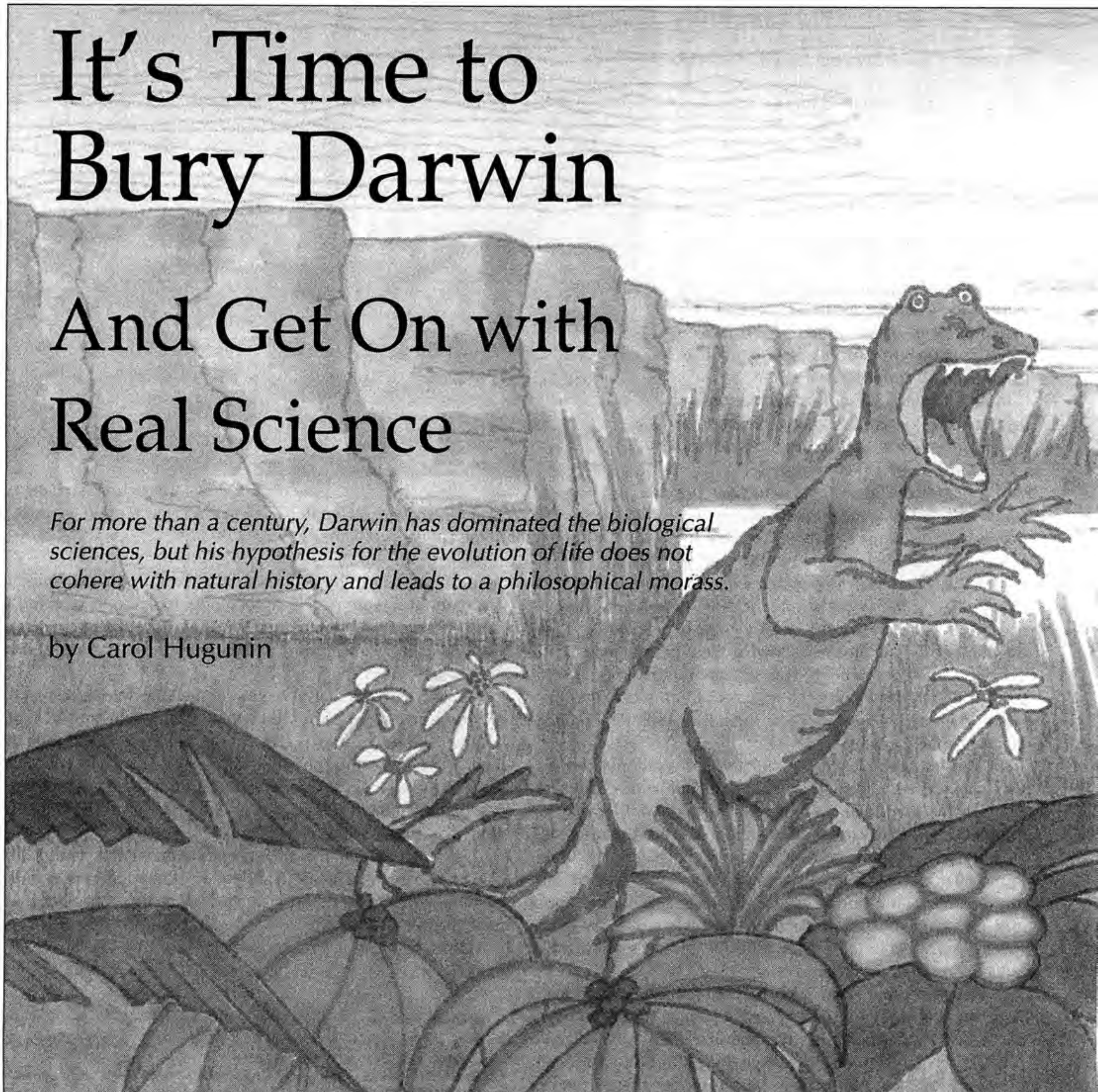
It's Time to Bury Darwin

And Get On with Real Science

For more than a century, Darwin has dominated the biological sciences, but his hypothesis for the evolution of life does not cohere with natural history and leads to a philosophical morass.

by Carol Hugunin



Today Charles Darwin and Isaac Newton are still taught to students as the figures fundamental to the development of the biological and physical sciences. Although Darwin is still very much debated and some scientists have deliberately devised experimentation to refute him, the epistemological assumption behind the Newton-Darwin pair—the idea that fundamentally matter is little hard balls randomly interacting entropically in empty space—still dominates science. Life is thus considered to be merely a more complicated version of this simple epistemological model, which *appears* to be quite adequate for the physical sciences.

Since Darwin first introduced the idea that chance could serve as the deepest causality explaining the evolution of life, epistemological approaches based on chance, in the form of statistical methods and chaos theory, have come to dominate mainstream science. In fact, the modern synthesis of the Darwinian thesis, developed by Julian S. Huxley and others in the late 1930s and early 1940s, is much more deeply en-

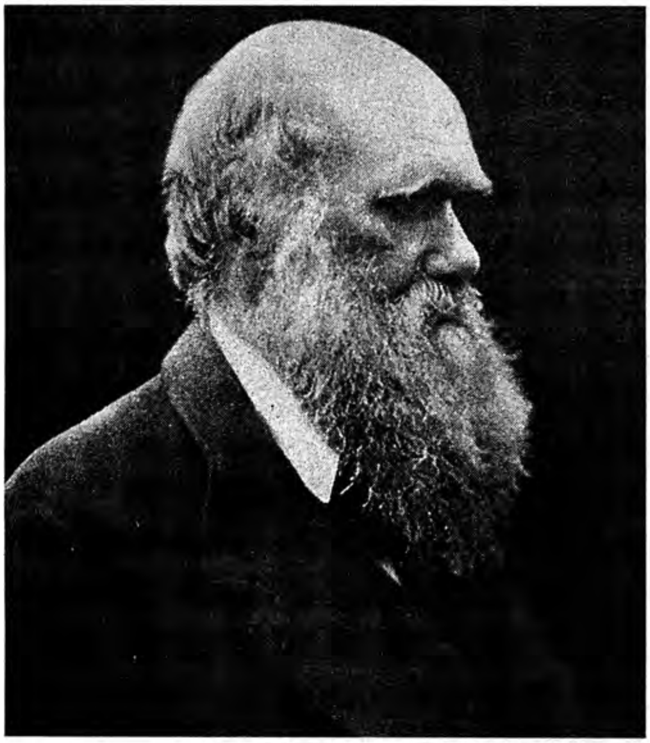
Illustration by Brenda Brown

meshed in chance as a *method* of inquiry—in the form of the statistical approach and systems science—than was the historical Darwin. And today in the social and political realm, that old Tennyson concept, "Nature, red in tooth and claw," is very much alive and well in the form of a revival of Darwinian eugenics.

In order to get beyond Darwin and the perennial Darwinist-Creationist debate, it is necessary to go back to the historical Darwin and the period in which he lived. What was the science of his day? What were the epistemological assumptions behind Darwin's approach, and were they in any way different from those of other scientists in his period?

The latter part of the 18th century and the first half of the 19th century was a period of tremendous advances in the natural sciences, including the study of life.

At the start of the 19th century, the German biologist Carl Friedrich Kielmeyer pondered the nature of the evolution of life and its relationship to different geological epochs. "Many



Library of Congress, from a photograph by Mrs. J.M. Cameron

Charles Darwin (1809-1882): "I admit that if we really now know the beginning of life on this planet, it is absolutely fatal to my views."

species have apparently emerged from other species, just as the butterfly emerges from the caterpillar," wrote Kielmeyer in 1804. "The idea of a close relationship between the developmental history of the Earth and the series of organized bodies [life forms], in which each can be used interchangeably to illuminate the other, appears to me to be worthy of praise."

"Finally," stated Kielmeyer during a 1793 lecture, "the task is to understand how both the continuity and change in species are grounded in the causes and effects of these forces," including sensibility, reproductive power, and power of propulsion. In this lecture, Kielmeyer proposed several intriguing ordering principles and areas for exploration; for example, that the species with the greatest reproductive capacity expressed by number of new individuals reproduced are the most primitive, least complex, and smallest. Species with a capacity to regenerate damaged parts, he proposed, have little or no sexual differentiation.

At a time when the science and technology of organic chemistry and biochemistry hardly existed and genetic material was an unknown but postulated mysterious vital force, Kielmeyer pressed for the study of embryogenesis as a way of understanding the continuity between different species. This led to a century of tremendous advances in embryology.

However, with the later rejection of the idea that ontogeny recapitulates phylogeny (that is, that the history of a lineage reappears in compressed form in the embryological development of its present descendants), worthwhile scientific babies were thrown out with the bathwater. Georges Cuvier, for example, a correspondent of Kielmeyer's student Christian Heinrich Pfaff, excluded embryology from the study of life forms and deprecated the idea of evolution. Yet, he made suggestive explorations of the principle of order and harmonies among organ systems in his study of the internal structures of various species.

Most relevant for today is the work of Cuvier's student Alexander von Humboldt, who took nothing less than the entire cosmos and its fundamental laws of development as his field of investigation.

Humboldt's Exploration of the Harmonies of Nature

Humboldt is best known today for his exploration of South and Central America, during which he also visited the United States. On the eve of his first voyage, in 1799, Humboldt wrote to his former instructor at the Freiberg mining school: "I shall endeavor to find out how nature's forces act upon one another and in what manner geographic environment exerts its influence on animals and plants. In short, I must find out about the harmonies of nature."

Humboldt's *Personal Narrative* and other writings describe how this quest guided his immense empirical studies during the voyage. He brilliantly described flora and fauna, climbed into volcanic craters, investigated ancient civilizations, made celestial observations, and took geomagnetic readings. It was Humboldt who developed the notion of what is now called an ecosystem, but he did this as a basis for fostering human population growth and scientific progress—the opposite of the Malthusian insanity it has become today. He systematically related the occurrence of zones of differing life forms with climate, precipitation, latitude, elevation, soil composition, and other geological conditions. Crossing the Andes, Humboldt found six zones of vegetation, each with its corresponding animal life.

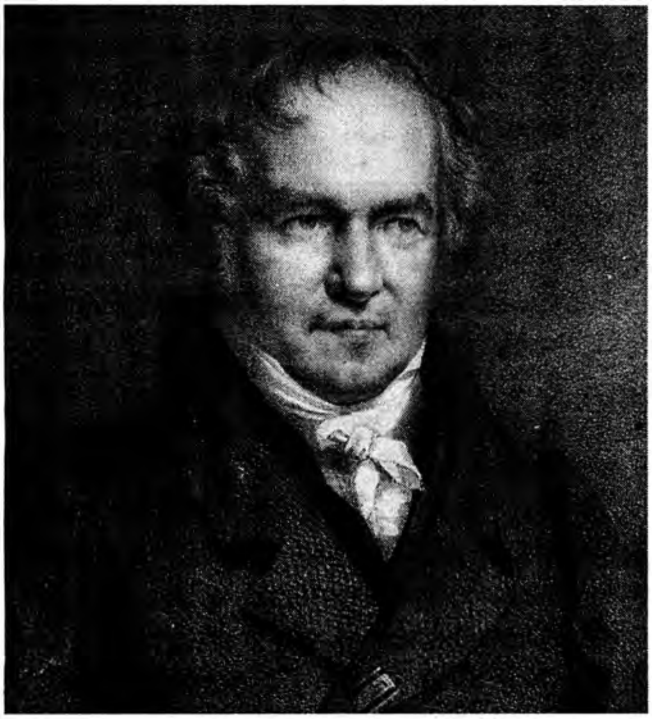
Such concepts were invaluable for agricultural innovation and thus for expanded population potential. Humboldt discovered that a ton of guano (the droppings of Peruvian sea birds) was the fertilizer equivalent of 33 tons of barnyard manure. He then recruited the great chemist Justus von Liebig to continue systematic analysis of chemicals that might be used as artificial fertilizers, as well as of different soils.

In exploring unknown territories (often at the risk of his life), Humboldt investigated past and present languages, institutions, and demography—all from the standpoint of how mankind could make these regions more productive: He evaluated soils and minerals, mapped natural waterways for transportation, and even planned canals, including what later became the Panama Canal.

Thus, everywhere Humboldt went in the Americas (and also in his 12,000-mile journey across the Russian empire in 1829), he focused on expanding the potential human population density of these vast, scarcely inhabited areas by means of the latest science and technology. He recruited fellow scientists to work on the problems involved in developing these frontier areas, promoted new mining and farming techniques there, and introduced individuals interested in rapid development of the Americas and Russia to scientists and like-thinking political figures in Europe.

'The Realm of Mind'

Although Humboldt thought that there was relative stability in living forms during the past few thousand years, he hypothe-



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Alexander von Humboldt (1769-1859) was insatiable in his quest for knowledge of "the harmonies of nature." He explored South and Central America in 1799, at age 30, and led a 12,000-mile expedition across Russia and Asia in 1829, at age 60. His seven-volume work, Cosmos: A Sketch of a Physical Description of the Universe, *defines man and his creative intellect as the pinnacle of the universe. His descriptive studies of flora, fauna, and geological resources provided the basis for agricultural and industrial development of frontier areas.*

HUMBOLDT'S SOUTH AMERICAN EXPEDITIONS
Humboldt's famous journey took him from the Venezuelan coast into the Amazon and from Cartagena, Colombia, to Lima, Peru.

HUMBOLDT'S CENTRAL ASIAN EXPEDITION
Beginning in Riga (now the capital of Latvia), Humboldt went through St. Petersburg, Moscow, and Gorki, and sailed on the Volga to Kazan. Then he traveled overland through Sverdlovsk to Barnaul in the Altai Mountains, ending near Lake Zaisan.

Source: Maps adapted from Ann Gaines, *Alexander von Humboldt: Colossus of Exploration* (New York: Chelsea House Publishers, 1991)

sized that life had evolved considerably over geological time, above all as a result of lawful changes in the flux density of the solar energy reaching the Earth. We know more today about how the intensity of sunlight reaching the Earth changes with long-term astronomical cycles, creating ice ages. However, it is clear from the continuing debate around the ozone and global warming issues and the failure of computer weather modeling, that we do not yet have a good handle on the way the Sun continually influences weather and climate on Earth.

In the 1840s, toward the end of his life, Humboldt published a seven-volume work, *Cosmos: A Sketch of a Physical Description of the Universe,* whose immense span of knowledge and investigation of fundamental principles encompass the geological development of the Earth and the development of life in its myriad manifestations. It is fascinating to note the way Humboldt bridges the gap between the evolution of the inorganic world and living creatures and the evolution of man:

> By maintaining the unity of the human species, we at the same time repel the cheerless assumption [here a footnote refers the reader to Aristotle's *Politics*] of superior and inferior races of men. . . . Laws partially known have enabled us in some degree, to arrange these [natural] phenomena; other laws of a more mysterious nature prevail in the highest sphere of the organic world, in that of man which has varied conformation, the creative intellectual energies with which he is endowed, and the languages which have sprung therefrom. We have thus reached the point at which a higher order of being is presented to us, and the realm of *mind* opens to the view: here, therefore, the *physical* description of the universe terminates: it marks the limit, which it does not pass.

In the late 1820s and 1830s, Ernst Heinrich Weber and his brother Wilhelm, working in Leipzig, founded the latter-day discipline of physiology by applying to biological problems Leonardo da Vinci's method of studying wave functions. Later Humboldt brought them together at Göttingen University to collaborate with the great mathematician Carl Friedrich Gauss. The Webers' friend Ernst Chladni, a physicist and musician, had reproduced some of Leonardo's experiments in the visualization of nodal lines of waves; Weber approached fluid dynamics through anatomy, at first studying the circulation of blood as a fluid in closed pipes, as Leonardo had done.[1] Although much of the Webers' work continues to be ignored,

From a portrait by J. Linnell, 1833

Thomas Malthus (1766-1834)

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Francis Galton (1822-1911)

Darwin's theory of survival of the fittest was inspired by Thomas Malthus (1766-1834), who, in turn, took his theory from the Venetian Giammaria Ortes (1713-1790). Francis Galton (1822-1911), Darwin's cousin, added to Malthusianism the idea of eugenics, of preventing the so-called inferior races and classes from reproducing.

The Darwinian Duo: Reductionism and Holism

For the past 100 years, ever since the Darwinian view took hold, it has become fashionable to limit science either to a statistical approach that reduces the world to readily observable phenomena or, alternatively, to a holist approach that pretends to look at the whole picture. The rationale for this change from the old-fashioned tradition of not separating science from philosophy was that science had to be made more objective and independent of any particular philosophical outlook.

Let's look at the consequences of this divorce:

Reductionism. Imagine that a very bright race of fleas is trained as good empiricist scientists and that they have gathered together for a convention to discuss the nature of the beast they live on. Each reports on the nature of the beast from the standpoint of the area that his researchers have investigated. They argue—for they are very spirited about getting down to the truth of the matter—over the statistical dominance of long hairs versus short hairs, over the dominance of various colors of hairs, over whether the surface of the beast is predominantly warm or cool, moist or dry, pitted or smooth.

Let's say that these fleas are as bright, relatively speaking, as the best of humans, and let's give them considerable time to figure this question out. Even if a few flea groups stumble over a really lucky research find, will they ever be able to figure out the kind of geometry they are in? Will they discover whether it is a baboon, a dog, a cat, a rat, or even a skunk?

This is the problem of reductionism, ever so busy studying life, but with absolutely no idea what geometry it is in.

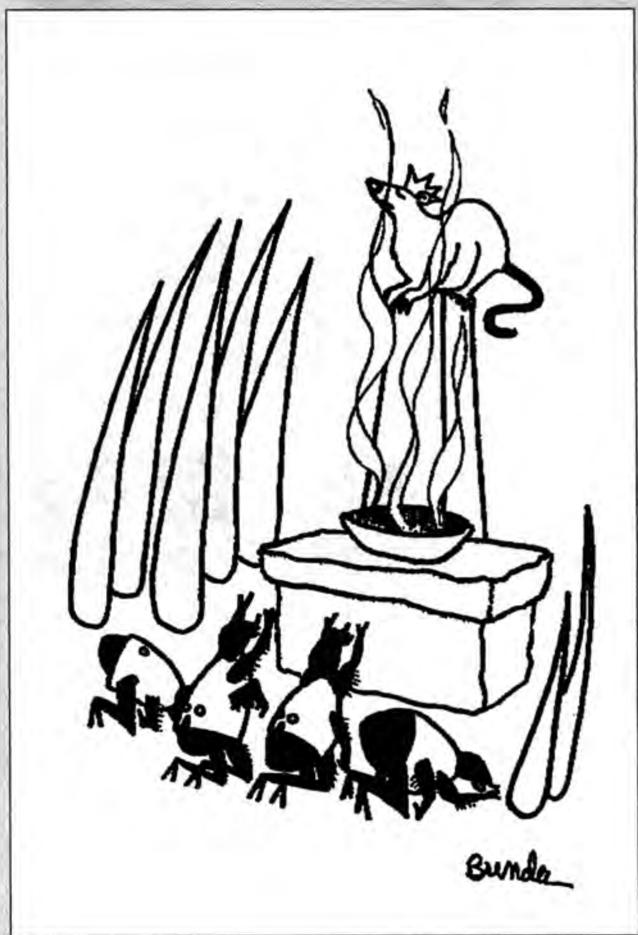
Why take a bunch of brilliant scientists and cripple them with reductionism, so that they spend their lives discovering relatively trivial things, when they are quite capable, if they rejected this method, of making much more profound discoveries?

British Holism. Holism appears, at least superficially, very similar to that old-fashioned Christian-Platonic tradition associated with Leibniz, Nicholas of Cusa, and continental science. However, in British holism, all the terms have been redefined so that the quest for the deeper reason and causality in life—those questions bordering close to the areas of philosophy and religion but still part of a scientific approach to a problem—are no longer possible.

Although not reductionist, holism is like Darwinian reductionism in that it does not allow for any studies bordering on those deeper issues of causality and reason: of first cause.

this approach to blood circulation was used as the basis for the recent development of the artificial heart.

By 1838, under the influence of the embryologist Karl Ernst von Baer, biologist Theodor Schwann had elaborated his theory that all life was organized into cells and reproduced itself through these units. By 1842, the chemist Justus von Liebig had elaborated the notion of catalytic forces so essential to the development of biochemistry. In 1852, Liebig's colleagues Carl Bergmann and Rudolph Leuckart published a least-action approach to physiology, in the spirit



Also, like reductionist Darwinism, holism holds that all species are equal. Rather than studying up close a multitude of sense-certain things, holism steps back and looks at the whole. But it is an undifferentiated, unfocused whole. Things become blurry and mystical because there is no avenue left open for redifferentiating the soupy field holism has generated.

To return to the fleas: Imagine that they are holding another convention. One flea who has attended hundreds of such conventions, and becomes tired of hearing the same sorts of arguments over and over, gets up and announces that after reading British holists J.B. Haldane and J.C. Smuts, he has concluded that the convention attendees are wasting their time with this reductionist approach, and they should go with British holism instead.

Meanwhile, unbeknownst to the fleas, their beast has been dead for 10 hours, and it is getting dark and cold, really cold, much colder than usual, for unknown reasons. Times change. The entire convention of fleas is becoming upset with the rapidly dropping temperatures. They all convert to holism, and begin worshipping the great beast on which they reside. The temperature is still dropping rapidly.

Because holism gives them no way to scientifically study their beast, to figure out why the great beast became so angry with them as to deprive them of warmth, they become desperate. A shivering flea gets up and demands sacrifices to the great beast to appease its anger. The motion carries. Group sacrifices of flea scientists begin. Will their conversion to holism lead the dwindling numbers of fleas to an answer to the question of what geometry they are in?

Is either the reductionist or the holist approach superior to the tradition of not totally separating science and the so-called objective approach from the so-called subjective approach of philosophy, religion, and the arts? Does this separation really lead to a superior understanding of such fundamental questions as what is life or what kind of geometry are we in?

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Louis Pasteur (1822-1895) exemplified the thinking of the continental school in his approach to science and the question of the evolution of life. He hypothesized that life was a function directly or indirectly of the "dissymmetry" of the universe—a hypothesis that totally negates the Newtonian view of a universe of Euclidean geometry.

of von Baer and Ernst Weber, exploring the higher-order principles that subsumed the chemistry and physics involved in life forms' solutions to problems of reproduction, metabolism, and locomotion.[2]

Humboldt's French collaborator Joseph-Louis Gay-Lussac, a physician and pioneering chemist, taught not only Justus von Liebig but also another of the greatest chemists of the 1820-1850 period, Jean-Baptiste Dumas. Dumas, in turn, became the teacher of Louis Pasteur. Centered around Göttingen and the heirs of the Ecole Polytechnique, along with others, including the anti-Darwinian naturalist Louis Agassiz and the geologist James Dwight Dana in the United States, these scientists were opening up new fields of inquiry with a rigorous search for causal, higher-order unifying principles. The potential was strong for a theory of biological evolution coherent with their approach.

Enter Darwin and Malthus

By 1831, Charles Darwin had "read and reread" Alexander Humboldt's *Personal Narrative.* It fired him with enthusiasm and zeal. In fact, Darwin was the only British scientist willing to meet Humboldt when Humboldt came to England. He came back to the Humboldt work repeatedly in the rough parts of his long voyage on *H.M.S. Beagle,* which began in 1831. But later he and his advisers abandoned Humboldt's vision.

Instead, Darwin's stunning brilliance was to come up with the idea that evolution worked by tiny, random variations in living organisms, of which only the fittest variant specimens survived in a competition for scarce sustenance. In an entry to his diary dated October 1838, the affable Darwin tells exactly how he came up with this hypothesis:

> I happened to read for amusement Malthus *On Population,* and being well prepared to appreciate the struggle for existence which everywhere goes on from long-continued observation of the habits of animals and plants, it at once struck me that under these circumstances favorable variations would tend to be preserved, and unfavourable ones to be destroyed. The result of this would be the formation of new species. Here, then, I had at least got a theory by which to work.

Parson Thomas Malthus, an economist working at the British East India Company college in Haileybury, England, had insisted that population (of men and of other living creatures) tends to expand geometrically, while food supply expands arithmetically. Hence, the Malthusian world is so arranged that in the natural course of things, horrible crises must occur as population presses against fixed resources. This cycle can be alleviated only by the depopulating effects of "vice and misery"—that is, nonreproductive sexual activity and death-dealing poverty. To cull the human flock, neo-Malthusians advocated active social measures beyond acceptance of starvation and disease.

The original full title of Darwin's 1859 opus, it should be noted, is *Origin of Species by Means of Natural Selection, or the Preservation of Favored Races in the Struggle for Life.*

UNDERLYING AXIOMS

Darwinian science	Continental science
(1)	
Chance	Directedness
Random changes	Nonrandom changes, purposeful, teleological
(2)	
Linear	Geometric
Continuous	Discontinuous jumps
Gradual mutation in the small on the level of genes	Chromosomal reordering
(3)	
Survival of fittest, fierce competition	Harmony of nature mirroring external and internal bounding conditions
(4)	
Inbreeding	Outbreeding
Bred for specific traits suitable to fixed environment	Bred for plasticity in changing environment
(5)	
All species equal	Man is pinnacle of evolution
Man is just another beast	Man is in the image of God

Francis Galton, Charles Darwin's cousin, went a step further than Malthus in explicitly proposing that the human race should be culled on the basis of the inferiority of certain subgroups, thus winning his title as the father of British eugenics. With the support of T.H. Huxley, Darwin's publicist, Darwin's son Leonard wrote *The Need for Eugenic Reform,* "dedicated to the memory of my father. For if I had not believed that he would have wished me to give such help as I could towards making his life's work of service to mankind, I should never have been led to write this book."

As for Malthus, publication of his dogmas led to the enactment of the 1830s Poor Laws in England, which abolished "outdoor relief"—the equivalent of today's welfare payments—and forced the unemployed into workhouses, where they slaved for scant rations of food until they took sick and died. This was the practical corollary of Malthus's precept that charity (or, even worse in his view, policies of elevating a nation's per capita living standards and productive capabilities) would simply lead to disastrous overpopulation.

Like Alexander von Humboldt, Malthus and the East India Company knew that statecraft can transmit the benefits of scientific progress throughout society. The United States was already a living example of geometric expansion of new resources when Malthus assembled his *Essay*. Humboldt and his associates devoted themselves to promoting that statecraft, while the Malthusians devoted themselves to opposing it.

Malthus's collaborator Sir James Mackintosh at Haileybury was the father-in-law of Darwin's cousin Hensleigh Wedgwood; Charles himself married his Wedgwood cousin and lived on his wife's Wedgwood wealth. The Darwin-Wedgwood clan were among the leading merchant-banking clans with immense control over colonial raw materials.

Can we simply ignore those dark, Malthusian thoughts, or are they perhaps relevant to the scientific issues? It is generally said that Darwin synthesized and subsumed the work of the scientists such as Humboldt who preceded him, but can this be the case, when we consider how at variance their fundamental assumptions really are?

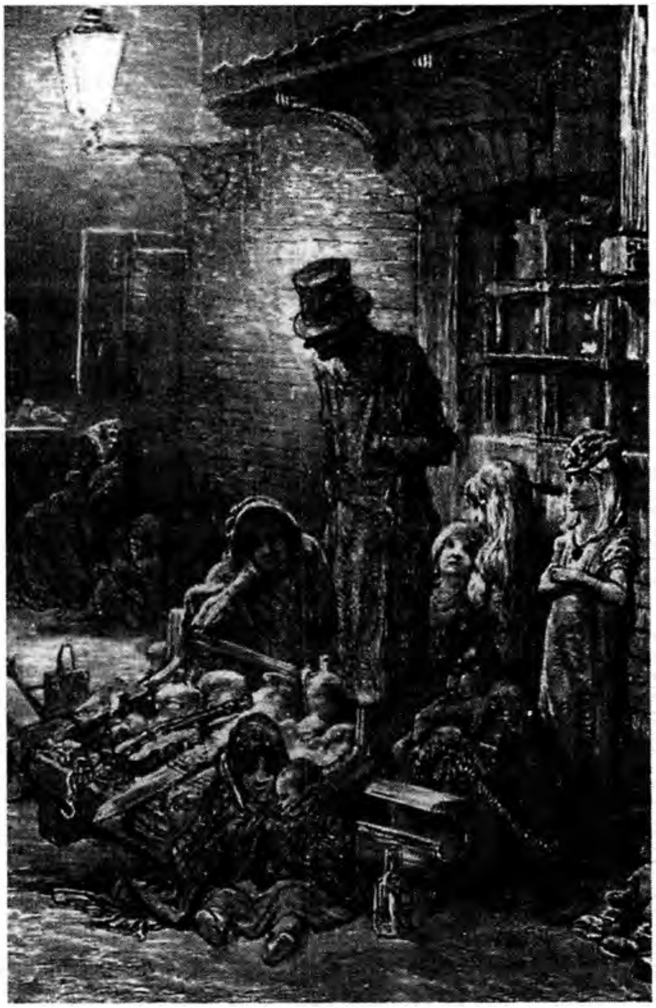
Let's look at the underlying assumptions of the Darwinians and what we will loosely call the continental tradition, those scientists, like Humboldt, who rejected the Newtonian empirical approach (box, p. 38).

Something funny seems to be going on here: Darwin's axiomatic approach leads directly to modern views on the significance of chance, random changes, and, ultimately, chaos theory. On the other hand, the continental tradition emphasizes directedness, teleology, purposiveness—or, might we not say, God. For Darwin the universe is definitely entropic. The continental school, in contrast, does not rule out the possibility that entropy is merely local reality and not global.

Let us examine the Darwinian axioms one by one.

(1) Chance and Random Changes

The more ordered life becomes, both in its origin from simple molecules and in its further development into more and more complex, differentiated, least-action geometries, of course, the further one gets from chance, randomness, and symmetry. But are these geometries themselves arbitrary or are they in some sense, as one contemporary paleontologist put it, "organized around one exigency: the accelerated populating of the surface of the Earth and the taking in charge of the planet by man"?[3]



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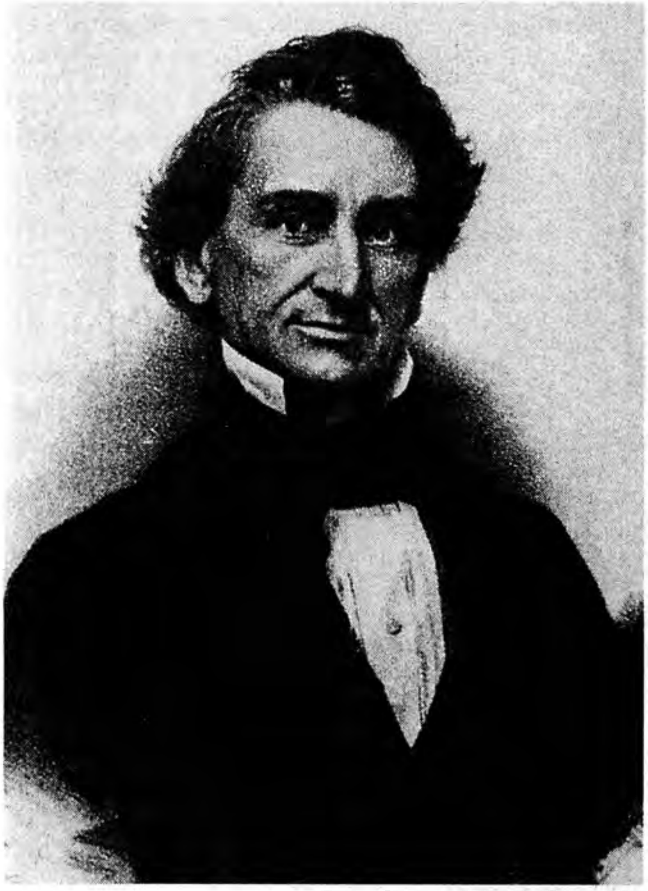
Beggars on the streets of London in the mid-19th century. Malthus argued that both humans and animals produced more offspring than the Earth could support and that in the competition for limited resources, only the fittest would survive the struggle.

In this latter tradition, from the 1850s through the 1870s, as Darwin was busy compiling the *Origin of Species* and the *Descent of Man,* the great French biologist Louis Pasteur was studying the optical dissymmetry of biological molecules.[4] He had been inspired in this direction by the suggestions of Humboldt's friend, the Göttingen University-trained crystallographer Eilhard Mitscherlich.

"The universe," wrote Pasteur, "is a dissymmetrical whole, and I am persuaded that life, as manifested to us and observed by us, is directly or indirectly a function of the dissymmetry of the universe." Pasteur used polarized light to study the symmetry or dissymmetry of various chemical substances. "If we consider material objects," Pasteur wrote, "we quickly recognize that they fall into two classes, characterized as follows: those which, when held before a mirror, give an image which can be superimposed on the original; and those whose image . . . cannot be superimposed upon it." Pasteur then gives ex-



Library of Congress/Photograph by M.B. Brady

James Dwight Dana (1813-1895), an American naturalist who criticized Darwin's theories, hypothesized that the evolution of life was purposive and directed, moving in the direction of cephalization—increasing development of the brain.

amples of a straight staircase or a cube for the former; and of a spiral staircase, a screw, or a leaf stalk with spirally arranged leaves for the latter:

> All substances produced artificially in the laboratory and all mineral species, have a superimposed image. On the other hand, most organic natural substances . . . are dissymmetrical, and their dissymmetry is of the kind whose image is not superimposable.[5]

In this century, Swiss physicist Charles-Eugène Guye made a simple calculation: What is the probability—by totally random changes and normal thermal action—of producing just one molecule of a molecular weight of 20,000 and possessing the high dissymmetry found in the optically active molecules of life. Egg albumen has a molecular weight of 34,500, so this hypothetical molecule is the size of a simple protein. Setting 0.5 as zero dissymmetry, or perfect symmetry, and 1.0 as maximum dissymmetry, Guye did his calculations for a molecule of 0.9 dissymmetry.

Guye concluded a probability of 2.02×10^{-321}, which is a chance of almost nil. If one assumed 500 trillion shakings per second—corresponding to the order of magnitude of light frequencies—it would take 10^{243} billion years for such a single molecule to be formed in a volume equivalent to that of Earth. But life has existed for only 3 billion years, and the Earth itself for roughly 4.5 billion years. To complicate matters, this is the probability for only one such dissymmetrical molecule (typical of what is found biochemically in life) to develop by chance. In order for life to originate, many, many such molecules would have had to have developed by chance and become ordered in an exceedingly complex way.[6]

This calculation is *not* a refutation of the possibility of the natural origin of life: Life obviously did originate billions of years ago, under conditions that we still do not fully understand. It neither refutes nor forms a mathematical model for the experimentation of A.I. Oparin, Harold Urey, and Stanley Miller on the formation of simple sugars and amino acids, the building blocks of starches and proteins, respectively, under conditions hypothesized to be similar to those under which the origin of life once occurred. (Oparin, Urey, and Miller synthesized much, much simpler molecules, probably in optically inactive mixes.) Guye's calculation is simply for the formation of one simple protein, of average size and of the type of high dissymmetry found in living forms.

In spite of its limitations, this calculation shows that given the underlying assumptions of the Darwin view of the universe, life could not possibly have begun without bringing in miracles from the outside. Is the universe entropic, with little hard balls of matter interacting randomly? Or is it nonentropic, a nonrandom universe, in which the geometry of spacetime, far from being a totally empty construct, determines the nature of the lawfulness found in that space? If it is entropic and random, as both Newton and Darwin hypothesize, then how can the origin of life and the sudden development of man possibly be explained?

This is by no means a trivial question or one that biologists can afford to overlook.

Obviously, Darwin did not have access to the same sophisticated biochemistry that permitted Guye to make such calculations. But was he aware of such problems?

Consider Darwin's exchange of letters with the American scientist James Dwight Dana, best known as a geologist, who in 1838-1842 had taken a surveying voyage sponsored by the U.S. Navy on a path very similar to that of Darwin and *H.M.S. Beagle.* Dana thought that the evolution of life was characterized by directedness, that it was purposive, and that the Earth with its geological forms and organic kingdoms evolved as a unitary whole.

Specifically, Dana hypothesized, evolution moved from the development of the most primitive species in a direction he called *cephalization:* increasing development of the brain and nervous system and deemphasis on lower functions like locomotion. This culminates in man and his unprecedented capacity for creative reason, Dana said.

Dana had written to Darwin on Feb. 5, 1863, citing his empirical points of criticism against Darwin's *Origin of Species,* including "the absence, in the great majority of cases, of those transitions by small differences required by such a theory," as well as "the fact of the commencement of types in some cases by their higher groups of species instead of their lower," and the discontinuous resumption of pathways of evolution following "exterminations of species."

Darwin replied on Feb. 20, 1863:

With respect to the change of species, I fully admit your objections are perfectly valid. I have noticed them, excepting one of [geological] separation of countries, on which perhaps we differ a little. I admit that if we really now know the beginnings of life on this planet, it is absolutely fatal to my views. I admit the same if the geological record is not excessively imperfect; and I further admit that the *a priori* probability is that no being lived below our Cambrian era.

Nevertheless I grow yearly more convinced of the general (with much incidental error) truth of my views. . . .[7]

Thus, Darwin knew that his hypothesis would be considered workable only so long as his followers could claim that the missing fossil links exist to show that life evolves by small continuous changes, but that these links had not yet been found. Today, more than 130 years later, it is difficult to argue that these missing fossil links are still to be found. In cases where the evolution of a species has been well documented, such as that of the modern horse, intermediate stages indeed appear (six, in this case, starting with Hyracotherium and Eohippus in the Eocene period), but each intermediate stage appears abruptly.

Directedness in Development

In contrast to the hypothesis of evolution proceeding by chance and random changes, scientists in the continental tradition hypothesized that the development (or evolution) of life was directed and purposeful. For example, the great 19th century mathematician Bernhard Riemann, in discussing the mechanism of hearing and the general function of the ear, asks how the ear

solves the problem of the organ. . . . We must, as it were, reinvent the organ, and, insofar as we consider what the organ accomplishes to be its purpose, we must also consider its creation as the means to that purpose. But this purpose is not open to speculation, but rather is given by experience, and so long as we disregard how the organ was produced, we need not bring into play the concept of final cause.[8]

Dana, a naturalist and a minister, put it in a different way:

Thus God throughout nature has evolved diversity out of unity, eliciting ten thousand concordances out of single profound enactments in His plan of creation. These laws are universal truths, limited in so far only as the range of objects to which they relate is limited. Thus any truth with regard to life which characterizes all living beings, is a law in the Science of Life. . . .

The external attributes of existences have indeed been graciously made so transcendent in beauty and full of harmonies, that "he may run that readeth." But there are also revelations below the surface, open to those who will earnestly look for them. For God's hand was never outstretched to create, but beauty and wisdom appeared in every tracing; and, if seemingly wanting in the outer vestments, they are still profoundly exhibited through the structure beneath, in the ordering of the parts from which the externals are educed, and in the universal laws there contained; these are literally secrets of the Almighty, to be diligently "sought out of all them that have pleasure therein."

Thus, these scientists saw no conflict between their religion and science, viewing science's task as to seek out this hidden lawfulness in order to continue creation in the image of the Creator, through the capacity of creative reason to imitate and thus participate in the creative quality of the intellect of God the Creator.

The aging Karl Ernst von Baer, an Estonian nobleman famed as an embryologist, first learned of Darwin's theory in 1859 from T.H. Huxley and Richard Owen, while visiting London. Unlike many of the continental scientists mentioned above, von Baer was still alive as the Darwinian theory began to take hold even on the continent. By 1871, when Darwin published *The Descent of Man,* von Baer, acting on behalf of the continental science tradition, began to challenge the Darwinian view. Von Baer points out that

In Darwin's hypothesis all goal-directedness is avoided as much as possible. Nothing happens without sufficient reason; that is certain. But natural forces which are not directed to an end cannot produce order, never a mathematically determinant form much less a complex organism. . . . How is it possible to mistake that all of these [physiochemical] operations are ordered with respect to a future need? They are directed to that which is to come into being. Such a relationship was designated by the Latin philosophers a *causa finalis,* a cause "which lies in an end or result."

(2) Continuous, Gradual Mutation

Darwin, in all his examples, talks about variation within the species, and extrapolates this to become a mechanism for evolving new, totally different species. He does this by hypothesizing the random occurrence of the tiniest changes, variations, and assumes that given enough time, one small change can be added to another until one has something totally unlike the previous species. In the modern synthesis, these tiny, inherited changes are assumed to be changes on the gene level. If enough genes change, one by one, the assumption is that over time, a new species could occur. But then how could one explain much larger changes, such as the difference between the plant, animal, and fungi kingdoms, or the difference in different families within the animal kingdom?

Darwin glides over this crucial point, confessing to his friend and collaborator Asa Gray:

As an honest man, I must tell you that I have come to the heterodox conclusion that there are no such things as independently created species. That species are only strongly defined varieties. I know this will make you despise me.[9]

Here we see that Darwin, who wrote a monumental work on the origin of species, does not even believe in species!

In contrast to Darwin's approach, the continental school focuses on large-scale changes of a discontinuous and geo-

What Is the Difference Between Man and Beast?

Is there any fundamental difference between man and beast? An intelligent young dog will mimic its human pack leader, and will develop a sign and body language, clear to both, to roughly communicate its desires. Think of the dog's behavior in the kitchen, for example, that tells the cook it is hungry.

In fact, any bright member among the higher mammals that have a highly organized social structure in the wild can, if domesticated, readily be trained to do a very intricate series of tasks. This is not because it understands the rationale behind the tasks or the human technology that might be employed along the way, but because it has an innate drive to communicate with, mimic, and please its human "pack leader." Primates are not unique in that sense, although, to some, a chimpanzee might look more human than a dog or a raccoon.

Give a young dog a ball. It will play with it and explore the ball's behavior. A young chimp or a young child would do the same, and each appears on the surface to be playing with the ball in the same way. However, only the human being can take the ball, toy with it, study it, and come up with a totally hypothetical abstract idea that does not exist in tangible form: the absolutely perfect sphere.

Only the human *sees* the ball as the solution to a least-action problem of enclosing the maximum volume within a minimum surface area. And the human *sees* something else no other species can see in that ball: a hypothetical center, from which a point can be rotated, by circular action, at a fixed distance from that center in order to generate the surface of the sphere.

From this conception of rotation, of circular action, a whole geometry and science can be built up. And from this geometry and science, man creates specific practical technologies, all based directly or indirectly on circular action—from the obvious, like the wheel and ball bearings, to the less obvious.

From the technological spinoffs of this simple idea of rotation, man has been able to transform his way of life from that of a simple hunter-gatherer, in which each human required an immense tract of land to maintain himself calorically, to what it is today. This is an increase of several orders of magnitude! No beast ever did that, not even the cleverest, just as no other species has been able to create the science and technology to put itself on the Moon.

This is the difference between man and the beast. Through the power of creative reason, man exerts dominion over nature and generates new technology that continues to increase his power over nature and transform it at a still more rapid pace. Man, through successive generations of technology, continues evolution on a nonbiological level.

Linda Ray

It may be cute, cuddly, and even affectionate and loyal, but it can't create the science and technology to discover new worlds.

metric nature. By 1834, von Baer, perhaps better known for developing the science of developmental morphology, had developed a very rich concept of adaptive radiation, exploring the idea of the way one life form is modified to generate others:

> The development of life in this or that direction produces variations of the major types, which are themselves essentially different in their vital manifestations. . . . The classes divide themselves further into lesser variations, which we call families. These not only bear the modification of the major type but also include a particular modification of the class, which forms the characteristic of the family. Modifications of lesser degree in these families give rise to species and similarly for races and varieties. . . . Every type may be manifested in higher and lower degrees of organization, for Type and degree of development together determine the individual forms. This produces, therefore, grades of development for each Type, which in certain instances form series, but not a continuous developmental series and never one which completes all possible developmental grades. . . . It is no accident that certain forms of organization are realized in fewer variations. The cause must lie in the essence of the forms themselves. . . . But these subordinate modifications of a particular grade [classes, families, species, and so on] are

> mostly quite similar, and only a few ever appear to be radically different, so that a theme of these organic variations can be compared to a sphere, which consists of a densely compacted center surrounded by thinly populated atmosphere. . . . From this emerges two noteworthy rules: First, that the more compressed the center of the sphere, the more limited is the extent of the atmosphere, both in the larger, higher spheres, as in the smaller, lower spheres. . . . Second, in each large sphere, spheres subordinate to the center are richer in subordinate forms than those subordinate to the periphery.[10]

Von Baer insisted that all potential for variation is not actually developed because environmental factors must be conducive for the potential capacity in order for variation to be realized.

In criticizing Darwinian evolution, Louis Agassiz states flatly that

> the study of species as the basis of a scientific education is a great mistake. It leads us to overrate the value of species, and to believe that they exist in nature in some different sense from the other groups; as if there were something more real and tangible in species than in genera, families, orders, classes, or branches.[11]

(3) Survival of the Fittest

The Darwinian view stresses a fierce dog-eat-dog competition: survival of the fittest. But what does survival of the fittest really mean? What is the most fit, but that which survives? So, here we have a tautology: whatever survives, survives—a fitting view for an empire to ride roughshod over all other interests. In contrast, the continental science tradition believed in the harmony of nature and was republican, not colonial, in its politics.

Like Alexander von Humboldt, von Baer had a distinct, nonsimplistic notion of the harmony of nature. Von Baer wrote:

> What we have discussed here: the reciprocal interconnections of organisms with one another and their relationship to the universal materials that offer them the means for sustaining life, is what has been called the harmony of nature, that is a relationship of mutual regulation. Just as tones only give rise to a harmony when they are bound together in accordance with certain rules, so can the individual processes in the wholeness of nature only exist and endure if they stand in certain relationships to one another. Chance is unable to create anything enduring, rather it is only capable of destruction.[12]

But what is the evidence? If one looks at the most primitive species, it might appear that the Malthusian-Darwinian view is appropriate. Lower species have a prodigious number of offspring, of which very few survive to adulthood. Why one individual rather than another survives in such species may appear superficially to be the result of chance. Fish, reptiles, and insects eat each other and even, in some cases, their sexual partners and their own eggs.

If you look at the highest species, however, such as higher mammals, the opposite seems to be the case. Most higher mammals have elaborate social structures and extensive collective nurturing of the young. Even with dogs, which can fight to kill for food or to establish rank, once rank is established, the fight ends with the less successful individual acknowledging defeat. Social rituals, which maintain the cohesion and population size of the pack, dominate over the Darwinian model of individual dog-eat-dog fights to the death.

Why should the reproductive strategy of the higher species be so drastically different from that of the lower species?

(4) Inbreeding versus Outbreeding

Darwin developed much of his hypothesis by studying the way British horse and dog breeders produced separate breeds. Indeed, genetic variation allows breeders to select for specific traits: the fastest, the largest, the most brightly colored, and so on. From this he extrapolated the idea of "natural" selection as a selection for the individuals best adapted to conditions in the wild. However, horse and dog breeding produce variation only *within a single species.*

In addition to this limitation, the show-animal breeding method has its problems. Inbreeding mother to son, sibling to sibling, does indeed often produce progeny very similar to the proven champion parents, but the price paid for this shortcut to riches is a rapid increase in very serious genetic diseases, poor temperament, and other problems.

Farm animals and other working animals, as well as agricultural plants, are *outbred* to maintain both physical and—for the animals—psychological versatility and vigor. They are generally bred for vigor, endurance, and versatility (plasticity) under a wide variety of circumstances. For example, new strains of seed are judged agriculturally by whether they produce well under a wide variety of climate and soil conditions, including how well they can withstand diseases common to that crop. Hybrid vigor, the wellspring of modern agriculture, is produced totally by outbreeding.

What does this question of outbreeding or inbreeding have to do with evolution?

There is a basic flaw in the assumption that one can breed for just a few very specific traits to get a species perfectly adapted to very fixed and limited conditions, and that this is the way evolution generates speciation: This view assumes that the environment—nature—remains fixed and stable. However, living conditions are *not* fixed. External bounding conditions change. Continents and oceans have come and gone. Climatic conditions have fluctuated from extremely hot, steamy tropical conditions or hot arid conditions to glacial ice ages. Numerous species have emerged and died out. Perfect adaptation to fixed environmental conditions is not the way evolution proceeds. Although this strategy may work on the race track or in the show ring, the species that used this strategy are long since extinct. Instead, successful species must have a certain flexibility and vigor that makes them adaptable to changing environmental conditions.

It took life eons to generate species that are progressively more and more adaptable to different and varying conditions. Life becomes increasingly homeostatic (able to regulate its own physiological conditions internally) as higher forms of life evolve. First, life escapes from dependence on an aqueous environment and becomes able to regulate its own salt and water content, protecting itself, by various means, from desiccation and other extremes. With mammals and birds, homeotherms evolve: species able to regulate their own body temperature.

Finally, man appears. From the physiological standpoint, man appears in Darwinian terms to be the least well adjusted to environmental conditions, being both weak and naked. Yet, from the standpoint of adaptation to changing environmental conditions, he is the best adapted, because he has creative reason and develops language and society. Man is thus free from the fixed instinctual drives of lower animals. During a prolonged child-rearing phase, the young develop the mental aptitude to generate new technologies that can conquer any environment—and even colonize space.

The Earth and its biosphere are the antithesis of a fixed environment. Looked at from the perspective of geological time—the eons during which life has evolved—life is constantly changing with the biospheric environment; it is constantly modifying and transforming for its own ends. From this standpoint, the number of species that have become extinct as a result of changes wrought by human civilization is paltry in comparison with the number of species extinctions caused by major climatic and similar drastic environmental changes that occurred prior to man's appearance.

In reality, the natural world is filled with extinctions of species that could not adapt to a changing environment; man, like other more highly evolved forms of life, is more capable of transforming his environment than are the more primitive species.

There is a general lawfulness of evolution that is not unique to man: life forms evolve to generate new species with greater versatility and greater capacity to transform the biosphere.

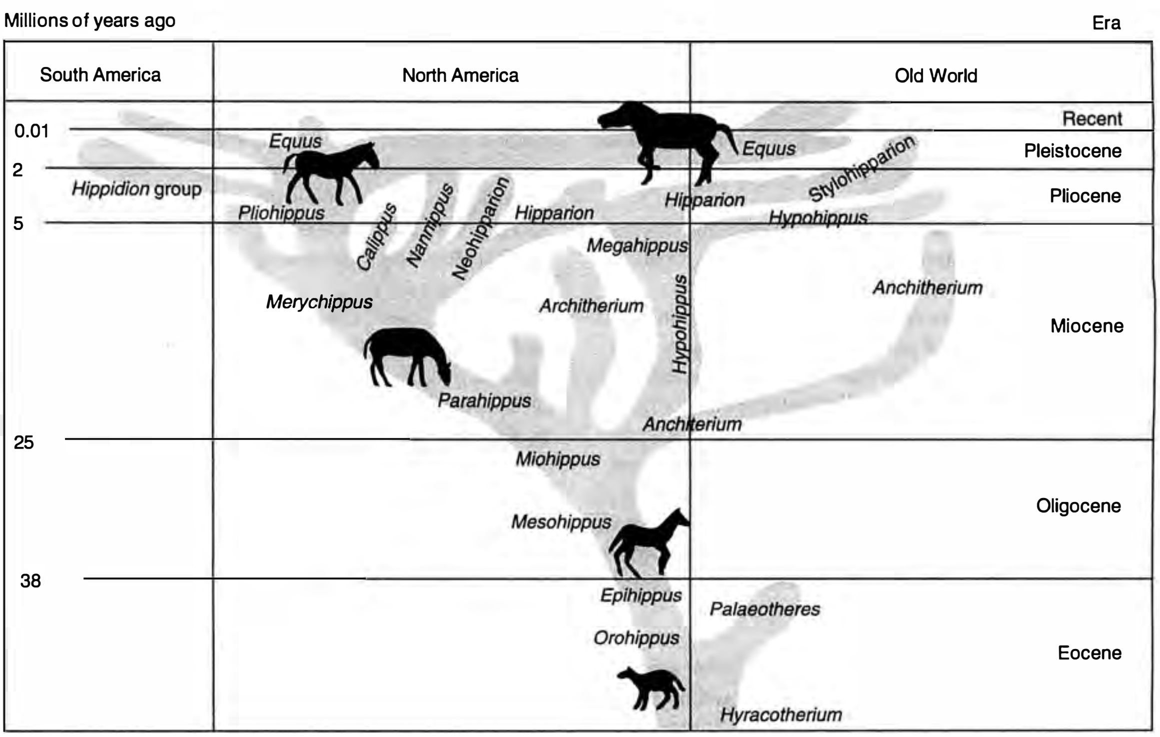
(5) Man Just a Beast?

This brings us to the last assumption on the chart. The Darwinians assume that man is just another beast. Darwin states:

> It is absurd to talk of one animal being higher than another. *We* consider those, where the intellectual faculties most developed, as highest,—A bee doubtless would [use] . . . instincts.

Man, in Darwin's view, is just another beast and thus the human herd might be culled (via eugenics) just as one might cull a herd of cattle. And once one tries to justify eugenics, inevitably the claim is made that some groups of men, for reasons of skin color, religion—or whatever—are more fit than another.

Compare Darwinian eugenics to Alexander Humboldt's view: Humboldt insists that man and human civilization are of a higher order that is not dominated by the same kind of lawfulness that characterized the evolution of life up to that point.



THE EVOLUTION OF THE HORSE

If evolution followed the linear model of Darwin, the evolutionary path of the modern horse would not look like a complex tree with many branches (shown here), some of which appear abruptly. Instead it would be a straight line that proceeded with incremental, gradual changes. The horse evolved in the context of the development of grasslands.

Source: Adapted from *The Encyclopedia of Animal Evolution*, eds. R.J. Berry and A. Hallam (New York: Facts on File Publications, 1987)

Humboldt, Dana, and others of the continental science tradition assert not only that man is the crowning glory of the process we call evolution, but also that man goes beyond this, taking evolution into a different, a higher realm.

This is very much a hot issue today. The much publicized book *The Bell Curve,* for example, by scientists Charles Murray and Richard Herrnstein, claims that human beings of darker pigmentation are just not as "fit" as those of lighter pigmentation. The research for the book was supported by The Pioneer Fund, which had its start in the eugenics movement of the first half of this century. Before World War II, Harry Laughlin, leader of the Pioneer Fund, wanted the "lowest" 10 percent of the human population sterilized, in order to better build a race of human thoroughbreds. Laughlin and his Fund distributed Hitler's propaganda films in American schools, while Hitler put the Darwinian implications of eugenics into practice in slave labor camps.

Other contemporary researchers with a eugenics theme include neuroscientist Xandra Breakerfield at Harvard University, who is trying to prove that violent behavior is genetic, while others are trying to prove that homosexual behavior is genetic.

At this point, it ought to be clear that *no* scientist studying something as broad as the origin and evolution of life can totally avoid issues that have political, philosophical, and religious connotations. As much as such scientists might want to stay out of politics, the political questions are raised because of the very nature of the underlying assumptions adopted.

The End of Darwin

And so we come to the embarrassing moment of having to acknowledge that the views of Darwin and friends do not stand up well to the massive amount of scientific evidence accumulated about how evolution works. In fact, from the standpoint of the paleontological record and similar evidence, the Darwinian hypothesis is a miserable failure.

There have been many "improvers" of Darwin's theory during this century, and the holist school has pretended to offer an alternative theory. None of these scientists, however, has been willing to contradict any of Darwin's fundamental axiomatic assumptions about the nature of the universe and man, as outlined in the box. Nor is any such scientist willing to expose the fraud in the still-taught dogma that modern biology and physical anthropology rest upon Darwin's fundamental discovery.

Yet, as we finally bury Darwin and his comrades in arms, as we watch the clods of dirt fall upon their coffins, let us contemplate the humbling admission that, fundamentally, science today does not really know much about life and how it evolves. What is life? What is the difference between the biochemical composition of the components of various tissues and the living form of those tissues? Why are those biochemical components found in life only in specific, optically active forms? What does this have to do with other cosmic forces Pasteur noted that are dissymmetric—the universe with its magnificent spiral galaxies, polarized sunlight, magnetic and electromagnetic fields? Why are the biochemical components of life found in crystallized forms only *after* death? How have the numerous changes in both the polarity and field strength of the Earth's magnetic field affected the evolution of life? How did the origin of life occur? How do chromosomal reorderings occur in a stable form that leads to new forms of life? What is the difference between those chromosomal reorderings, and the unstable chromosomal reorderings that can occur in multinucleated cancer cells? Is it only a difference in geometric stability? Does the genetic material of life have other vital roles beyond the genetic code? Why does DNA have all kinds of fascinating properties, such as its piezoelectric capacity, and what does this have to do with functions beyond the immediate role of the genetic code?

We have a lot of work to do. What we know is clearly dwarfed by what we don't know. But attempts to answer these fundamental questions, no matter how imperfect, in the long run will open up exciting discoveries and new realms of medical technologies that we cannot even dream of today, but that we *know* our grandchildren and our grandchildren's children will understand.

A century has passed since the Darwinians drove the proponents of the continental science tradition out of science. It is impossible now to judge what scientific breakthroughs and new technologies would have occurred had this not happened. We cannot simply turn back on that road. But we can use the continental science tradition as a sort of road map to move out into that great dark void and begin to explore it. We can reexamine the underlying axioms of these continental scientists. We can study the method, the philosophical tradition of Gottfried Leibniz and Nicholas of Cusa, that guided these men and apply it to today's world of scientific knowledge and technology. But we can only do so if we are honest enough to admit that Darwin has died and that it is time to get down to some really hard work.

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Notes

1. See the Appendix to *Leonardo da Vinci on the Human Body,* edited by Charles D. O'Malley and J.B. de C.M. Saunders, eds. (New York: Greenwich House, 1982).
2. Carl Bergmann and Rudolph Leuckart, *Anatomisch-physisch Uebersicht des Thierreiches. Vergleichende Anatomie und Physiologie. Ein Lehrbuch fuer den Unterricht und zum Selbststudium* (Stuttgart, 1852), as cited in Timothy Lenoir in *The Strategy of Life—Teleology and Mechanics in 19th Century German Biology* (Chicago: University of Chicago Press, 1982).
3. See Jean-Michel Dutuit, "Man Is Evolution Become Conscious," *Fusion,* Vol. 9, No. 1, Jan.-Feb. 1987, pp. 36-43.
4. Whether this dissymmetry is right- or left-handed depends on the chemical involved. Amino acids are all in the levo form, rotating to the left, or counterclockwise, while sugars are in the dextro form, rotating to the right.
5. Hilaire Cuny, *Louis Pasteur: The Man and His Theories* (Greenwich, Conn.: Fawcett Publications Inc., 1963), pp. 68-69, 150-152.
6. See Lecomte du Noüy, *Human Destiny* (New York: Longmans, Green and Co., 1947), chapter 3.
7. This exchange of letters is found in Daniel C. Gilman, *The Life of James Dwight Dana: Scientific Explorer, Mineralogist, Geologist, Zoologist, Professor in Yale University* (New York: Harper & Brothers, 1899), pp. 294-295. Darwin adds, "I should not much value any sudden conversion, for I remember well how many years I fought against my present belief."
8. Bernhard Riemann, "The Mechanism of the Ear" (1866), translated from the German in *Fusion,* Sept.-Oct. 1984, Vol. 6, No. 3, pp. 31-38.
9. Adrian Desmond and James Morse, *Darwin* (New York: Warner Books, 1991), p. 457.
10. Karl Ernst von Baer, *Ueber die Entwickelungsgeschichte der Thiere* (Koenigsberg, 1828); and "Beitraege zur Kenntniss der Niedern Thiere" (*Nova Acta Leopoldina,* Vol. 13, 1827, pp. 740-743), as cited in Timothy Lenoir, *Strategies of Life* (Chicago: University of Chicago Press, 1982), pp. 89-90.
11. Louis Agassiz, *Gists from Agassiz,* John Kasper, ed. (New York: Karper and Horton, 1953).
12. Karl Ernst von Baer, "Ueber den Zweck in den Vorgaengen in der Natur," in *Reden,* Vol. 2; and "Ueber Zielstrebigkeit in den organischen Koerper insbesondere," ibid., as cited in Timothy Lenoir, *Strategies of Life* (Chicago: University of Chicago Press, 1982).