

## Ladders and Cones: Constraining Evolution by Canonical Icons

### *I. Cultures of Presentation and the Role of Iconography*

Since the closing years of this millennium will be marked by growing concern and respect for ethnic and cultural pluralism--"the separate and equal station to which the laws of nature and of nature's God entitle them"--"a decent respect to the opinions of mankind" (to continue the quotation from a dead white American male) should also impel us to chronicle the striking differences among our academic communities. The disparities in content between arts and sciences have been much discussed and lamented, most notably by C. P. Snow in his *Two Cultures*, but few have documented, or even mentioned, the striking differences (by no means trivial or superficial) in style and manner of presentation.

Consider, for example, the important academic forum of oral presentations at professional meetings, an essential launching pad for nearly all scholarly careers. The two major differences between scientific and humanistic styles of presentation strike me as wondrously ironic. In stereotypes well known to all, scientific talks may possess empirical content, but usually fail for want of linguistic grace or skill in communication, while humanists, at their best, will at least dazzle with thoughts "ne'er so well expressed," even if the ten thousandth analysis of Shakespeare's one hundredth sonnet fails to present anything truly novel in content. Yet--and hence my judgment of irony--the two major differences between professions show superior intuition among scientists about use of language and style of communication.

First, humanists almost invariably read their papers from a written manuscript (and almost always badly, with head buried in text and bland inflexion quite unsuited for oral presentation). Scientists hardly ever read; we think through the order or logic of the argument, make outlines and notes, and then speak extemporaneously. I would have thought that the superiority of such truly oral presentation would be self-evident. First of all, as a practical matter, the scientists' strategy takes so much less time for the same amount of genuine care (many of the humanists' written documents are not meant for later publication and truly represent wastage).

Second, extemporaneous speech is so much more attractive and compelling of attention than the bland and spiritless style of most readers. I realize, of course, that a good reader can overcome this obstacle with a few simple rules (like memorizing a sentence at a time and looking up at the audience), but, in practice, few people read well--and the aggregate boredom of bad reading far outweighs the cumulative awkwardness of dubious grammar and parsing among scholars unskilled in extemporaneous speech. I assume, by the way, that many humanists adopt a strategy of reading out of fear, for linguistic style is their *summum bonum*, and they will trade freedom from one spontaneous misconjugation for overall tediousness and even incomprehension--while scientists, who are not much judged by their peers for linguistic style, will opt for better communication with a few potential errors.

But thirdly, and most importantly, written and spoken English are utterly different languages --and humanists, above all, should know this. Documents meant for speaking usually don't work in print (Martin Luther King's "I have a dream" is the greatest speech of the twentieth century, but, as oral poetry based on rhythmic repetition, it reads terribly). The differences are legion. To cite just one: oral speech needs a cyclic structure of studied repetition, for presentation is linear and the listening audience cannot go back; but written documents may be more sequential and non-redundant because a reader can pause to consult an earlier passage. (I have found over the years that the redundancy in a good extemporaneous speech sets the major reason for such discouragement when one reads a transcript. "Did I say such drivel?" one wonders--but the presentation *was* good.)

As a second difference between talks of scientists and humanists, scientists nearly always show slides (or visual material in some other form), while humanists usually rely on text alone (with some striking and obvious exceptions, like art history, where simultaneous use of two slide projectors has become *de rigueur*). Slide projectors are always and automatically provided for any scientific talk. I never think about asking for one; I simply assume that the machine will be there. Therefore, I frequently forget to submit the specific request that must be made when giving a speech to humanists (often in rooms with no screens and no way to darken windows). On three embarrassing occasions, I have shown up with a talk to humanists absolutely dependent upon slides only to find no means for projection. In each case, I was able to put forth an SOS for projector and screen to a colleague in a scientific department.

This striking difference even applies to talks by humanists about explicitly visual subjects. I recently attended a conference in Paris to celebrate the two hundredth anniversary of the Musée d'Histoire Naturelle. Talk after talk commemorated the great scientists (Cuvier and Lamarck, for example) and spoke in detail about the exhibits and the importance of their arrangement and aesthetics, but almost no one showed a picture.

Why do scientists grasp the importance of visual imagery, while most humanists accept the hegemony of the word? Scholarly publication in the humanities generally degrades imagery and in many ways. Many thick tomes have no pictures at all--not even a likeness of a central figure in a narrative. Images, when present, are often only "illustrative" in the slightly pejorative and peripheral sense; they are often collected in separate sections, divorced from textual reference and therefore subsidiary.

But visual imagery is central to our lives. Speaking biologically, primates are the quintessentially visual animals among mammals (a glance at the standard "homunculus" image of the human brain shows how much of the cerebral cortex serves our visual system). Much of our judgment in social matters, particularly our emotional feelings, depends upon images. Where would patriotism be without the Statue of Liberty, the Spirit of '76, and the raising of the flag on Mount Surabachi. And try understanding modern American culture without Ms. Monroe over the subway grating or Mr. DiMaggio at the bat.

From a scholar's point of view, much can be learned from the study of imagery (including its neglect). Since humanists take words as their explicit stock-in-trade, they scrutinize texts with intense care and invest most of their attention in removing biases and clarifying arguments. Since iconography is usually seen as superfluous, motives that attend the choice and form of images are less conscious than those of scientists--and therefore underlying personal and social biases become exposed in the pictures that we use.

I am particularly intrigued by the subject of "canonical icons," i.e., the standard imagery attached to key concepts of our social and intellectual lives. Nothing is more unconscious, and therefore more influential through its subliminal effect, than a standard and widely used picture for a subject that could, in theory, be rendered visually in a hundred different ways, some with strikingly different philosophical implications. The shock of seeing non standard imagery can be revealing: we instantly realize how constraining the canonical icon had been, though the limitation had never before crossed our mind. For example, as a Jew with no great stake in the subject, I was struck by how unnerving I found the beardless Jesus of Byzantine imagery when I first saw this representation (and realized that we knew absolutely nothing about the appearance, not to mention very little about the existence, of the historical Jesus).

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This essay treats the canonical imagery of my own profession: evolution and the history of life. I know no other subject so distorted by canonical icons: the image we see reflects social preferences and psychological hopes, rather than paleontological data or Darwinian theory. This theme of constraint by standard pictures is particularly important in science, where nearly every major theory has a characteristic icon. Consider the standard rendering of the Copernican solar system (or the Keplerian version with corrected orbits), and then recognize how much the Bohr atom became the microcosm of this macrocosmic icon. The Cartesian geometry of the celestial icon may be empirically adequate, but drawing electrons as planets cycling about the neutrons and protons of a central "sun" does not accurately represent the atomic world.

## *II. The Ladder or Linear March of Evolution*

The most serious and pervasive of all misconceptions about evolution equates the concept with some notion of progress, usually inherent and predictable, and leading to a human pinnacle. Yet neither evolutionary theory nor life's actual fossil record supports such an idea. Darwinian natural selection only produces adaptation to changing local environments, not any global scheme of progress. We can interpret local adaptation as "improvement" in a particular circumstance (the hairier elephant that becomes a woolly mammoth does better in ice age climates), but a historical chain of sequential local adaptations does not accumulate to a story of continuous progress. (The vector of climatic change is effectively random through time, so why should creatures, tracking such vectors by natural selection, become better in any general sense?) Moreover, for each local adaptation achieved through increasing complexity by some definition, another equally successful local solution evolves by "degeneration" of morphology or behavior. (Consider only the numerous parasites that, protected from the rigors of external environments, become little more than bags of feeding and reproductive tissue attached to the bodies of their hosts; yet the parasites have as much prospect of evolutionary success as the hosts.)

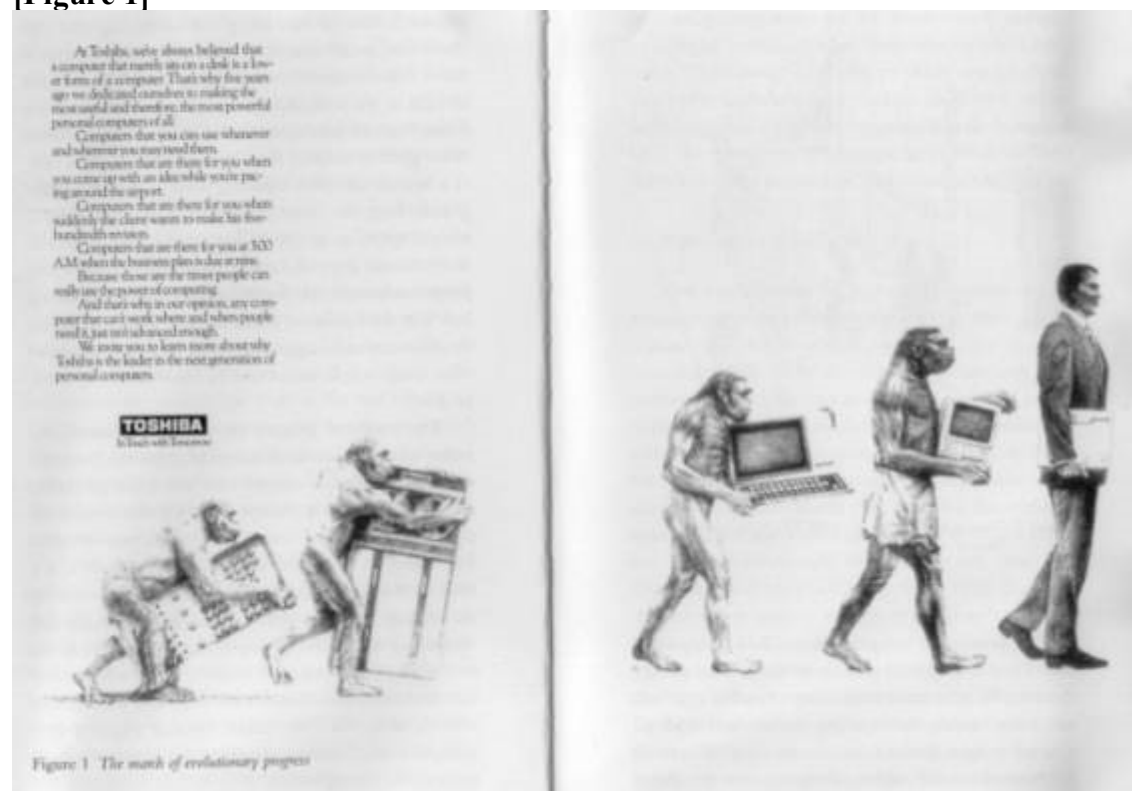
As for the fossil record, its pattern of nearly three billion years of exclusively unicellular life, followed by the introduction of nearly all major multicellular groups in a single episode lasting some five million years (the famous "Cambrian explosion" of 535-530 million years ago), grants little credence to any idea of slow and steady advance. At the very most, one might say that a few lineages have expanded into the originally empty sphere of anatomical elaboration (since life had to arise at the lower limit of its conceivable, preservable complexity--that is, as tiny, simple, single cells). But, without question, these earliest and simplest cells, the bacteria and their allies, remain the most abundant, widespread, and successful of all living things. And if one insists on multicellular animal species, some 80 percent of them are insects, and these enormously successful creatures have not shown any pervasive vectors of improvement over the past 300 million years.

This conceptual problem has pervaded evolutionary biology ever since Darwin. The very word "evolution," as a description of biological change through time, entered our lexicon through Herbert Spencer's more general usage (for cosmology, economics, and a host of other historical disciplines) in the service of his firm belief in "universal progress, its law and cause." Darwin himself had consciously avoided the word in the first edition of the *Origin of Species*, preferring to describe biological change as "descent with modification." Taking an uncommon position among nineteenth-century biologists, he did not interpret evolutionary change as inherently progressive.

Thus, the false equation of evolution with progress records a sociocultural bias, not a biological conclusion, and one hardly needs great insight to locate the primary source of this bias in our human desire to view ourselves as the apex of life's history, ruling the earth by right and biological necessity. This fundamental misconception of evolution is strongly abetted by one of the most pervasive of all canonical icons for any scientific concept--the march or ladder of evolutionary progress.

The standard form of this icon--largely a staple of popular culture in cartooning and advertising, but not absent from professional textbooks and museum exhibits--shows a linear sequence of advancing forms (depicted left to right as we read, though my only Israeli example, a recent Pepsi ad, runs right to left). The sequence is shown either globally, running from an amoeba to a white male in a business suit (thus recording another form of iconographic bias), or more parochially as moving from a stooped ape to an upright human. Such a single sequence is, of course, a parody. Most reasonably well-educated people understand that evolution is not a single advancing line. But the caricature works because it epitomizes, by simplification and exaggeration to be sure, the essence of what many people understand by evolution: in a word, progress.

[Figure 1]



The march of progress has enjoyed an astonishing variety of uses, primarily in commercial humor. I wonder if any other scientific concept is so well and immediately recognized (though in this case almost perversely misinterpreted) by a canonical icon. Consider just two examples from hundreds in my collection. The first (Figure 1) is a favorite of the computer industry. They want to convey the message that their products have gotten smaller and cheaper, so they show a stooped chimp weighted down by a vacuum-tube computer evolving into a white-male-in-business-suit-with-PowerBook. Regional versions also abound, as in *The New Yorker's* form of Figure 2 (my example from California shows the evolution of swimming trunks through time).

[Figure 2]



Figure 2 Drawing by P. Steiner; © 1990 The New Yorker Magazine, Inc.

The power (and recognizability) of the icon is perhaps shown best by numerous parodies (of the primary parody) that never fail to be immediately comprehensible. In a Frank and Emie cartoon, for example, the standard sequence runs left to right, from a fish in the sea up a hill to Frank at the summit, who holds a fishing rod over the cliff to farther right, and is just about to hook a fish identical with the starting image at extreme left. In my favorite example, an editorial cartoon entitled "Education in the United States," four identical stooped monkeys wearing dunce caps form a single line. Surely an icon has become powerful and canonical when comprehension of a parody depends upon the absence of the original image itself, with the opposite concept encoded into the picture actually shown.

### III. High Culture's Version of the Ladder

One might dismiss the pop culture versions as pure misconceptions of a scientifically illiterate mass culture, mistakes that would not be made so readily by well-educated people or by scientifically sophisticated non-professionals. But the closest version we have of evolutionary iconography intended for a more sophisticated culture makes exactly the same errors--more subtly but at the same time even more pervasively. I am thankful to the historian of science Martin J. S. Rudwick for explicitly examining this high-culture genre in his recent and excellent book on iconography of prehistoric life, *Scenes from Deep Time* (University of Chicago Press, 1992). Rudwick ends his survey with an account of this genre's establishment in the nineteenth century; I have extended the analysis to our own time.

High culture's version comprises series of paintings for the history of life in geologically sequential order, one for the Cambrian, one for the Ordovician, etc. In other words, we are not viewing single scenes of a selected moment in prehistoric life, but representations of life's history expressed as a series in proper geological order. The demand for such paintings has been small--primarily in museum murals and coffee-table books, though a modest art market for paintings of prehistoric life has emerged for the first time in our generation.

Moreover, this genre could only have originated in the mid-nineteenth century for two reasons. First, no adequate reconstructions of fossil vertebrates existed before Cuvier's seminal work of 1812. Second, the geological time scale was not well worked out until the 1840s or 1850s. As a result of this limited market and restricted time, the high-culture iconography of sequential painting for life's history is small and manageable. One need not take a sample from a large statistical universe; one can actually survey all major examples for common characteristics and differences.

As a primary conclusion to be drawn from a survey of all influential series, we find no essential variation at all. The same misconceptions are encoded in eerily common ways into all examples--a stunning case for the power of canonical iconography to maintain narrowly prejudicial notions about a subject. Rudwick shows that the first influential series of lithographs was produced by Edouard Riou (1833-1900), also Jules Verne's lithographer, for a famous book on the history of life by the French popularizer, Louis Figuier (1819-1894)—*La Terre avant le déluge*, first published in 1863. (An earlier version was published in 1851 by the German paleobotanist F.X. Unger as *Die Umwelt in ihren*

*verschiedenen Bildungsperioden*; but Unger's work appeared in a very small and expensive edition and his concentration on plants, with very few animals represented, ran counter to another of our parochial prejudices, and therefore limited interest in his work.)

Until the current generation,, twentieth-century portrayals of the history of life were dominated by the great American artist-naturalist Charles R. Knight (1874-1953), who virtually owned the genre from the 1920s until his death. (Knight did almost all the major murals in American institutions--New York's American Museum of Natural History, Chicago's Field Museum, and Los Angeles's tar pits museum, for example.) Then, in the 1950s, a Czech duo of artist Zdenik Burian and paleontologist Joseph Augusta published a series of wonderful folio books filled with paintings in color--the fist real rival to Knight's hegemony.

The domination of this iconographic tradition by the fallacious theme of progress is even more striking than in the familiar ladders of pop culture imagery--both because the particular pictures, without exception, show the same sequence (leading, at least passively, to the notion that such scenes represent the history of life, rather than one pathway among hundreds of potential and undepicted alternatives), and because greater subtlety of presentation masks the iconographic bias. Both the bias and its invariance can be illustrated by comparing Figuier's original series of 1863 with the most prominent of twentieth-century examples, Charles R. Knight's series, painted for *National Geographic* magazine in 1942 and entitled *Parade of Life Through the Ages*.

### [Figure 3]



The bias of progress has led all these artists to paint the history of life as a progressive sequence leading from marine invertebrate to *Homo sapiens*. Diversification and stability, the two principal themes of natural history, are entirely suppressed, and the tiny, parochial pathway leading to humans stands as a surrogate for the entire history of life. (One might object less if these artists explicitly stated an intent to show the particular excursion through the evolutionary bush that led to human beings--for then we could only accuse them of parochialism. But a look at the titles, and a reading of their text, clearly shows that they claim to be painting *the* history of life. Figuier's work is called *Earth Before the Deluge*, while Knight's bears the tide *Parade of Life Through the Ages*.)

The world of invertebrates occupies the first long stretch of life's geological history, but, in an initial display of pervasive prejudice, invertebrates receive only two or three plates (out of thirty to sixty in total) --see Figure 3 for Figuier's version and Figure 4 for Knight's. Figuier's plate shows another interesting iconographic bias, or rather tradition in this case, by depicting invertebrates as thrown up and drying out on the shore, rather than *in situ* as we might view them in an aquarium.

This inadequate conception had long been traditional in Western iconography and did not yield to the more satisfactory *in situ* view until the aquarium craze of the 1840s and 1850s made such a perspective sufficiently familiar to all. Even the "obviously objective" can be more a matter of artistic convention than "plain truth."

I would not object so strongly to the scarcity of plates showing "invertebrates only" if subsequent paintings continued to include invertebrates along with newly risen vertebrates. But as soon as fishes evolve, we never see an invertebrate again (except in the background, and then only occasionally). How can such a narrow view be justified? Invertebrates didn't go away just because fishes appeared. Invertebrates didn't stop evolving when the history of fishes began. Four hundred million years of invertebrate history are simply expunged from the conventional representation of life through the ages. This immense span includes most of the multicellular history of animal life, including such fascinating events as the death of some 95 percent of all species in the Permian mass extinction some 225 million years ago.

### [Figure 4]



Figure 4 Knight, *Earliest life*—marine invertebrate creatures of 530,000,000 years ago

Fish fare no better. As soon as terrestrial vertebrates appear, artists never again show a fish. But fishes make up more than half of all vertebrate species today, and most of their evolution occurred after terrestrial vertebrates arose. For example, nearly all modern fishes belong to the Teleostei, or higher bony fishes. But teleosts didn't evolve until well after the origin of amphibians and reptiles. So this most important of all events in the evolution of vertebrates, the source of more than half of all living vertebrate species, goes entirely unrecorded in the canonical iconography. Is this the history of life--or just a disconnected sequence of animals judged "highest" because, in genealogy or complexity, they closely approach humans through time--a prejudiced perspective indeed?

The canonical sequence then continues from early amphibians to dinosaurs, usually depicted in mortal combat (contrast Figuiet's lumbering creatures of Figure 5 with Knight's more agile dinosaurs of Figure 6, but note the similarity of pose and activity). A canonical plate from the time of dinosaurs also serves as the rule-proving exception. Although no fishes are shown after terrestrial vertebrates arise, convention permits another marine scene dated during the reign of dinosaurs--though the only animals depicted are marine reptiles (ichthyosaurs, plesiosaurs, and mosasaurs), never fishes. In other words, one may draw members of "highest" groups that return to ancestral environments, but never the ordinary, and supposedly superseded, forms of those realms.

And so the sequence continues on its familiar route from dinosaurs, to mammals, to humans (note the similarity in dress and pugnacity of Figuiet's early people in Figure 7 and Knight's in Figure 8).

[Figure 5]

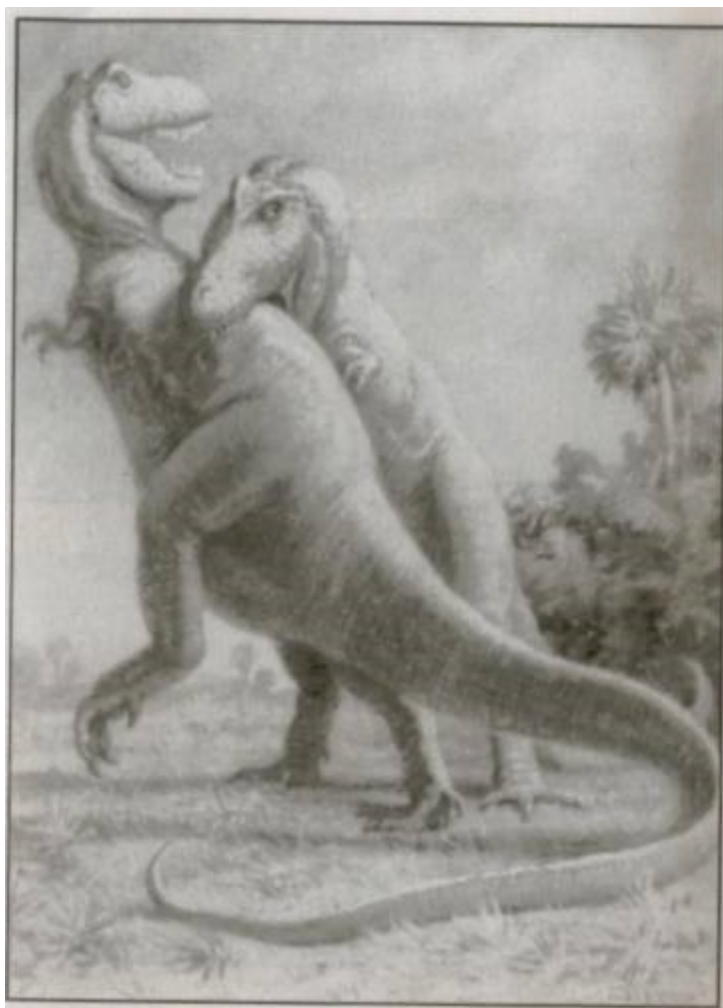


Figure 6 Knight, 'King-tyrant Lizard, Most Terrible of the Dinosaurs, Locked in Mortal Combat'

[Figure 6]



Figure 5 Figuer's 'The Iguanodon and the Megalosaur (Lower Cretaceous Period)' from Earth Before the Deluge (1863)

[Figure 7]





Figure 7 *Figuier's 'Appearance of Man' from Earth Before the Deluge (1863)*

[Figure 8]





Figure 8 Knight, *'With Flint-tipped Spear, Stone Ax, and Rocks, Neanderthal Men Repel an Invader'*

The hegemony of conventional imagery is so complete that the sequence of pictures moves on through its exceptionless order no matter what the stated philosophy of the artist, whether the sincere Christianity of Charles R. Knight:

Those of us whose minds are imbued with a proper amount of religious conviction will detect in this apparent selection [for increased human intelligence] the intervention and assistance of a power higher than ourselves—a certain definite purpose, divine or otherwise, whose control has shaped our destiny.

Or the supposed materialism of communist Czechoslovakia, as depicted by Augusta and Burian in the 1950s:

From the very beginning of the history of life on Earth we see how life constantly develops and progresses, how it is constantly being enriched by new, ever higher and more complex forms, how even man, the culmination of all living things on Earth, is tied to it by his life.

When an iconographic tradition persists for a full century in the face of such disparate ideologies expressed in

accompanying text, then we truly grasp the power of pictures and the hidebound character of assumptions that go unchallenged because they are unrecognized in icons rather than explicit in texts.

#### IV. *The Cone as a Canonical Icon of Diversity*

Darwin correctly noted that evolution presents two fundamental problems with potentially different solutions (and certainly, I might add, with disparate iconographies): anatomical change within lineages (solved by Darwin with the principle of natural selection), and diversification of species, or increase in the number of lineages. Darwin called this second issue the "principle of diversity" and he developed no satisfactory solution until the middle 1850s. (This timing helps us to resolve the old mystery of why Darwin, having formulated the principle of natural selection in 1838, delayed publication for more than twenty years. The reasons are complex, and mostly involve Darwin's fear of exposure for the radical philosophy underlying his evolutionary views. But failure to solve the problem of diversity also disturbed Darwin, for he knew that he did not possess a complete theory of evolution while he only grasped anatomical change through natural selection, but had not yet formulated an adequate explanation for the splitting of a lineage into two daughter populations.)

The problem of diversity is so topologically distinct from the problem of transformation that a different iconography must be employed for basic illustration. Just as the ladder provides a canonical icon for transformation misconstrued as progress, the same error of falsely equating evolution with progress yields a canonical icon for diversification: the cone of increasing diversity. This icon is less familiar to the general public, for it does not appear either as a popular version like the ladder or as a more sophisticated, but still non-professional, genre like paintings of prehistoric life. Thus, the cone of increasing diversity resides largely in textbooks and professional publications for scientists--but it constrains thought no less.

[Figure 9]

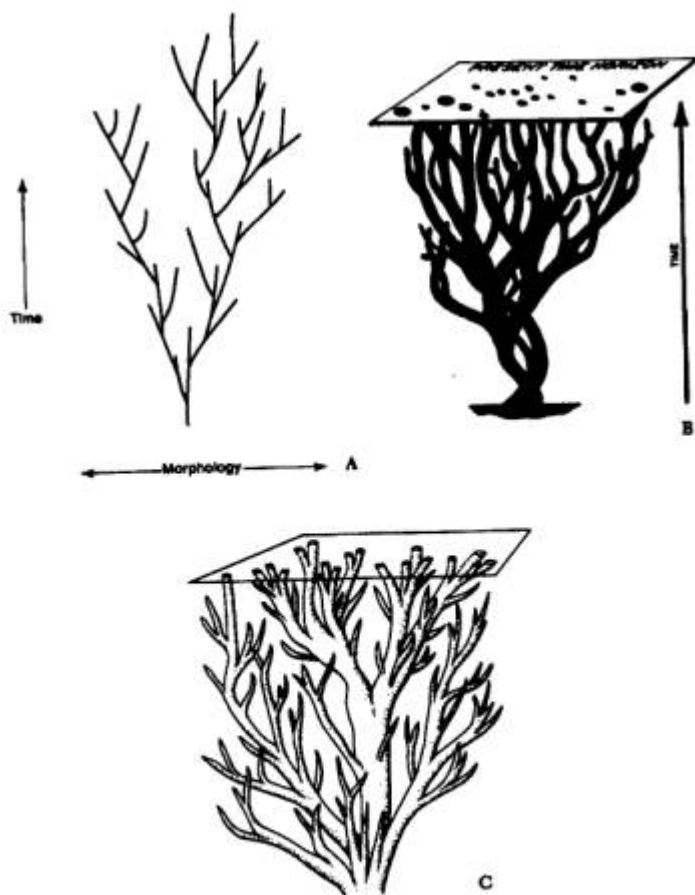


Figure 9 *The iconography of the cone of increasing diversity*

In the cone of increasing diversity, the history of a lineage begins with a single trunk (the common ancestor) and then moves--gradually, smoothly, and continually upward and outward, occupying more and more space as the number of branches (species) grows (Figure 9 shows typical examples from a modern textbook). But why should such an icon be called biased? What alternative could be suggested? Evolutionary theory demands a common ancestor for related forms, so the tree must emerge from a single trunk at its base. (I accept this argument and regard the common trunk as required by theory, not imposed as a sociocultural bias.)

The biases rather emerge from the canonical shape of such trees above their common trunk--and thus I refer to the canonical icon as a "cone" of diversity. Nothing in theory requires a smooth upward and outward flow for the tree, the feature that sets the tree's shape as an inverted cone or funnel. This arbitrary cone owes its canonical form to several subtle effects of progressivist bias as applied to diversity (rather than to anatomy as in the ladder). First of all, the cone shape requires that the early history of a lineage be composed of only a few major branches, and these must then represent primitive precursors of later forms, thus implying a predictable expansion from limited initial diversity.

Second, and more pervasively, the bias in this canonical icon rests upon a conflation in the meaning of axes. The horizontal axis represents morphology, and greater spread of the tree therefore records expansion in number of species and their adaptations. The vertical axis is supposed to record time alone, so higher branches on the tree should represent greater geological youth. But, with the ladder almost inevitably in mind, a higher position on the tree easily becomes conflated with anatomical progress and the cone of diversity then folds back into the ladder of progress, and the two icons overlap in meaning.

[Figure 10]

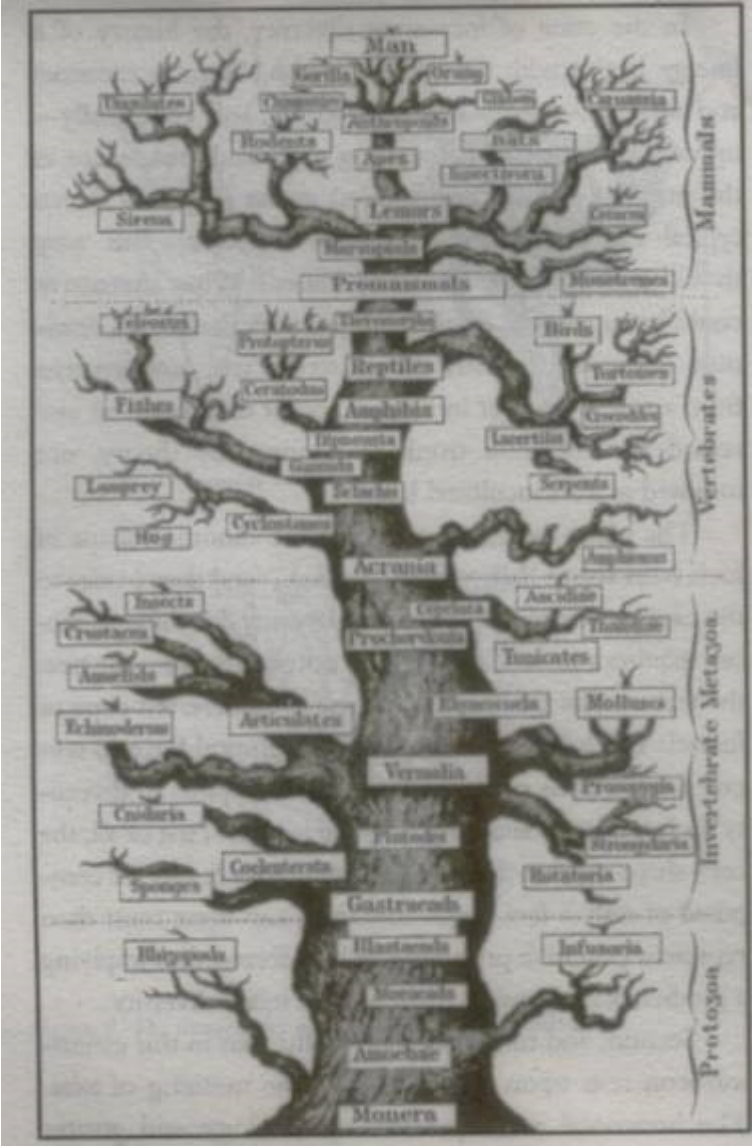


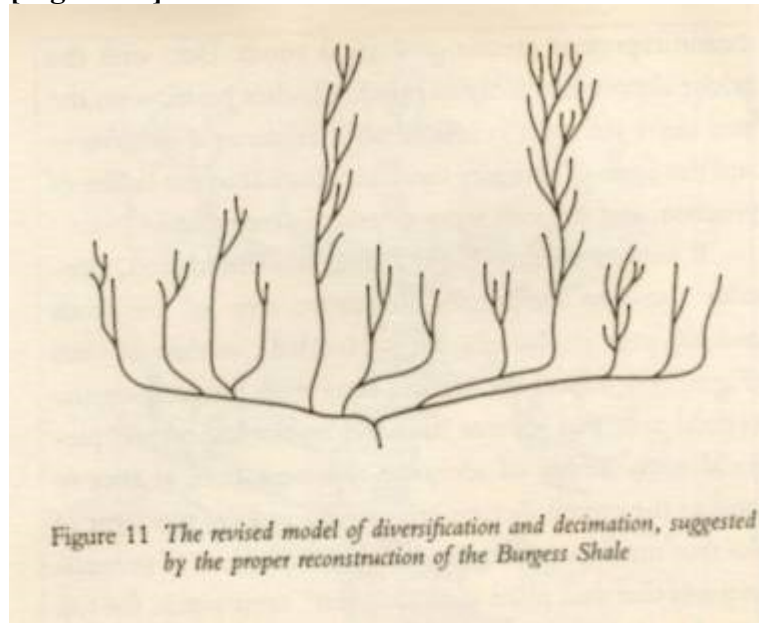
Figure 10 Haeckel's evolutionary tree

If anyone doubts that the cone is a biased icon, consider the first historically important tree of life (bark and all) ever published--Emst Haeckel's version of 1866 (Figure 10). Haeckel conflates time with progress on the vertical axis, and his tree founders on the logical and pictorial impossibility of adequate representation, at least so long as the cone's dictates are obeyed and the top layer of the tree must therefore spread widest. The bias of progress requires that you place your "highest" creatures in the top layer because you view this lofty place as indicating maximal advance. The cone dictates that this level must bear the most branches. But suppose that the "highest" group is not diverse and contains only a few species. How can you spread them so thin?

Haeckel encounters this insoluble dilemma because he takes a conventional view and regards mammals as superior beings--so he grants them exclusive residence in the top layer of the tree. But mammals are a small group of only 4,000 species or so, and Haeckel, to fill the space, must make fine distinctions, with full branches (and numerous sub-twigs) for whales, carnivores, and, inevitably in the center, primates. But insects, representing almost a million described species, must all occupy a single unbranched twig (more than halfway down at the left) because, as "primitive" forms,

they have to be fitted into a lower level of the tree (with much less room on the cone) and must, moreover, share this limited space with other lesser creatures!

[Figure 11]



Alternatives to such misleading images exist, but the unconscious hegemony of canonical iconography has generally prevented their consideration and the canonical icons have therefore continued to constrain our thinking, for pictures are such powerful guides to our theorizing. (Unconscious hegemony may sound oxymoronic, but such quiet and unobtrusive rule can be the most powerful of all. We all know, after all, that the administration of our offices is most effective when smooth operation remains unnoticed.) For example, in Figure 11, I have tried to draw a non-cone to encompass the very different view of life presented by the full effect of the Cambrian explosion as recorded in the Burgess Shale (see my book *Wonderful Life*, 1989). Here, maximal diversity occurs right near the geological beginning, and life's subsequent history features the loss of most initial anatomical experiments, with concentration of later diversity upon a few surviving designs.

But even this icon of a grass field with most stems mowed and just a few flowering profusely, while circumventing (and almost inverting) the canonical cone, does not capture the most philosophically radical concept arising from our modern study of life's early multicellular history--the notion that most losses occurred by the luck of the draw rather than by the predictable superiority of a few founding lineages, and that any particular lineage still alive today (including our own) owes its existence to the contingency of good fortune. All our canonical icons are based upon the opposite notion of progress and predictability, and therefore preclude proper consideration of contingency as the major force affecting the directions of life.

If icons are central to our thought, not peripheral frills, then the issue of alternative representation becomes fundamental to the history of changing ideas in science (and even to the quite legitimate notion of scientific progress!). How shall we draw the geometry of contingency? How else may we draw the history of life, so that we may come closer to meeting our ancestors face to face and may even probe pictorially into our own psyches to release the potential thoughts that lie even too deep for tears?