**Holmes Rolston III, *Science and Religion: A Critical Survey***
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## *Introduction to the 2006 Edition*

# Human Uniqueness and Human Responsibility

## Science and Religion in a New Millennium

On the scale of decades and centuries, ongoing science is reconfigured into human history that must be interpreted. So I concluded two decades back: "Progressively reforming and developing theories are erected over observations. . . . This leads at a larger scale to progressively reforming and developing narrative models. . . . The story is ever reforming" (pp. 338–39). I faced the future with hopes and fears about the escalating powers of science for good and evil, finding it simultaneously powerless for the meaningful guidance of life, the classical province of religion. So now, having turned the millennium, what's new in the story?

If I had to give a sound-bite answer (as we now must do with the media), my reply would be: increasing concern about *human uniqueness and human responsibility*. We are reforming our accounts of who on Earth we are, where on Earth we are, and what on Earth we must and ought do. Paradoxically, the more we naturalize ourselves (as many scientists wish to do), finding ourselves products of an evolutionary process, descended from the apes, incarnate in flesh, we find ourselves the only species that knows its origins. We demonstrate our continuity with natural history, and in so doing find that the capacity to demonstrate this, requiring paleontology, genomics, cladistics, disrupts the continuity demonstrated. And, if this epistemic crisis were not enough, the scientific knowledge so gained simultaneously generates a moral crisis.

*Homo sapiens*, the wise species—so we have named ourselves—is the one species in the history of the planet that, now in this new millennium, has more power than ever for good or evil, for justice and injustice; indeed, the one species that puts both its own well-being and that of life on Earth in jeopardy. I was right, closing that book, that today we find ourselves seeking and "doing the truth on the cutting edge of nature and history" (p. 344). The media metaphor for this is "playing God"; the archaic metaphor is whether this creature rising from dust can act in the "image of God."

I began two decades ago: "Science is the first fact of modern life, and religion is the perennial carrier of meaning. . . . Science and religion are the two most important forces in today's world" (p. vii). That has not changed. Not so, my critics may reply: science is the new millennium; religion has been left in the last millennium. The last millennium does already seem history, almost antique. Who would open a physics or a biology text from the 1980s if one from the 2000s were at hand? Neither should one bother with a dated science and religion book. Great novels, such as *War and Peace*, can be classics, as can philosophical treatises, such as Immanuel Kant's *Critiques*. But in the science and religion debate one needs to be on the front lines.

In the original preface I wrote: "The religion that is married to science today will be a widow tomorrow. The sciences in their multiple theories and forms come and go. . . . But the religion that is divorced from science today will leave no offspring tomorrow. . . . Religion cannot live without fitting into the intellectual world that is its environment. Here too the fittest survive" (p. ix). After two decades, nearly a generation later, what are the winds of change in the disciplines of science? Is religion still a good adapted fit? What's new in the new millennium?

In the biological sciences, for organisms to survive and reproduce in the next generation is mostly a matter of conserving genetic information from the past, embodied in present organisms. This is likely to be useful today and tomorrow. But surviving also requires genetic variation, innovations that yield still better adapted fit, selected when these novel forms and behaviors critically track changes in the surrounding world. I would not be reprinting this book if I did not think that there is much of value here to be conserved in the next generation(s). Mostly, my arguments still stand. All of them are part of our survival in past and present. But neither can one stand still. One must generate and test new ideas. What are the critical innovations that, in a new millennium, we must track?

## 1. AN OPEN FUTURE

A major innovation is a sense of accelerating change and open future. Yes, we conserve the past; but today, as never before in the past, there is new possibility space, opened up by advances in science and technology, by industrial and agricultural capitalism, by global communication and exchange, by an explosion of ideas and activities. With the turn of the millennium, there is a sense that what is past is more past than when turning previous centuries, more behind us than ever. It's a new day, a new epoch, a new millennium, an exponential future. This is good, bad, and uncertain news. The possibilities of good and evil are escalating. Across multiple levels, from the quantum world through chaos theory, from genetic mutations and engineering, from medical advances to military prowess, to stock markets and terrorist attacks, we face uncertainties and unknowns. The discoveries and powers of science, once supposed to give us rationality, law, and predictability, now feed as much into this openness. We face at once promise and peril.

Looking into the future is hazardous. The sun will rise tomorrow because it rose yesterday and the day before. Induction is reasonably reliable if one is predicting simple systems. But induction is notoriously problematic, both for logical and empirical reasons, the more so if one is dealing with complex systems, exponential not linear, as our world is increasingly becoming. If one predicts on the basis of past and present, one will be right much, even most of the time—at least that has previously been the case. But one will be wrong at the times of critical innovation, the most important times of all, when the future is unlike the past. That has been so before; but, such a time, as never before, is now.

The future develops from what is already seeded into the present. That is true in biology, in science, in theology. But, when we survey such a past in natural and human history, in science and in religion, the one thing certain is that there will be surprises, the more so in more complicated systems. It is easier to predict eclipses a century hence than to predict tomorrow's headlines. We have been living through a century of change in our ideas about how determinacy and contingency, design and chance, order and chaos fit together to make up the world. These changes shape religion in its account of both science and nature. It now looks as though that reshaping will continue. There are no laws, plus initial conditions, by which we can predict the new millennium; but there are stories that we will enact and tell. Science deals with causes, and religion deals with meanings (pp. 22–31); we can be sure that both causes and meanings will be ingredients perennially interwoven in the fabric of history. And, dramatically, we write the next chapters of the story. Today, the future is open, as never before in the history of the planet.

Anticipating the future relations between science and theology, we can only extrapolate and wonder. In this century, we humans have come to know who we are and where we are in ways unprecedented in all past millennia. We know the size, age, and extent of our universe; we know the deep evolutionary history of our planet, and ourselves as part of this story. We know our molecular biology; we have sequenced our genome. These facts of science have required integration into our classical religious worldviews; and this blending of theory and principle in science and religion will continue. In this century, we humans have gained, through science and technology, more power than ever before to affect, for better or worse, our own well being, that of the human and natural worlds, and even planetary history. That is power, promise, hope, as never before. But caution! Danger! The fate of the Earth, the fate of all who dwell thereon, depends, in the next century, on the responsible use of that power. Everything depends on how we join science, ethics, and religion, with policy, with economics in practice.

Right on the edge of the new millennium (1999), I concluded:

> These three features of our human life on Earth—knowledge, power, and duty—are especially puzzling. How does reason, the mind with its knowledge, fit into the biological picture? Does it produce only more survival power? Does not this human mind gain some new power, manifest in cumulative transmissible cultures, that changes the evolutionary story? (Rolston 1999, p. 215)

Such power, if cumulating over thousands of years, seems, in the last century turning into the new millennium, to have crossed a new threshold.

Editing a *Scientific American* issue on managing planet Earth, William Clark writes that humans are moving toward consciously managing the Earth. Here "two central questions must be addressed? What kind of planet do we want? What kind of planet can we get?" (Clark 1989, p. 48). This, they say, will be the principal novelty of the new millennium: Earth will be a managed planet. Nature will be increasingly humanized. Humans have, now and increasingly, the power to impose their will on nature, re-making it to their preferences. The era when nature was the principal determinant of events on Earth is coming to an end; we are entering a post-natural world.

We will manage the planet, so the enthusiasts say, at the global level. Such resourceful management continues at all scales, down to microlevels, even to nanotechnology. The breakthrough is epitomized in genetic decoding and modification. Edward Yoxen writes:

> This is not just a change of technique, it is a new way of seeing. . . . The limitations of species can be transcended by splicing organisms, combining functions, dovetailing abilities and linking together chains of properties. The living world can now be viewed as a vast organic Lego kit inviting combination, hybridisation, and continual rebuilding. Life is manipulability. . . . Thus our image of nature is coming more and more to emphasise human intervention through a process of design. (Yoxen 1983, pp. 2, 15)

But who will manage the managers? Can the managers manage themselves? When they intervene, what ought they to design? Is the only human relationship to nature one of engineering it for the better? Of manipulating a vast Lego kit? Ought these engineers be impressed with the spontaneous self-assembling of this Lego kit that has generated biodiversity and biocomplexity over millennia? Do we have a duty of caring for a good, a godly creation? Ought humans make nature an end in itself, complementary to their own human ends? Yes, we humans are dominant, but what responsibility comes with this unique role? Invoking those contemporary and archaic metaphors again, are we playing God? Ought we to do this without concern whether we are imaging God?

These questions remain unanswered. In the last two decades, the increase of human knowledge and power has increased the paradox of our evolving out of nature with novel capacities to change natural history. This is nowhere better illustrated than in *Homo sapiens* decoding its own genome, surprised to find how few genes we had, confirming our kinship with other primates, unable as yet to discover what makes us so different, and wondering whether in our genetics laboratories we ought to remake ourselves (treating ourselves as a Lego kit, and asking whether to use stem cells to discover how to do so). This future, with its increasing knowledge opening up new possibility space, confirms human uniqueness and human responsibility.

## 2. MATTER, ENERGY, INFORMATION

At cosmological scales there is deep space and time: this a matter-energy question. At evolutionary scales Earth is a marvelous planet, a living wonderland in this deep space-time: this is an information question. The wonder is coded in the vital know-how in DNA. There is an originating matter/energy big bang, when the universe is formed. There is a second big bang, when biological information explodes on Earth. Both the first and the second big bangs result in us: the *Homo* that is so *sapiens*. A third takes place within us, the mind's big bang in the explosion of cultures with radical capacities for the generation and cumulative transmission of ideas—knowledge, wisdom. And we humans today, passing into a new millennium, seem poised on the edge of yet another combinatorial information explosion, with escalating possibilities in science and technology, evidenced in that recent decoding (and possible transforming) of our own genome or in unprecedented information storing and sharing on the Internet.

I wrote two decades ago:

> We humans do not live at the range of the infinitely small, nor at that of the infinitely large, but we may well live at the range of the infinitely complex. . . . The human being is the most sophisticated of known natural products. In our hundred and fifty pounds of protoplasm, in our three pounds of brain, there may be more operational organization than in the whole of the Andromeda galaxy. . . . The most significant thing in the known universe is still immediately behind the eyes of the astronomer. On a gross cosmic scale, humans are minuscule atoms. Yet the brain is so curiously a microcosm of this macrocosm, since the mind can contain so much of nature within thought and thus mirror the world. (p. 66)

If that has changed, it has become truer than ever. Our minds contain more of nature within (from quarks to antimatter, fossil history to the sequence of our own genome), and we continue to search out our world (its biodiversity, natural history) and our place within it (unique minds on Earth, planetary manager, sustainable developer, Earth's trustee, self-transforming species). Here is my current assessment:

> Alone among the other species on Earth, *Homo sapiens* is cognitively remarkable for being a spirited self and for self-transcendence. . . . *Homo sapiens* is the only part of the world free to orient itself with a view of the whole. That makes us, if you like, free spirits; it also makes us self-transcending spirits. Consider this transcendence first in the sciences. . . . With our instrumented intelligences and constructed theories, we now know of phenomena at structural levels from quarks to quasars. We measure distances from picometers to the extent of the visible universe in light years, across 40 orders of magnitude. We measure the strengths of the four major binding forces in nature (gravity, electromagnetism, the strong and weak nuclear forces), again across 40 orders of magnitude. We measure time at ranges across 34 orders of magnitude, from attoseconds to the billions-of-years age of the universe.
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> Nature gave us our mind-sponsoring brains; nature gave us our hands. Nature did not give us radiotelescopes with which to "see" pulsars, or relativity theory with which to compute time dilation. These come from human genius cumulated in our transmissible cultures (though we do not forget that nature supplies these marvelous processes analyzed by radiotelemetry and relativity theory). (Rolston 2005, pp. 30–31)

We continue to find these cosmic processes marvelous, amazed more than ever by how they are "fine tuned" or "anthropic" in such a way that the natural history we know takes place (for a view open to theism, see Barr 2003; for a multiverse view, see Rees 2001). The subsequent decades have buttressed what I said two decades back:

> There seem to be in fact all kinds of connections between cosmology on the grandest scale and atomic theory on the minutest scale, and we may well suppose that we humans, who lie in between, stand on the spectrum of these connections. The way the universe is built and the way micronature is built are of a piece with the way humans are built. The shape of the rest of the universe, of all the levels above and below, is crucial to what is now taking place close at hand. In its own haunting way, the physical structure of the astronomical and microphysical world is as prolife as anything we later find in the prolife biological urges. Prelife events can have, and have had, prolife consequences. The universe is a biocosmos. (p. 70)

It is difficult to envision any cosmology that does not require creation of the complex out of the simple, more out of less, something somehow out of nothing. It is difficult to imagine that all of the remarkable phenomena that have worked together to make our universe possible will disappear. It is difficult to imagine a universe more staggering, dramatic, and mysterious, for all its rationality. It is difficult to imagine a universe that starts simpler (perhaps as quantum fluctuation in a vacuum) and becomes more complex (*Homo sapiens* sequencing its own genome; moral debates about the war in Iraq). The universe story, the Earth story, is a phenomenal tale of more and more later on out of less and less earlier on. As events move from quarks to protons, from amino acids to protozoans, to trilobites, to dinosaurs, to persons, from spinning electrons to sentient animals, from suffering beasts to sinful persons, the tale gets taller and taller. No doubt there will be surprises in cosmology in the next century, a taller tale still, but it would be even more surprising if these were wholly uncongenial to theology.

In astronomical nature and micronature, at both ends of the spectrum of size, nature lacks the complexity that it demonstrates at the mesolevels, found at our native ranges on Earth. On Earth, the surprises compound, and this is vitally keyed to its genetics, as we see next. The Earth-system is a kind of cooking pot sufficient to make life possible. Spontaneously, natural history organizes itself. The system proves to be prolife; the story goes from zero to five million species (more or less) in five billion years, passing through five billion species (more or less) that have come and gone en route, impressively adding diversity and complexity to simpler forms of life. That life support and promise evolve richness in biodiversity and biocomplexity that, after eons of millennia, reaches humans with their uniqueness and responsibility. Earth is a kind of providing ground for life, a planet with promise, a promise offering still more fulfillment in this oncoming millennium.

There are other planets. In the two decades since the first edition, the presence of over a hundred possible planets has been detected, though none suitable for life is yet known. If there proves to be a second (or prior) genesis of life elsewhere, that will be welcome. But Earth will not on that account cease to be remarkable, nor will its particular natural history—trilobites, dinosaurs, primates—and social history—Israel, Europe, China, global capitalism, the Internet—cease to be unique in the universe.

Two decades ago what needed to be explained was the generation of *complexity*. In recent decades scientists have come more to focus on the *information* required for specifying and generating such complexity. In the beginning, and, continuing in the astronomical and geophysical sciences, there have been two metaphysical fundamentals: matter and energy. At deeper levels, physicists reduced these two to one: matter-energy. Later, cyberneticists began to insist that there were still two fundamentals: matter-energy and information. Norbert Wiener, a founder of cybernetics, insisted, "Information is information, not matter or energy" (Wiener 1948, p. 155). Hans Christian von Baeyer, a physicist, anticipates, "If we can understand the nature of information, and incorporate it into our model of the physical world . . . then physics will truly enter the information age" (von Baeyer 2003, p. 17).

The term "information" is complex and has been used variously in differing sciences. There is information on the surface of the moon, in the sense that a geologist can read some of the history of the moon from the overlay of meteoric impacts there. Mathematical information (or communication) theory, Shannon information, deals with reliable signal transmission, without regard to the significance, the semantic content, of the signal transmitted. Relevant information in addition has both signal reliability and signal significance. Any science, physics included, is a question of information gained.

The discovery that information is a critical determinant of history has thrown the causal/contingency debate into a new light. The world is composed of matter and energy, with the two united in relativity theory—so physics and chemistry have insisted. But the earthen world, biologists now insist, is composed by information that superintends the uses of matter and energy. The biological sense of information is more proactive, agentive than the physical sense. Such vital information is carried in the genes. What makes the critical difference is not the matter, not the energy, necessary though these are; what makes the critical difference is the information breakthrough with resulting capacity for agency, for *doing* something. Something can be discovered, learned, conserved, reproduced on Earth, but not on the moon.

Afterward, as before, there are no causal gaps from the viewpoint of a physicist or chemist, but there is something more: novel information that makes possible the achievement of increasing order, maintained out of the disorder. The same energy budget can be put to very different historical uses, depending on the information in the system. The miraculous is not the punctuation of natural order with supernatural intent—God sneaking into the causal gaps. The miraculous is the more out of less that the coupling of natural order with disorder generates, with nature wonderfully, surprisingly, regularly breaking through to new discoveries because there is new information emergent in the life codings. These achievements are, if you like, fully natural: they are not unnatural; they do not violate nature. But they also are novel achievements of "know-how," of agentive power. Something higher is reached, and in that sense there is something "super" to the precedents, something superimposed, superintending, supervening on what went before; there is more where once there was less, something "super" to the previously natural. The "super" for scientists is "cybernetic." For the theologians, what is added to matter-energy is "logos."

This was already on my horizon two decades back:

> An evolutionary life stream . . . conserves basic chemistries and maintains an information flow for millions and even billions of years. . . . Life is a kind of fire that outlasts the sticks that feed it, except that with ordinary fire the flame is merely a chemical product of the fuel burned, devoid of heredity, while the characteristics of the life "fire" are coded in an information flow from the parental fires that light it. The food that fuels the fire is taken over and "informed" into this life form. The information persists and increases over time, is more or less as long-enduring as the particles it employs, and is no less real or significant. In this world in which the atoms present early on have organized themselves into life and mind, the total tale of the pattern states of these atoms hardly seems told until these later levels have been given their place. . . . If one is to understand what is going on, one has to rest explanations at the appropriate level of informational control. (pp. 73–75)

One finds as fact of the matter that human affairs and astronomical and microphysical affairs are not irrelevant to each other, with the superposing of increasing information on matter-energy, and the apical manifestation of this in ourselves. One wonders at this hint that there must be some great Cause adequate to this great effect, something that infuses meaning across the whole and suffuses meaning in ourselves. The macrophysics and the microphysics are affecting our metaphysics.

## 3. GENETICS: PAST, PRESENT, FUTURE

The last two decades have been spectacular for genetics, and if I were re-writing Chapter 3, on life, I would now feature genetics as much as evolutionary theory, the intertwining of the genetic molecular scale with the scale of evolutionary natural history (as I have done in my *Genes, Genesis, and God*). Biologists have not only agreed but even more insisted on these two metaphysical fundamentals: matter-energy and information, with a more complex sense of information distinctive to life. Genes do not contain simply descriptive information "about" but prescriptive information "for" the vital processes of life. There is natural selection "for" what a gene does contributing to adaptive fit. Stored in their coding, genes have a "telos," an "end." Magmas crystallizing into rocks and rivers flowing downhill have results but no such "end." Genes are *teleosemantic*.

That differentiates physics from biology; and, biologists argue, biologists need to be alert to this. George C. Williams is explicit: "Evolutionary biologists have failed to realize that they work with two more or less incommensurable domains: that of information and that of matter. . . . The gene is a package of information" (in Brockman 1995, p. 43). John Maynard Smith says: "Heredity is about the transmission, not of matter or energy, but of information" (Maynard Smith 1995,

p. 28). Massive amounts of information are coded in DNA, a sort of linguistic or cognitive molecule. Now the semantic content of such information is critical, as it was not in the minimal, mathematical, physical sense. "Life is guided by information and inorganic processes are not. . . . The sequence hypothesis in the genome and in the proteome is a new axiom in molecular biology . . . unique to biology for there is no trace of a sequence determining the structure of a chemical or of a code between such sequences in the physical and chemical world" (Yockey 2005, pp. 8, 183).

Some leading theoretical biologists are now calling this genetic information "intentional," using that word in a nonconscious sense. John Maynard Smith claims: "In biology, the use of informational terms implies intentionality" (Maynard Smith 2000, p. 177). That word has too much of a "deliberative" component for most users, but what is intended by "intentional" is the directed life process, going back to the Latin: *intendo*, with the sense of "stretch toward," or "aim at." Genes have both descriptive and prescriptive "aboutness"; they stretch toward, "attend to" what they are about. This is tropistic, tensed behavior. Kim Sterelny and Paul E. Griffiths speak of "intentional information" in contrast to "causal information." "Intentional information seems like a better candidate for the sense in which genes carry developmental information and nothing else does" (Sterelny and Griffiths 1999, p. 104). Genes specify an ordered trajectory that produces highly complex organized, functional organisms.

Intentional or semantic information is for the purpose of ("about") producing a functional unit that does not yet exist. Here there arises the possibility of mistakes, of error, and genes have some machinery for "error correction." Sometimes that is by using gene copies that are "redundant." None of these ideas make any sense in chemistry or physics, geology or meteorology. Atoms, crystals, rocks, and weather fronts do not "intend" anything and therefore cannot "err." A mere "cause" is pushy but not forward looking. A developing crystal has the form, shape, and location it has because of, caused by, preceding factors. A genetic code is a "code for" something. The code is set for "control" of the upcoming molecules that it will participate in forming. There is proactive "intention" about the future. This line of analysis confirms the actively cybernetic nature of biology.

Although dominant throughout biology, evolutionary theory has continued to prove quite problematic itself (independently of any theological agenda). Many of these issues surround the questions of what to make of this natural history of increase of biodiversity and biocomplexity resulting in humans, and what to make of human uniqueness and human responsibility. There are disagreements involving the relative degrees of order and contingency, repeatability, predictability, the role of sexuality, competition and symbiosis, the extent of social construction in evolutionary theory, the evolutionary origins of mind, especially the human mind, and differences between nature and culture.

Does the Earth set-up make life probable, even inevitable? Already in my discussion of evolutionary history two decades back, I was apprehensive about accounts that find natural history to be essentially "a random walk" (pp. 104–09) and I was searching for "an alternative paradigm" (pp. 109-119). In the subsequent two decades, biologists have continued to spread themselves across a spectrum thinking that natural history is random, contingent, caused, unlikely, likely, determined, inevitable, open. Many continue to hold, with John Maynard Smith, that we need "to put an arrow on evolutionary time" but get no help from evolutionary theory (Maynard Smith 1972, p. 98; cited p. 120). Others think that any trends toward biodiversity or biocomplexity are read into, not out of, the evolutionary record. A somewhat surprising trend in the last two decades has been to interpret any such reading as nothing but social construction.

Michael Ruse, a philosopher of biology, reports: "A major conclusion of this study is that some of the most significant of today's evolutionists are Progressionists, and . . . we find (absolute) progressivism alive and well in their work" (Ruse 1996, p. 536). Nevertheless, Ruse thinks, they are all wrong, because, biased, they are reading progress into the evolutionary record. They have slipped into "pseudo-science." "For nigh two centuries, evolution functioned as an ideology, as a secular religion, that of Progress" (p. 526). In fact, he argues, today more "mature" scientists, unbiased, "expelled progress" from evolutionary history (p. 534). "Evolution is going nowhere–and rather slowly at that" (Ruse 1986, p. 203). One of the reasons Ruse's book is so long is that he has to argue away what most biologists have believed and continue to believe. Similarly, Daniel McShea finds a clear consensus among evolutionary biologists that there has been increasing complexity over evolutionary time, but he suspects this arises from cultural bias interpreting the fossil evidence (McShea 1991).

Other biologists argue the contrary with equal conviction: Simon Conway Morris is recently the most vigorous paleontologist arguing that human life has appeared only on Earth but did so here as a law of the universe: We are "inevitable humans in a lonely universe." "The science of evolution does not belittle us. . . . Something like ourselves is an evolutionary inevitability" (Conway Morris 2003, p. xv). Christian de Duve, Nobel laureate, argues, "Life was bound to arise under the prevailing conditions. . . . I view this universe [as] . . . made in such a way as to generate life and mind, bound to give birth to thinking beings" (de Duve 1995 pp. xv, xviii).

Many evolutionary theorists doubt that the Darwinian theory predicts the long-term historical innovations that have in fact occurred. John Maynard Smith and Eörs Szathmáry analyze "the major transitions in evolution" with the resulting complexity, asking "how and why this complexity has increased in the course of evolution." "Our thesis is that the increase has depended on a small number of major transitions in the way in which genetic information is transmitted between generations." Critical innovations have included the origin of the genetic code itself, the origin of eukaryotes from prokaryotes, meiotic sex, multicellular life, animal societies, and language, especially human language. But, contrary to Conway Morris and de Duve, they find "no reason to regard the unique transitions as the inevitable result of some general law"; to the contrary, these events might not have happened at all (Maynard Smith and Szathmáry 1995, p. 3).

So what makes the critical difference in evolutionary history is increase in the information possibility space, which is not something inherent in the precursor materials, nor in the evolutionary system. This is not something for which biology has an evident explanation, although these events, when they happen, are retrospectively interpretable in biological categories. The biological explanation is modestly incomplete, recognizing the importance of the genesis of new information channels.

A major feature of genetic natural history is co-option generating novel possibilities. This introduces new possibilities of order, layer by layer. The biological constructions are historical, but they are not simply linear combinatorial processes. In the DNA molecules the coding is linear, and the changes are incremental in the linear sequences. But these changes also involve reassorting blocks that reshuffle to produce surprises. A few changes in the linear sequence produce quite different folding patterns at tertiary and quaternary levels in the finished protein. Novel possibilities open up whole new regions of search space; old molecules recombine to learn new tricks in unprecedented circumstances.

Such composition is not linear because, at critical turnings, it involves co-option: An existing gene and its product are recruited to a new function. Such co-options open up new possibility space, and the new genetic information achieved proves valuable in an evolutionary search for better environmental information. For example, lens crystallins used in eyes first evolved in an altogether different role, as heat stress proteins. They happened to be transparent, irrelevant to their original use. Surprisingly, they get used to make eye lenses (Wistow 1993). Hearing evolves from body pressure cells sensitive to touch, greatly elaborating and modifying such cells, developing complex ears able to receive information at a distance. With continuing co-option, vertebrate ears open up the possibility of animal communication (Bear, Conners, Paradiso 2001, Chapter 11).

Spoken language requires simultaneously the evolution of genes for speech, and such genes, differentiating humans from other primates, arose at a highly critical period in our evolution. The FOXP2 gene, called a speech gene, arose less than 200,000 years ago and became the subject of strong selection, making language and culture possible. But if one is to have something to say, ideas to communicate, one needs a complex brain/mind. Acetylcholine, an ancient molecule, was around for millennia doing other things in plants and bacteria; when nerves appear it gets co-opted for use in synaptic transmission, which makes mental life possible (along with other neurotransmitters). Ideas pass from mind to mind, and for this, hearing is more important than sight—at least until the invention of writing. Millennia later, written language (needing those eyes and their crystallins) transforms cultures by making possible the transmission of thoughts non-orally, across centuries and peoples. Printing makes possible massive public communication, followed by radio, television, electronic communication, the Internet. Escalating co-option drives the information explosion.

There are remarkable forks off pre-existing pathways. Previously disconnected parts working along unrelated pathways are co-opted off and put together to start serving a novel function, perhaps only slightly well at the first. Radically different selection pressures begin to work in new directions that are completely unanticipated when they occur. Once launched, the novel functions may improve steadily and completely transform the course of natural and human history. Perhaps it all takes place by slight modifications of a precursor system. These incremental changes keep "bootstrapping" on themselves and hence the self-organization.

But these slight modifications are sometimes made in new, unprecedented directions. The co-opting modification is not improving the initial function but angles off in a new direction.

The change is not iterative; it is metamorphic. Co-option breaks up channelized and entrenched developmental lines (more and better pressure cells) and opens up new directions (hearing at a distance, meaningful sounds). Restriction enzymes, one of the most important features of genetic innovation and a principal tool in genetic engineering, were first invented by bacteria to cut their parasites into pieces. They turned out to be useful for organisms to cut their own genomes into pieces and reshuffle them in the search for co-options.

Evolutionists can make *ex post facto* explanations. After the events have taken place, the paleontologist can say, well, this is what happened, and this is what resulted. But prior to the co-opting events, if asked what would be the result, if such and such happened, one could seldom, from the knowledge of the constituent parts, say in advance what the results of co-option would be. Much less could one predict that such results had to happen. Perhaps one will say, since it has so often happened in evolutionary history, that there must be some tendency in biological nature to co-opt, a disposition to improvise, to be opportunistic. But where is such tendency located? Hardly from "bottom up" in the precursor materials. Hardly either from "top down" in the planetary system.

One can say that evolution is disposed to exciting serendipity. In such cases of co-opted emergence, repeatedly compounding, something that is genuinely new pops out, pops up. The novelty is, of course, based on the precedents, but there is genuine novelty not present in any of the precedents. What emerged required the precedents, but the presence of the prior organisms did not determine or make inevitable these results. There are critical turning points in the history of life that hinge on events more idiographic (unique, one-off events) than nomothetic (law-like, inevitable, repeatable trends). Things get recruited for new roles. Novel possibilities open up whole new regions of search space; old molecules recombine to learn new tricks.

Sometimes the explanatory account is by laws applied to initial conditions, and the same laws again reapplied to the resulting outcomes, now treated as further initial conditions. But sometimes, with co-options, endosymbioses, lateral genetic transfers, and mutations, the outcomes are not just further sets of initial conditions. The novel outcomes revise the previous laws; the rules of the game change, and the future is like no previous past. One can say that all this surprising serendipity is somehow "inherent" from the start; but the explanatory power of such a claim is rather vague. The main idea in co-option is the unpredictable and unexpected; co-option is as revolutionary as it is evolutionary.

Stuart Kauffman ponders this ongoing co-option of what he calls pre-adaptations, adaptations previously used for some other function:

> Consider the concept of Darwinian pre-adaptation, the idea that a feature that was selected for one purpose turns out to be useful for a second purpose. . . . Do you think you could ever say ahead of time what all possible Darwinian pre-adaptations are? . . . We can never say ahead of time what the relevant variables are in the evolu-

> tion of the biosphere. This means the biosphere keeps inventing new functionalities and we can't say ahead of time what they are. That's a radical new kind of failure to predict. It's not quantum uncertainty, and it's not chaos theory. Still, it's the kind of uncertainty that seems central. Life keeps inventing things. (Kauffman 2002)

Kauffman calls this "the mystery of the emergence of novel functionalities in evolution where none existed before: hearing, sight, flight, language. Whence this novelty? I was led to doubt that we could prestate the 'configuration space' of a biosphere. . . . Life is doing something far richer than we may have dreamed, literally, something incalculable" (Kauffman 2000, pp. 5, 7). With the opening up of new possibility space, the future is unanticipated. In my own account of a "supercharged nature" two decades ago, I had termed this "an inexhausible open-endedness . . . greater than we now know, or can foreseeably know" (p. 301).

The system rings the changes (rings the chances!) until there is high probability, even near certainty, that something creative will happen. Those discoveries are coded in the genetics, and the adventure continues next generation. The randomizing element begins to look different. It does not need to be taken away, at least not all of it, but it can remain as openness and possibility. This puzzling mixture of both the openness and the cybernetics in biology is what's new in biology with the turn of the millennium. And nothing here precludes going on to ask religious questions about the meaning of life on such an Earth.

It is not just the atomic or astronomical physics, found universally, but the middle-range earthen system, found rarely, that is so remarkable in its zest for complexity. My prediction is that, in the century to come, science will reveal this order achieved on Earth to be even more remarkable still, and that biological science will continue both to support and to underdetermine it. That will keep an active dialogue between biology and theology about the ultimate source of this creative ordering of our world.

The astounding drive that really needs explanation is what transforms chance into order, as the creatures emerge and exploit the opportunities in their environment, and are themselves transcended by later-coming, more highly ordered, more dazzling forms and dynamic processes, more intelligence, passion, consciousness, self-consciousness. Biologists, philosophers, and theologians will continue to need metaphysics adequate to occurrent reality. "Almost anything can happen in a world in which what we see around us has actually managed to happen. The story is already incredible, progressively more so at every emergent level" (pp. 301–02).

Astronaut Edgar Mitchell, a rocket scientist, reports being earthstruck:

> Suddenly from behind the rim of the room, in long, slow-motion moments of immense majesty, there emerges a sparkling blue and white jewel, a light, delicate sky-blue sphere laced with slowly swirling veils of white, rising gradually like a small pearl in a thick sea of black mystery. It takes more than a moment to fully realize this is Earth—home. (Quoted in Kelley 1988, at photograph 42)

The shining pearl is proving to be as much mystery as the surrounding black space. Humans have deep roots in and entwined destinies with this wonderland

Earth, and they and they alone can view their planet. So humans too are entwined in the mystery, remarkable on this remarkable planet, a wonder on wonderland Earth. To their nature, role, and place we next turn.

## 4. HUMAN UNIQUENESS: BRAIN, MIND, CULTURE

One of the ways my *Science and Religion* differs from similar books is in its attention to the human sciences, particularly psychology and sociology, also (if this be a science) to history. Twenty years ago, I began that inquiry worried about the possibility and limits of a human science (pp. 151–59): "Physics established a science of matter, from the seventeenth and eighteenth centuries onward. Biology established a science of life, from the nineteenth century onward. But how much science of persons can we have? This twentieth-century question is as yet unanswered" (p. 152). It still remains unanswered in the twenty-first century; indeed it has become more of an open question than ever—and that in spite of decoding our own genetics, despite sociobiology and evolutionary psychology, despite breakthroughs in neuroscience, cognitive science, and linguistics.

The challenge is what to make of the human mind, of the sharing, conserving, elaborating, criticizing, and acting upon these ideas, made possible by the symbolic and abstractive powers of language, and resulting in our cumulative transmissible cultures. We know time and space across 40 orders of magnitude, and we build cultures that, if we may phrase it this way, exceed anything known in animal cultures by 40 orders of magnitude. Compare a chimpanzee imitating its parent using an ant-fishing stick, with Einstein and his theory of relativity, used to build a nuclear bomb. The chimpanzee copied what he saw immediately before him. Einstein constructed his theory with mental genius, achieved as he stood on the shoulders of thinkers standing on the shoulders of other thinkers for five thousand years—with ideas passing from mind to mind, critically evaluated in each new generation.

Here's the way I posed that paradox and dialectic two decades back.

> The most baffling symbolic logic that we confront is not that of the mathematicians who write equations and metricize things, not that of the logicians who abstract into symbols portions of our thought processes. The ultimate symbolic logic is language itself, ordinary language, the languages of science and of religion, where words and texts become such powerful symbols of the world, of the world-logos, and of our place in the world. Humans have a double-level orienting system: one in the genes, shared with animals in considerable part; another in the mental world of ideas, as this flowers forth from mind, for which there is really no illuminating biological analogue. (p. 155)

The power of ideas in human life is as baffling as ever. The nature and origins of language is proving, according to some experts in the field, "the hardest problem in science" (Christiansen and Kirby 2003, p. 1). Paleoanthropologists can only speculate about when and how human language arrived; estimates vary over a million and a half years. Perhaps even recent hominids such as Neanderthals had quite limited capacities for speech. Genes went molecular (discovering DNA molecules) to discover that what is really of interest is not the chemical matter-energy transformations but the information stored in such transformations about how to cope, how to survive in a niche in an ecology. Neuroscience likewise went molecular (acetylcholine in synaptic junctions, voltage-gated potassium channels triggering synapsizing) to discover that what is really of interest is how these synaptic connections are configured by the information stored there, enabling function in the inhabited world.

Neuroscience has imaged much of the brain, to realize that it was imaging brains, or, more accurately, blood flow in brains, and not thoughts in minds. There is little or no success in correlating the flow of mental representations (as in a novel) with the details of neural architecture. What will neuroscientists think when, imaging their own thinking brains, they discuss with one another how it is that one species has gained the capacity to do this, to discuss the significance of such neuroscience, and watch the brain images of their discussion?

Animal brains are already impressive. But this cognitive development has reached a striking expression point in the hominid lines leading to *Homo sapiens*, going from about 300 to 1,400 cubic centimeters of cranial capacity in a few million years. There is only one line that leads to persons, but in that line at least the steady growth of cranial capacity makes it difficult to think that intelligence is not being selected for. "No organ in the history of life has grown faster" (E. O. Wilson 1978, p. 87). One can first think that in humans enlarging brains are to be expected, since intelligence conveys obvious survival advantage. But then again, that is not so obvious, since all the other five million or so presently existing species survive well enough without advanced intelligence, as did all the other billions of species that have come and gone over the millennia. In only one of these myriads of species does a transmissible culture develop; and in this one it develops explosively, with radical innovations that eventually have little to do with survival (such as symbolic logic or the equations of relativity theory).

The human brain has a cortex 3,000 times larger than that of the mouse. Our protein molecules are 97 percent identical (more or less) to those in chimpanzees, only 3 percent different. But we have three times (300 percent) their cranial cortex. The connecting fibers in a human brain, extended, would wrap around the Earth forty times. The human brain is of such complexity that descriptive numbers are astronomical and difficult to fathom. A typical estimate is $10^{13}$ neurons, each with several thousand synapses (possibly tens of thousands). Each neuron can "talk" to many others. This network, formed and re-formed, makes possible virtually endless mental activity. The result of such combinatorial explosion is that the human brain is capable of forming more possible thoughts than there are atoms in the universe.

Even more of interest is how thoughts in the conscious mind form, re-form, or, most accurately, in-form events in this brain space. We neuroimage blood brain flow to find that such thoughts can re-shape the brains in which they arise. Our ideas and our practices configure and re-configure our own sponsoring brain structures. In the vocabulary of neuroscience, we map brains to discover we have "mutable maps." For example, with the decision to play a violin well, and resolute practice, string musicians alter the structural configuration of their brains to facilitate fingering the strings with one arm and drawing the bow with the other (Elbert et al. 1995).

With the decision to become a taxi driver in London, and several years of experience driving about the city, drivers likewise alter their brain structures, devoting more space to navigation-related skills than have non-taxi drivers (Maguire et al. 2000). Similarly, researchers have found that "the structure of the human brain is altered by the experience of acquiring a second language" (Mechelli et al. 2004). Or by learning to juggle (Draganski et al. 2004). The human brain is as open as it is wired up. No doubt our brains shape our minds, but also our minds shape our brains. The process is as top down as it is bottom up.

Some trans-genetic threshold seems to have been crossed. Humans have made an exodus from determination by genetics and natural selection and passed into a mental and social realm with new freedoms. Humans may differ in their protein molecules from chimpanzees by only a fraction of a percent. But the startling successes of humans doing biological sciences can as readily prove human distinctiveness. Chimpanzees have no capacities for cumulative transmissible cultures leading to a science by which they can decode their own genes; much less can they debate the ethics of cloning or have their religious convictions challenged by reading Darwin's *The Origin of Species*.

Richard Lewontin, Harvard biologist, puts it this way:

> Our DNA is a powerful influence on our anatomies and physiologies. In particular, it makes possible the complex brain that characterizes human beings. But having made that brain possible, the genes have made possible human nature, a social nature whose limitations and possible shapes we do not know except insofar as we know what human consciousness has already made possible. . . . History far transcends any narrow limitations that are claimed for either the power of the genes or the power of the environment to circumscribe us. . . . The genes, in making possible the development of human consciousness, have surrendered their power both to determine the individual and its environment. They have been replaced by an entirely new level of causation, that of social interaction with its own laws and its own nature. (Lewontin 1991, p. 123)

The genes outdo themselves in culture (Tomasello 1999). Human societies are a spectacular anomaly in the animal world (Richardson and Boyd 1995, p. 195). Mind of the human kind seems to require incredible opening up of new possibility space. An information explosion gets pinpointed in humans. Humans alone have "a theory of mind"; they know that there are ideas in other minds. Linguistic cultures make possible these escalating achievements as ideas pass from mind to mind.

The surprise is that human intelligence becomes reflectively self-conscious as it builds these cumulative transmissible cultures. What is really exciting is that human intelligence is now "spirited," an ego with felt, self-reflective psychological inwardness. In the most organized structure in the universe, so far as is known, molecules, trillions of them, spin round in this astronomically complex webwork and generate the unified, centrally focused experience of mind. For this process neuroscience can as yet scarcely imagine a theory. A multiple net of billions of neurons objectively supports one unified mental subject, a singular center of experience. Synapses, neurotransmitters, axon growth—all these can and must be viewed as objects from the "outside" when neuroscience studies them. But what we also know, immediately, is that these events have "insides" to them, subjective experience. There is "somebody there," already in the higher animals, but this becomes especially "spirited" in human persons (Russell et al. 1999).

The self-actualizing and self-organizing characteristic of all living organisms in humans now doubles back on itself in this reflexive animal with the qualitative emergence of what the Germans call "Geist," what existentialists call "Existenz," what philosophers and theologians often call "spirit." This sense of existential self, the Cartesian "I think, therefore I am," is present in all persons and remains at once our central certainty and the great unknown. An object, the brained body, becomes a spirited subject. A team of neuroscientists concludes: "It is difficult to study the brain without developing a sense of awe about how well it works." They also concede: "Exactly how the parallel streams of sensory data are melded into perception, images, and ideas remains the Holy Grail of neuroscience" (Bear, Connors, and Paradiso 2001, pp. 740, 434).

If language is not the hardest problem in science, then what to make of the human mind in nature is. In the deeper philosophical senses—how mind evolved, whether the evolution of mind was inevitable, probable, contingent, the uniqueness of human mind, with its cumulative transmissible cultures, why there is a universe that (on Earth at least, elsewhere? but rarely?) evolves mind—remain the deepest mysteries we face. This has now become the main agenda: the place of this spirit awakened in nature. What does human uniqueness imply for human responsibility? Science and religion are equally challenged, and stressed, to answer. And we, with self-reflective consciousness, are right at the center of such mystery.

At this point much of what is in Chapter 4 can now seem quaint. Freudianism has lapsed, behaviorism seems archaic. Personality theory continues to seek self-actualizing persons but now psychologists may prefer Prozac to do so (affecting levels of the neurotransmitter serotonin with effects on personality). Still, these thinkers are part of the history one needs to learn when recounting the dialogue of science with religion. The story has moved on to cognitive science, to neuroscience. But what is of more interest to those interested in relating religion to the human sciences is how the same issues return in new form.

Sigmund Freud thought unconscious determinants were buried in the *id*; B. F. Skinner discounted mind as determinant of behavior and replaced this with empirically verifiable stimulus-response patterns. Neither allowed for personal freedom, for agency. Two decades later the questions of determinants within are now genetic, biological, physiological, or sociobiological, but parallel to those of Freud. The question of determinants without is now environmental, sociological, or economic, but parallel to those of behaviorism. How to relate both determinants within and without to human self-making (as in humanistic psychology) is still a central issue, only the location has shifted. "Mind: Religion and the Psychological Sciences" (Chapter 4) would be differently written, were I to start today. But those who read it will be smarter today at detecting science passing into scientism, then and now.

The sciences often claim that we humans in our behaviors are motivated by causes that are largely invisible to us. Consider, for instance, contemporary claims that we are genetically determined. "Now we know, in large measure, our fate is in our genes" (replacing what Freud would have said: unconscious mind). That comes with great authority from one of the discoverers of the genetic code, Nobel laureate James Watson, first director of the Human Genome Project (quoted in Jaroff 1989, p. 67).

But many geneticists demur: J. Craig Venter and over 200 co-authors, completing the Celera Genomics sequencing of the human genome, caution that genetic "determinism, the idea that all characteristics of the person are 'hard-wired' by the genome" and accompanying "reductionism" "are two fallacies to be avoided." They continue, in their concluding paragraph:

> In organisms with complex nervous systems, neither gene number, neuron number, nor number of cell types correlates in any meaningful manner with even simplistic measures of structural or behavioral complexity. . . . Between humans and chimpanzees, the gene number, gene structural function, chromosomal and genomic organization, and cell types and neuroanatomies are almost indistinguishable, yet the development modifications that predisposed human lineages to cortical expansion and development of the larynx, giving rise to language culminated in a massive singularity that by even the simplest of criteria made humans more complex in a behavioral sense. . . . The real challenge of human biology, beyond the task of finding out how genes orchestrate the construction and maintenance of the miraculous mechanism of our bodies, will lie ahead as we seek to explain how our minds have come to organize thoughts sufficiently well to investigate our own existence. (Venter et al. 2001, pp. 1347–48)

The "massive singularity" is this self-investigating creature so full of ideas about both self and world. Natural selection passed over into something else. Nature transcended itself in culture, with radical new chapters in the ongoing story of the evolution of information, cognition, and history. The world moved into a future quite unlike its past—the "wise" (*sapiens*) species rebuilding, exploiting nature, "playing God" with unprecedented powers for good and evil, and putting the community of life on Earth into jeopardy. Indeed, this species decoding its own genome and pondering remaking itself is again "playing God," choosing good from evil, quite unprecedented on Earth. Such escalating powers of agency we might still call "natural," not "supernatural," but they are evidently "super" to anything previously called natural.

Another effort to deny such "massive singularity" in humans and to bind the mind to natural selection is found in evolutionary psychology. Humans have what John Tooby and Leda Cosmides call an "adapted mind" made up of a set of "complex adaptations" that, over our evolutionary history, have promoted survival. "What is special about the human mind is not that it gave up 'instinct' in order to become flexible, but that it proliferated 'instincts'—that is, content-specific problem-solving specializations" (Tooby and Cosmides 1992, pp. 61, 69, 113). "These evolved psychological mechanisms are adaptations, constructed by natural selection over evolutionary time" (Cosmides, Tooby, and Barkow 1992, p. 5). These channelled reaction patterns form a set of behavioral subroutines more like a "Swiss army knife," tools for survival, rather than a general purpose learning device (Cosmides and Tooby 1994, p. 60). These "Darwinian algorithms" are each dedicated to task-specific functions such as picking mates, desiring many children, eating fats and sweets, or helping family, or obeying parents, defending one's tribe, fight or flight, being suspicious of strangers, dealing with non-cooperators by ostracizing them, or preferring savannah-type landscapes. In picking mates, for example, men are disposed to select younger women, likely to be fertile. Women select men of social status, likely to be good providers.

The human mind is indeed complex, and various "automatic" subroutines to which we are genetically programmed may indeed be convenient shortcuts to survival, reliable modes of operating whether or not persons have made much rational reflection over these behaviors. Nevertheless, these need to be figured back into a more generalized intelligence. Genetically programmed algorithms seem unlikely for the detail of such decisions under changing cultural conditions. Capacities to select a good mate across decades of marriage and over diverse cultures are perhaps somewhat "instinctive," but they are unlikely to be an adaptive mechanism isolated from general intelligence and moral sensitivity.

Even by accounts of evolutionary psychologists, the mind is not so compartmentalized that humans—modern ones who read this literature at least—cannot make a critical appraisal of what behavioral subroutines they suppose they inherit by genetic disposition, and choose, if they wish, to offset these. Cosmides and Tooby call for "conceptual integration" of the diverse academic disciplines studying humans, their behavior, and their minds. These include "evolutionary biology, cognitive science, behavioral ecology, psychology, hunter-gatherer studies, social anthropology, biological anthropology, primatology, and neurobiology," among others (Cosmides, Tooby, and Barkow 1992, pp. 4, 23–24). These are not disciplines in which one becomes expert by behavioral mechanisms in a Swiss-army-knife mind.

They and their readers must have quite broadly analytical and synoptic minds. The mind is fully capable of evaluating any such behavioral modules, and of recommending appropriate education so as to reshape these dispositions in result. When evolutionary psychologists wonder whether to re-adapt by critical thought their own adapted minds, we as their colleagues wonder whether they are alone in this capacity. We see the Freudian problem returning, the behaviorist problem returning, the selfish gene problem returning—the perennial problem when any science that proposes to explain human behavior is made self-referential. No one—scientist, philosopher, ethicist, theologian—can be free to evaluate such theories unless they are free to think and to act on the basis of such evaluations.

Cognitive science, switching from genetics and neuroscience to computer science, often models mind as some kind of computer. I worried about that in 1987, and that worry has become prophetic. The mind is capable of information processing; there is no doubt about that. The mind is less capable than computers in doing some kinds of information processing: scanning vast data sets or making complex calculations (on the basis of algorithms programmed into the computer by smart computer engineers). But the mind, embodied in flesh, incarnate, works at different levels of information processing: experiential, self-consciously reflective, narrative story lines, biography, facing death, disease, giving birth to and rearing a next generation, educated into and re-evaluating a cumulative transmissible culture. People wonder who they are, where they are, what they ought to do. All this seems vastly more than the capacity of computers of whatever kind.

Indeed, computer analogies can be quite misleading. That danger comes first from the genetics. No computers reproduce themselves by passing a single set of minute coding sequences from one generation of computers to the next, like sperm and egg, with the next generation of computers self-organizing from this single transferred information set. Such danger comes, secondly, from the neuroscience. Software and hardware, which can be easily separated in a computer, are completely interwoven in brains. Brains generate minds that re-form these brains, both during development and across adult life, modifying, rebuilding synaptic connections, and even generating new neurons. Although some computer programs have open search programs, none of those mutable cognitive maps reformed by resolute decision (those violin players) have any significant parallels in existing computers. Computers do not have minds with which to reconfigure themselves.

The computer model is misleading because of those mutable maps, of minds forming brains, but even more because minds inhabit incarnate flesh. The problem is not hardware, not software, but "wetware." Now we do need both the biology and the spirit, both the blood and the *Geist*. We are self-actualizing persons who can both think and suffer.

> Have we reached a model competent to the whole human person? At this point limitations in the cybernetic model begin to appear. Storing, retrieving, and using information are certainly important. But are these the only, or the central, features of personality? Even in terms of a biological model, cognitive processors as such do not suffer, and here we could wish for more awareness within this psychology of that dimension in experience of which evolutionary biology has left the organic world almost too full, of the cruciform nature of life. In terms of a human model, cognitive processors do not feel ashamed or proud; they do not have angst, self-respect, fear, or hope. They do not get excited about a job well done, pass the buck for failures, have identity crises, or deceive themselves to avoid self-censure. They do not resolve to dissent before an immoral social practice and pay the price of civil disobedience in the hope of reforming their society. They do not weep or say grace at meals. . . . They do not have heroes or saviors. They do not die for the sins of the world, launch the Kingdom of God, or fall into other passionate ideologies about the meanings of life and history. The model of the cognitive processor, while necessary, is yet insufficient for the human personality. (pp. 182–83)

Humans anticipate death; they sense their finitude. They face limit questions, sense the sacred, worry about communion with the ultimate or atonement of their sins. They know guilt, forgiveness, shame, remorse, glory, and pride. They suffer angst and alienation. They build symbols with which they interpret their place and role in their world. They create ideologies, affirm creeds, and debate their rights and responsibilities. They are capable of religious faith. They worship God. All of this can be summed up in the one word: *spirit*. In this life of the spirit, humans, arriving late on the planet, remain remarkably distinctive from the other millions of species, indeed the billions that have come and gone over evolutionary time. They also remain remarkably distinct from any machines they have yet built. The most complex thing in the known universe, the "massive singularity" (Venter), is still right behind our eyes. We humans live at the center of the most genesis yet known.

## 5. MIND KNOWING NATURE: REALISM AND SOCIAL CONSTRUCTION

Two decades ago, I recognized the "pervasive and persuasive characteristics of paradigms," alike in science and religion, in keeping with the insights of Thomas Kuhn (pp. 9–15). I worried about "observer involvement in science and religion (pp. 19–22). I sought "universal intent" (pp. 16–17), and I searched for good paradigms and feared lest they become "bliks." "The theory that begins as a synthetic judgment about the world can get subtly transformed into an analytic prejudgment brought to the world, so that variant experience can no longer transform the theory but rather the theory transforms the experience. A blik is a theory grown arrogant, too hard to be softened by experience" (p. 11). I resisted the claim that religions are nothing but a "social projection" (pp. 219–225). I closed the book with the claim that science must be fitted into a culture's ongoing sense of historical narrative.

Philosophers of science have continued to soften the realism in science in favor of more historical and culture-bound accounts. Science is an interactive activity between humans and a nature out there that we know only through the lenses, theories, and equipment that we humans have constructed. Much of this is welcome, I had already said. But I did not anticipate the "culture wars"—the way in which postmodernists, deconstructionists, pragmatists, feminists, and others would come to claim that all our knowing, science included, is little more than a "social construction."

Critics of science have pressed these claims about the social construction of science and theology further than most scientists wish (Hacking 1999; and with waffling, Ruse 1999). Theologians are of mixed opinions whether to welcome these developments. What Thomas Kuhn taught us a generation ago about science, Alasdair MacIntyre (1981) afterward applied to ethics, then George Lindbeck (1984) said much the same thing about theology. Each discipline is embedded in a conceptual framework so comprehensive that it shapes its own criteria of adequacy. These paradigmatic communities govern what all thinkers within them look for and how they interpret what they find. The search for any autonomous, universal truth, defended by a neutral rationality, has failed. All our claims are in a "web of belief" (Quine and Ullian 1978). They attach to dynamic, culturally conditioned, historical worldviews.

Earlier the problem was an adapted mind, so full of genetically programmed stereotyped behavioral modules that humans were not free to think for themselves. Now the problem is different, but similar: a socially constructed mind, so full of culturally imposed filters that humans struggle to be free to think independently. It can almost seem as though Freud and Skinner have been reincarnated. Both adapted minds and socially constructed minds challenge human freedom, human rationality, human uniqueness, and human responsibility. And both are challenged in turn by efforts to think through and think beyond our evolutionary and our cultural legacies.

Keep pushing these claims, for instance, and natural science loses all its objectivity, its powers to describe the natural world. Alexander Wilson claims, "We should by no means exempt science from social discussions of nature. . . . In fact, the whole idea of nature as something separate from human existence is a lie. Humans and nature construct one another" (A. Wilson 1992, p. 13). Don Cupitt puts this quite bluntly: "Science is at no point privileged. It is itself just another cultural activity. Interpretation reaches all the way down, and we have no 'pure' and extra-historical access to Nature. We have no basis for distinguishing between Nature itself and our own changing historically-produced representations of nature. . . . Nature is a cultural product" (Cupitt 1993, p. 35).

David Pepper, urging a postmodern science, insists "that there is no one, objective, monolithic truth about society-nature/environment relationships, as some [scientists] might have us believe. There are different truths for different groups of people and with different ideologies. . . . Each myth functions as a cultural filter, so that adherents are predisposed to learn different things about the environment and to construct different knowledges about it" (Pepper 1996, pp. 3–4). Science is one more myth, a Western cultural filter, no better (maybe at times worse) than the other, classically religious filters.

From a pragmatist perspective, Richard Rorty asks whether "science describes a world already there?" No, says Rorty, "we must resist the temptation to think that the redescriptions of reality offered by contemporary physical or biological science are somehow closer to 'the things themselves.'" The big mistake is "to think that the point of language is to represent a hidden reality which lies outside us" (Rorty 1989, pp. 16, 19). We must not think that "Reason" offers "a transcultural human ability to correspond to reality"; the best that reason can do is ask "about what self-image society should have of itself" (Rorty 1991, p. 28).

In the passing scientific fashions, Rorty concludes, "We may have no more than conformity to the norms of the day. . . . This century's 'superstition' was last century's triumph of reason . . . the latest vocabulary, borrowed from the latest scientific achievement, may not express privileged representations of essences, but be just another of the potential infinity of vocabularies in which the world can be described" (Rorty 1979, p. 367). Science only provides makeshift sketches that we will replace, after more explorations, with a new round of cartoons. At the turn of the millennium, philosophers found themselves back in their ancient epistemological prison, in Plato's cave, or like one of the Indian blind men groping at the elephant. If it isn't the genes that keep us in the cave, then it is our modular mind; if not those, then our cultures do.

This seems to make impossible any successful discovery of what is out there in astronomy, geology, in evolutionary natural history. It renders suspect all accounts of "nature for real" distinguished from "nature for us," "nature that I can functionally cope with." At this point, the deconstructionists may back off and explain that the items scientists see (stars, planets, meter readings, rocks, fossils, lions) may be there, but the interpretive framework is a mythical construction. Hence, as we saw earlier, Michael Ruse dismissed the conclusions of most biologists that biodiversity and biocomplexity have increased over evolutionary time, because, biased, they let evolution function as an ideology. They read British ideas of progress into the evolutionary record and thereby slipped into "pseudoscience." Ruse claims that his new evolutionary paradigm (the "going nowhere" one) is pushing out the old European cultural biases, but what Ruse cannot see is that his allegedly "more mature" scientists today, a minority but the best of them (so he claims), are just using the latest secular gestalt to read the record differently. If we take his book seriously as being self-referential, it too undermines itself. His new view is just the next passing scientific fashion. We will never get past different spokes for different folks, unless somebody can regain convictions about truth in science (Rolston 1997), for which Ruse himself is groping.

So there is an epistemic crisis, which, on some readings, can seem to have reached consummate sophistication, and, the next moment, can reveal debilitating failure of nerve. Taken to an extreme, postmodernist, pragmatist, deconstructionist views of science, those of the "strong program," seem to have become bliks, theories grown arrogant. Even Thomas Kuhn, though in some sense launching the postmodernist movement, came radically to reject where it was going.

> Nature itself, whatever that may be, has seemed to have no part in the development of beliefs about it. Talk of evidence, or the rationality of claims drawn from it, and of the truth or probability of those claims has been seen as simply the rhetoric behind which the victorious party cloaks its power. What passes for scientific knowledge becomes, then, simply the belief of the winners. I am among those who have found the claims of the strong program absurd: an example of deconstruction gone mad. (Kuhn 1992, pp. 8–9)

The extreme claim from the academic left that there are only differing ideologies, and that nobody is objectively right about anything, and that this finally gets the truth question right, if made self-referential, destroys itself. That claim is itself as spongy as all those they deconstruct. Illusion evaluating illusion is nonsense on stilts and soon collapses. These skeptics go the way of Freud, Skinner, genetic determinists, and evolutionary psychologists with their modular minds, since they leave no one, including themselves, free to think with any plausible rational powers.

Biologists all have their cultures, their personal backgrounds, their preferences, their biases, their worldviews. They can frame up the results of their observations differently, as we have already noticed in the spectrum across which they line up wondering about order, disorder, contingency, probability, predictability in evolutionary natural history; these frame-ups can reflect their educations. But meanwhile, biologists make many observations, construct many concepts, using many theories and instruments. Scientists do discover some things about surrounding phenomena, transcending their cultures, claims about events past and present that are true because they successfully (if also approximately) describe the phenomena as these exist in themselves.

There is no unmediated nature; therefore, we know nothing of nature as it is in itself. But this assumes that media cannot, reliably, descriptively, transmit truths about what is there. Biologists do abstract, and this can result in failing to see what is left out of the abstractions. They invent the theories with which they see, and these may blind them to other things. But inventions can also help us see. Science can regularly check its constructs against causal sequences in nature. Scientists can regularly cross-check each other. Some scientific claims will be revised; scientists work at that constantly.

But the general cluster of advancing scientific discoveries is not going to fail as passing cultural myth. As science progresses, scientists get clearer about what they are studying. Concepts are dynamic because scientists find out what was previously unknown. Older concepts will be used in new ways that align with the advances in the field; atoms, composed of electrons, protons, neutrons, can be broken apart. They can be split and relativity theory illuminates the distribution of matter and energy in their splitting. Darwin transformed the concept of fixed species into evolving species. Older concepts may also be entirely abandoned: phlogiston and entelechy.

In result, in Plato's famous phrase, scientists learn to "carve nature at the joints" (*Phaedrus* 265e). The sporophyte generation of mosses is haploid. Malaria is carried by *Plasmodium* in mosquitoes. Neither of those facts is likely to change with a new cultural filter. Golgi apparatus and mitochondria are here to stay. There is no feasible theory by which life on Earth is not carbon based and energized by photosynthesis, nor by which water is not composed of hydrogen and oxygen, whose properties depend on its being a polar molecule. Glycolysis and the Krebs cycle, ATP and ADP, will be taught in biology textbooks centuries hence, as well as lipid bilayers and immunoglobulin molecules. Oxygen will be carried by hemoglobin. Biologists are right that $CO_2$ is released in oxidative phosphorylation and that this cycles through photosynthesis II and photosynthesis I, so that in the world there is a symbiotic relationship between plants and animals and that this a vital ecosystemic interdependence (cf. Rolston 1999, pp. 187–88).

We have made progress in knowing who we are and where we are. Humans now know a round planet, orbiting the sun; we know something of its circulations, evolutionary origins, ecosystemic connections, fauna and flora. There is no more flat Earth, no turtle island cosmology, no more Earth created in 4004 BC with a garden planted in Eden in the Middle East, no Izanagi and Izanami stirring up the Japanese islands, or Amaterasu bringing order to them. There is no more enchanted world, populated with fairies and demons, though perhaps there remains, as much as ever, a sacred or numinous world. Any truth in these prescientific views, other cultural filters, will have to be de-mythologized. If one insists that this is re-mythologizing, then know that the right worldviews, the "true myths," must be trans-scientific, trans-humanist, trans-cultural. Science, humans, and culture must take reference points outside themselves in these planetary events if ever we are to describe them, much less make sense of their significance. Or know what ethic to construct.

## 6. SCIENCE AND CONSCIENCE

Hard science has a soft underbelly: conscience. We could almost say, provocatively, the harder the science, the softer the underbelly. The unavoidable question is what do scientists care about? What do those to whom their science becomes available care about? This probes the logic of science and worries about its zest for mastery, fearful lest this become a lust for mastery. If this seems unkind, then turn to Lord Acton: "Power tends to corrupt and absolute power corrupts absolutely" (Acton 1887, 1949, p. 364). He was absolutely right.

I worried about this two decades ago. I worried about it more a decade ago, in my *Genes, Genesis and God*:

> With this knowledge comes power. More than any people before, as a result of our technological prowess through science and industry, we humans today have the capacity to do good and evil, to make war or to feed others, to act in justice and in love. Nor is it only the human fate that lies in our hands. We are altering the natural history of the planet, threatening alike the future of life, the fauna and the flora, and human life. With such increasing knowledge and power comes increasing duty. Science demands conscience. . . .
>
> One can hardly claim that modern science has figured out ethics, either its historical origins or a current evaluation. The more usual account is that ethics is not science, nor science ethics; the one is a descriptive discipline, what *is* (was, or will be) the case; the other an evaluative discipline, what *ought* to be. "Good and evil" . . . are not categories that appear in science textbooks. . . . So, although there is a profound sense in which we humans now know who and where we are, there is an equally deep puzzlement about what we ought to do, and the grounds of its justification. Science has made us increasingly competent in knowledge and power, but it has also left us decreasingly confident about right and wrong. . . .
>
> The same science that demands a conscience has difficulty explaining and authorizing conscience, for we struggle to understand how amoral nature evolved the moral animal, how even now *Homo sapiens* has duties, humans to fellow humans, and humans to the community of life on Earth. The value questions in the twentieth century remain as sharp and as painful as ever in our history. (Rolston 1999, pp. 213–15)

If one needs proof of that, read the newspapers: The Iraqi war, 9/11, Enron, protests at G-8 summits, health care for the poor, corruption in government, deforestation, global warming, and so on.

Scientists may reply that these are not issues in science, though they may deal with its application in economics, technology, and public policy. But there is a rising and revealing critique of science, one that is likely to prove still more forceful in the decades ahead. Science presents itself as detached and objective, capable of describing the world as it is in itself. That first seems plausible. I was just defending such an account of science against the extremes of social construction. Yes, the claims of physics about the big bang and the expanding universe, or those of biology about evolutionary history, are claims about what once took place on Earth, long before humans arrived. The genetic coding in the DNA and the protein synthesis by which organisms are produced and maintained, the food chains in ecosystems, the adapted fitness of organisms, their capacities for coping as they make a way through the world—all these seem to be descriptive claims. Science seems to have its independent authority warranting these claims.

But look more deeply. Science is the quest for knowledge and knowledge is power. Even pure science is driven by a desire to understand, and that, ipso facto, is a desire to conquer, seldom pure. The fundamental posture of science is one of analysis, the discovery of laws and generalizations, theory with implications, prediction, testability, repeatability. One wants better probes, better techniques, higher resolution detectors, more computing power. This always invites control; but more than that, this very approach to nature is driven by the desire to control. The underlying premise of all scientific logic is mastery, and with that insight the claims to detachment, objectivity, and independence take on a different color. Allegedly objective science is inevitably bent, sooner or later, into the service of technology, and such scientific knowledge coupled with technological power is neither detached nor objective. Willy-nilly, such information will be put to use for some better or worse ends. Thus relativity theory is used to make nuclear weapons; the human genome, mapped, invites first medical therapy and later genetic engineering. Such utility is not simply an outcome of science: it runs in, with, and under its worldview.

Such an account sees not only the outcome but the presumption of science in the escalating consumerism of the First World and in the disproportionately distributed wealth between First and Third Worlds, or, as we increasingly say, between North and South. These are symptoms of a fundamentally misplaced caring. Science is the product of the powerful urge to dominate nature, and those who have it are ready enough to colonize elsewhere and harvest whatever resources they can wherever they can, to build machines of industry and of war, to dominate other peoples and races.

The scientist, to be sure, when moving from pure to applied science, pretends to care; the benefits of science in the service of humans are preached incessantly. No doubt such caring and benefits are often true; but it is equally certain that science lacking critical caring for others on behalf of the scientists, or those who exploit their science, is what has produced the present distributional crisis. And caring for others—loving one's neighbor—is the central claim in religious ethics. Science is not religion. Religion cannot suggest the content of any science, but religion can notice the forms into which such content is being poured; it can also defend a content of its own. One can do science without adverting to theology, but one cannot live by science alone.

Indeed, science cannot teach us what we most need to know—that about which we most should care. In that sense, science is not independent. There is an information gap, this time not in the causal chains of science, but in the very logic of science itself. More computing power is not likely to give us the information we need here. There are no algorithms for good and evil. Nor is more analysis of our brain-behavioral modules going to give us an answer, nor genomic analysis of our protein similarities with the chimpanzees. All this suggests that the dialogue between science and religion is likely to continue. There will be a humane future only if we can integrate the two.

Science could be part of the problem, not part of the solution. Science can, and often does, serve noble interests. Science can, and often does, become self-serving, a means of perpetuating injustice, of violating human rights, of making war, of degrading the environment. Science is used for Western dominion over nature. Science is equally used for Western domination of other nations. The values surrounding the pursuit of science, as well as those that govern the uses to which science is put, are not generated out of the sciences, not even the human sciences, much less the biological or physical sciences (cf. pp. 339–43).

Where science seeks to control, dominate, manipulate either persons or nature or both, it blinds quite as much as it guides. Nothing in science ensures against philosophical confusions, against rationalizing, against mistaking evil for good, against loving the wrong gods. "The whole scientific enterprise of the last four centuries could yet prove demonic. We may be caught in a Faustian bargain, in a scientific sink" (p. 342). As good an indication as any of that is our ecological crisis.

Not only has a science-based technology failed to solve the deeper problems of developed nations, but a larger problem looms globally. There are about five billion persons in the world. Approximately one fifth, those in the developed nations, produce and consume about four fifths of the material goods that a science-based industry provides; about four fifths of the world divide the remaining one-fifth of the wealth, and about half of these live in poverty (*World Development Report 2004*). There are more poor persons today than ever before; there will be more yet in decades ahead. For every person added to the population of the developed nations, twenty individuals are added in the less developed ones. For every dollar of economic growth per person in the one, twenty dollars accrue to each individual in the other. Of the 90 million new people on Earth this year, 85 million will appear in the Third World, the countries least able to support them. Meanwhile, the 5 million new people in the industrial countries will put as much strain on the natural resources and cause as much environmental degradation as the 85 million new poor.

There are three problems: overpopulation, overconsumption, and underdistribution. The reasons for these outcomes are complex, but whatever explanations one finds for this mal-distribution of wealth, the outcome hardly seems either just or loving. We in the West may say, with some justification, that we have earned or merited our wealth. There is a first tendency to say the problem is that too many of the Earth's peoples are unblessed by the fruits of science and technology; we need to teach everyone how to produce up to Western standards. The distribution patterns reflect achievement; what the other nations need to do is to imitate this.

For solving this problem, science is necessary, since providing for human needs in the next century without science and technology is unthinkable. But science is not sufficient without conscience that shapes the uses to which science is put, informing policy. Science and religion together must face the impending disaster of today's trends projected cumulatively into tomorrow: population explosion, dwindling food supply, climate change, soil erosion and drought, deforestation, desertification, declining reserves of fossil fuels and other natural resources, toxic wastes, the growing gap between concentrated wealth and increasing poverty, and the militarism, nationalism, and industrialism that seek to keep the systems of exploitation in place. Few problems or none loom more foreboding on the horizon than these, and I predict that these value problems are, in the coming century, likely to become more acute than ever.

Religion has been the classical informer of conscience, and still remains a powerful force in moral life. Ethics can be autonomous—independent of religion—but such ethical systems have not yet proved themselves capable of shaping cultural reformations over generations. Here the religious ideologies do persist over changing science. It is much safer to predict that the Golden Rule will be an imperative in ethics a century hence than it is to predict that cosmology will still have a big bang with an inflationary period in the first few seconds. It is also, alas, much safer to predict that the seven deadly sins will still be present a century hence, with human life needing to be redeemed from these sins, than that biologists will be emphasizing the contingency in natural history over against a tendency toward increasing complexity over evolutionary time. Whether the Golden Rule or covetousness will have done more to shape the future is not safe to predict; that outcome depends, in significant part, on the extent of the dialogue between science and religion.

The radical differences between nature and culture, if not already evident, will become yet more evident as the speed of cultural innovation increases, owing in large part to the powers of science. In the more recent centuries, and in the most recent decades of this century, information accumulates and travels in culture at logarithmically increasing speeds. The pace of the story steps up; and now, as we turn from the long evolutionary and cultural past to face the future, there is a certain feeling that the pace of the action is accelerating, both with excitement and danger. The computer revolution exemplifies this, with its dramatic capacities for extending the human computational power, for information storage and processing of data, including scientific data, for long-distance communication and networking (not to mention possibilities for exploitation and invasion of personal privacy). Discoveries in physics and chemistry show us how the world was made. Discoveries in the biosciences—mapping, for instance, the human genome, with the further possibilities of genetic engineering—offer us the possibility of remaking the world. We humans too are agents, increasingly powerful agents, but will that bring more blessing or corruption?

We seem to have reached a turning point in the long, accumulating story of cognition actualizing itself. We are now coming around to oversee the world and to face the prospect of our own self-engineering, to the genesis of a higher-level ordering of the world in the midst of its threatening disorder. Increasingly we are like gods. But we need the wisdom of God, and that need programs poorly on computers and is not found in physics, chemistry, or biology textbooks. There is an information gap about good and evil.

Though biologists are typically uncertain whether life has arrived on Earth by divine intention, they are almost unanimous in their respect for life and seek biological conservation on an endangered planet. Earth's impressive and unique biodiversity, evolved and created, warrants wonder and care. In that sense, many of the discoveries in biology sensitize us to the need for caring for life on Earth. Biologists and theologians, though they may continue to argue about the past origins of life, are likely to reach consensus that humans, facing the future, ought to care responsibly for this wonderland Earth. Pressing these questions of caring for Earth against those of using the Earth with justice and charity, choosing the right path and finding resolution to follow it, motivating such behavior, will demand all the resources and insight we can muster in both science and religion.

Crises lie ahead of us, not for the lack of science but for the lack of wisdom, a wisdom that only religion in the broad sense can supply—worldviews that orient us philosophically and that can redeem our human nature from its perennial failings. The need for justice, for love, for caring will remain undiminished, and science will need conscience in the next century more than ever before. What on Earth are we doing? What on Earth ought we to be doing? There is no figuring this out without both science and religion; there is no doing it right without integration of the two.

This is the Earth in which we live and move and have our being, and we owe this Earth system the highest allegiance of which we are capable, under God, in whom also we live and move and have our being. Biologists, again, may not share the monotheism, but they are coming to share the concern for the Earth, and concern for the springs of human motivation. When they do, the mentality of dominance in science, about which we have worried, can itself become regenerated, and science put in the service of responsible care for this only home planet. Scientists as much as anyone else, theologians included, wish a sustainable harmony between humans and this very special planet. The foreboding challenge is that these spectacular humans, the sole moral agents on Earth, now jeopardize both themselves and their planet. Science and religion are equally needed, and strained, to bring salvation (to use a religious term), to keep life on Earth sustainable (to use a secular, scientific term).

> Science, ethics, and religion all have to do with sharing what is valuable; science is itself valuable and enables us to generate more value. But science alone does not teach us all we need to know about sharing values. For all its recent brilliance, science has proved penultimate to ethics and religion. . . . Science is know-how without know-whether. Science describes what is (or was, or will be), not what ought to be. Scientists, qua scientists alone, are not ipso facto wise. After science, we still need help deciding what to value; what is right and wrong, good and evil; how to behave as we cope. The end of life still lies in its meaning, the domain of religion and ethics. (Rolston, 1999, pp. 161–62)

## 7. HISTORICAL AND CRUCIFORM NATURE: LIFE PERSISTING IN PERISHING

Life on Earth is indisputably historical. "Nature after science is *historical* to the core, more historical after science than before" (p. 246). Where once there were no species on Earth, there are today five to ten million. Prokaryotes dominated the living world more than three billion years ago; there later appeared eukaryotes, with their well-organized nucleus and cytoplasmic organelles. Single-celled eukaryotes evolved into multicelled plants and animals with highly specialized organ systems. First there were cold-blooded animals at the mercy of climate, later warm-blooded animals with more energetic metabolisms. From small brains emerge large central nervous systems. From primates emerge humans, the one primate with cumulatively transmissible culture. Biologists do find a need to put some kind of an "arrow on evolutionary time"; there are cumulative achievements that can reset initial conditions. To use the pejorative term of the deconstructionists, evolutionary natural history producing these humans with their cultural stories is quite a "grand narrative."

The evolutionary psychologists will join the deconstructionists to see "storytelling" as one more subroutine in our modular mind, helping us to survive by concocting stories, myths, and narratives that orient us to cope in the world. And, once more, such an account cannot be made self-reflexive, because if we all have a mind predisposed to self-serving storytelling, this undermines both their capacity and ours to evaluate whether and how far earthen natural history is indeed historical. One is going to need a more inclusive intelligence—capable of astronomy, geology, paleontology, climatology, botany, zoology, genetics, genomics, cladistics, radiometric dating, cognitive science, neuroscience, physical and cultural anthropology, comparative religion—a "conceptual integration" of disciplines to tell this story, much less to discover how much theory confirmation, narrative confirmation, mental bias, or "mythology" is being read into and out of the earthen "facts."

Surely this is among the commanding facts: Life persists in struggle, generated and regenerated, yesterday, today, tomorrow—from the dawn of life until now, with our value questions as sharp and as painful as ever, confronting the promise and peril of our open future. This claim is quite corroborated by evolutionary biology, by the very existence of social construction, and by evolutionary psychology, even if their results are increasing doubt about our human competence. The last two decades well underscore my closing claims about how science is configured and re-configured into an ongoing historical cultural narrative, an ongoing struggle to make sense of nature and culture on this wonderland Earth.

In retrospect across two decades, if asked to judge what has proved most insightful in my *Science and Religion*, this may well prove to be my analysis of a "cruciform nature." Life has its logic, its history; in the course of that history, life has its *pathos*. The story we have from Darwinian natural history echoes classical religious themes of death and regeneration. In the midst of its struggles, life has been ever "conserved," as biologists find; life has been perpetually "redeemed," as theologians find. Both in the divine Logos once incarnate in Palestine and in the life incarnate on Earth for millennia before that: "Light shines in the darkness and the darkness has not overcome it" (John 1:5).

I celebrate "green pastures in the shadow of death, a table prepared in the midst of mine enemies" (Psalm 23). Now the science reinforces native range experience. All living things are caught up in the struggle for life; we humans, too. Seen from space, Earth is a shining pearl in a sea of black mystery; seen on the ground, life shines across the eons of natural history, perennially renewed in its perpetual perishing. There is "abundant life" in the midst of death. This "secret of life" continues to challenge both science and religion.

I closed the chapter on biology twenty years back:

> To translate from evolutionary science to theology, just as the suffering at Calvary was human, creaturely suffering, out of which new life on Earth was redemptively to come, and yet, seen more deeply by Christian conviction, was the very suffering of God for the creation, so in the natural course there is creaturely suffering, autonomously owned, necessitated by the natural drives, though unselected by those caught in the drama. Yet this drive too may be construed, in the panentheistic whole, as the suffering God with and for the creation, diffused divine omnipresence, since each creature both subsists in the divine ground and is lured on by it. . . .
>
> In some way that we mixedly believe and dimly understand, the biology of the world, not less than the physics of the universe, is a necessary and sufficient habitat for the production of caring sentience and, at length, of suffering love in its freedom. Life is a paradox of suffering and glory, and this "secret of life" remains hidden in God, unresolved by biochemistry or evolutionary theory. The way of nature is the way of the cross; *via naturae est via crucis*. (p. 146)

Drawing the book to a close, I returned to this theme in my chapter on nature and history:

> Every life is chastened and christened, straitened and baptized in struggle. Everywhere there is vicarious suffering. The global Earth is a land of promise, and yet one that has to be died for. All world progress and directional history is ultimately brought under the shadow of a cross. The story is a passion play long before it reaches the Christ. Since the beginning, the myriad creatures have been giving up their lives as a ransom for many. In that sense, Jesus is not the exception to the natural order, but a chief exemplification of it. (p. 291)

That perspective has deepened. The story is of the evolution of suffering; this too is among the emergents. In chemistry, physics, astronomy, geomorphology, meteorology, nothing suffers; in botany life is stressed, but only in zoology does pain emerge. Genes do not suffer; organisms with genes need not suffer, but those with neurons do. Life is indisputably prolific; it is just as indisputably pathetic (Greek: *pathos*), almost as if its logic were pathos. The fertility is close-coupled with the struggle.

I returned to this theme in closing my *Genes, Genesis and God*:

> Suffering is a troubling fact, but the first fact to notice is that suffering is the shadow side of sentience, felt experience, consciousness, pleasure, intention, all the excitement of subjectivity waking up so inexplicably from mere objectivity. Rocks do not suffer, but the stuff of rocks has organized itself into animals who experience pains and pleasures, into humans whose *Existenz* includes anxiety and affliction. We may wonder why we suffer, but it is also quite a wonder that we are able to suffer. Something stirs in the cold, mathematical beauty of physics, in the heated energies supplied by matter, and there is first an assembling of living objects, and still later of suffering

> subjects. Energy turns into pain. The world begins with causes, mere causes; it rises to generate concern and care. . . .
>
> Struggle is the dark side of creativity, logically and empirically the shadow side of pleasure. One cannot enjoy a world in which one cannot suffer, any more than one can succeed in a world in which one cannot fail. The logic here is not so much formal or universal as it is dialectical and narrative. In natural history, the pathway to psychosomatic consciousness, the only kind of experience we know, is through flesh that can feel its way through that world. An organism can have needs, which is not possible in inert physical nature. If the environment can be a good to it, that brings also the possibility of deprivation as a harm. To be alive is to have problems. Things can go wrong just because they can also go right. Sentience brings the capacity to move about deliberately in the world, and also to get hurt by it. . . . The story is not merely of goings on, but of going concerns, that is, of values that matter.
>
> The system historically uses pain for creative advance. . . . Theologically speaking, this position is not inconsistent with a theistic belief about God's providence; rather, it is in many respects remarkably like it. There is grace sufficient to cope with thorns in the flesh (2 Corinthians 12:7–9). . . . The "birthing" metaphor is at the root of the concept of "nature"; here creativity comes only with "labor" and "travail." . . . In this struggle there is something demanding appropriate respect, something inviting reverence, something divine about the power to suffer through. The cruciform creation is, in the end, deiform, godly, just because of this element of struggle, not in spite of it. Among available theories, there is no coherent alternative model by which, in a painless world, there might have come to pass anything like these dramas of nature and history that have happened, events that in their central thrusts we greatly value. . . . The view here . . . is a tragic view of life, but one in which tragedy is the shadow of prolific creativity. (Rolston 1999, pp. 303–07)

I think I can argue my case here, but my argument is experiential, existential. When, each spring in the Rocky Mountains, I confront the pasqueflower, I am moved by life beset by storms, persisting through winter, and flowering again at Easter. Though plants do not suffer, plants are caught up in the struggle to survive. I confront this "cruciform creation," life dying and regenerated through death—nature as "*via dolorosa*." I find an encouraging beauty in life's perennial regeneration. I know the evolutionary science, I know there is life-death-life-death, but when I encounter the lovely blossoms breaking through the snow, I take the flower, a distributive token, as type for the collective Earth, with its millions of species, continuing after a turnover of billions of species. I put that as my creed in *Natural History*: "The Pasqueflower" (Rolston 1979).

The central fact of the matter biologically is the survival of life over millennia, life-death-life-death-life-death; but such fact of the matter is *ipso facto* valuable, vital. Nature produces matter and energy, then objective life, then subjective life, then mind and culture. The latter movements are increasingly in a minor key—and beautiful for the conflict and resolution. "Experiences of the power of survival, of new life rising out of the old, of the transformative character of suffering, of good resurrected out of evil, are even more forcefully those for which the theory of God has come to provide the most plausible hypothesis" (p. 135).

One must be in this river to sense the flow. "We must live at the eye of the storm" (p. 344). This book, after two decades, will still invite you into a "participatory universe." I guarantee it.

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