, out of appreciation for Britain's outlawing of slavery two years earlier. (Today, Gould notes, it is not considered appropriate to express political views in scientific publications.)

But Gould cannot get past a small problem. Tiedemann, he notes, publishes all of his raw brain size data, but his results show only the extremes of size – the smallest and largest – for each race. It is certainly possible to calculate a mean for each group, and Gould does so. What he found is that Tiedemann's data shows that the average size of the Caucasian skulls is the largest and the African skulls the smallest (although by a statistically insignificant amount)! Did Tiedemann not perform the required analysis, something that would have been out of character for him? Or did he consciously or subconsciously *decide* to not report it? Gould states that he cannot fairly criticize all those whose work he critiqued in *The Mismeasure of Man* without doing the same for Tiedemann, and concludes that it is possible that his clear (if admirable) political views affected the way in which he stated his results.

Introduction to essays 28-31

Stephen Jay Gould was a native New Yorker, and the events of September 11, 2001 were especially personal for him. The following are four short op-ed pieces he wrote within a month of the attacks. The tone reflects the days when the country and the world were completely united; before Afghanistan and Iraq, before the Patriot Act and Abu Grabe. He would die only eight months later.

The recurring theme of all four pieces is what Gould refers to as the Great Asymmetry (discussed earlier in BFB 24, ELP 19, and LSM 10): that there are thousands of good, kind, constructive acts for every terrible, destructive one. While the effects of good and evil may balance themselves out in history, the number of good people and good acts vastly exceeds the evil ones; at times like this it is worth discussing some of the former.

IHL 28. The Good People of Halifax

Gould and his wife were flying into to New York from Italy on the morning of September 11. Their plane, along with 44 others, was redirected to Halifax, Nova Scotia, where they remained for several days. He wrote this op-ed piece for the Canada's national paper, *The Globe and Mail*, as a deeply-felt thank-you to the hosts of 9,000 trapped passengers in the days that followed. The citizens fed them, clothed them, put them up in their homes, all with graciousness and kindness.

IHL 29. Apple Brown Betty

This op-ed piece appeared in *The New York Times* on September 26, about two weeks after the attacks. Gould has a home in lower Manhattan, about a mile from the World

Trade Center, and volunteered it as a ferry station for supplies for the firefighters and other emergency workers. He stopped to eat at a local restaurant on his way to deliver shoe inserts and filter masks, and the owner asked him to please also take a dozen of his best desserts, called apple brown bettys, to the emergency workers. He promised to do so, but quietly thought it to be a futile gesture: twelve desserts for thousands of exhausted workers. But he had overlooked the Great Asymmetry; small acts of kindness and goodness, multiplied by thousands and millions, are what allow us to break even with history in the face of massive, singular tragedies. The desserts were received with joy, along with thousands of other desserts and contributions from many, many people.

IHL 30. The Woolworth Building

Gould wrote this short piece for *Natural History* magazine, several months after retiring from writing his column. It is an ode to a building in Manhattan: not the World Trade Center, but rather the Woolworth Building. It was the tallest building in the world between its opening in 1913 and the opening of the Chrysler building in 1929, and surfaced with warm terra cotta and a highly diverse array of ornamentation. Gould remembers it fondly from his youth, before it was effectively hidden behind the twin towers. It is the kind of quirky, humanistic creation, he argues, that is the secret to keeping the human need for building bigger and better ("excelsior", the state motto of New York) into the fanatical zealotry that broaches no individualism. The horrible destruction of the twin towers re-exposed it. Seeing the self-contradictory but beautiful "cathedral of commerce" again made him feel more secure about the future, despite the carnage around him at ground zero.

IHL 31. September 11, '01

This is an op-ed piece from the *Boston Globe*. Gould reiterates the story of how his maternal grandfather arrived at Ellis Island as a poor immigrant in 1901. "Papa Joe" wrote the words "I have landed" beside the date in an inexpensive book on English grammar [IHL 1]. Gould had planned to visit Ellis Island with his mother, Papa Joe's only surviving child, on the 100th anniversary of that date. But that date was September 11, and Gould's return flight from Europe was diverted to Halifax. He quotes Ecclesiastes: a time to be born (or arrive at a new life), a time to die. He goes again to the Great Asymmetry: America will survive because there are millions of little stories, like his grandfather arriving in New York, to counter the few large but horrible ones like "Nine-Eleven."