A Novel Approach to Biological Evolution and Some Theistic Notions of Creation

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ABSTRACT

In *Origins of Order* (1993) and *At Home In the Universe(*1995), Stuart Kauffman (a member of the Santa Fe Institute) advances the view that currently-accepted versions of Darwinian evolutionary theory are radically incomplete. He contends that such accounts of biological evolution require supplementation by explicit recognition of the importance of coherent structures --the prevalence of "order for free". Kauffman's approach contrasts markedly with standard evolutionary doctrine, especially with "selfish-gene" concepts advocated widely and persuasively by Richard Dawkins --who has claimed evident superiority of naturalistic modes of understanding over theistic ones. This paper explores, in a preliminary way, relationships that might exist between this current scientific (or meta-scientific) diversity of opinion and some theistic notions of "creation". In this respect, recent approaches of Lewis Ford and Robert Neville (both related to the thought of Alfred North Whitehead) are contrasted with more-traditional doctrine, summarized by Robert Sokolowski.

(End of Abstract.)

Naturalistic and theistic approaches may appear as contraries--mutually-exclusive ways of dealing with intellectual questions. But from some points of view, the opposition between these modes of thought, and perhaps even their sharp distinction, may be less clear. Specific notions of deity that have figured in theistic conceptual systems of long-past civilizations have certainly been influenced by prevailing technology--the ways in which people made their living (Levi-Strauss, 1974; Renfrew, 1994). Recent developments in science have also had major influence on how the object of religion is now conceived, at least in some circles (Haught, 1995). On the other hand, to the extent that Whitehead (1925) was correct when he wrote:

"...Faith in reason is the trust that the ultimate nature of things lie together in a harmony which excludes mere arbitrariness. It is the faith that at the base of things we shall not find mere arbitrary mystery. The faith in the order of things which has made possible the growth of science is a particular example of a deeper faith. ...."

to that extent at least, all authors employ modes of thought that can be taken to have theistic overtones.

Mithen (1994) suggested that the change that archaeologists count as the beginnings of "modern" behavior, the transition from the Middle Paleolithic to the Upper Paleolithic at about 50,000 years before the present, can best be understood as the beginnings of "increased accessibility between mental modules". It seems to be generally agreed among archaeologists that. in the Lower and Middle Paleolithic, *homo sapiens* was capable of several fairly complex behavior-patterns: ability to work stone to produce effective tools ("technical intelligence"), skill in interpreting certain environmental clues ("natural history intelligence"),

and the power to deal effectively with other members of human groups-- knowing and exploiting "the character of other individuals and their social relationships" ("social intelligence"). Mithen claims that prior to the Middle Paleolithic/ Upper Paleolithic transition, the genus *homo* had all these capabilities developed to a level quite comparable to that found in present-day humans, but with the important difference that these skills were quite separate--intelligence was "domain-specific" rather than "generalized"--mental abilities were "modular". Mithen's thesis is that at and after that transition, in a gradual way, skills developed in one area became available for application in other areas of human life. In particular,

"...From the Upper Paleolithic onwards, the non-social world is explored and exploited partly using thought processes which evolved for social interaction."

On this basis, transfer of concepts and approaches between diverse areas of activity has been characteristic of properly human life since its origin. Clearly the millennium now ending differs in major ways from earlier phases in human evolution (McNeill, 1990), but should we really expect, even in our own day, that division between the meaning-giving (theistic) and scientific-technological (naturalistic) activities of our society could be sharp?

A serious complication in comparing naturalistic and theistic approaches is that both these modes of thought are in continual change and development. The science and technology of the last decade of this century differ in important ways from what went before. Widespread availability of powerful computers has made a major change in the sorts of problems that scientists and technologists can tackle, greatly altered the methods used to attack problems, and directly and indirectly brought about major upheaval in rather fundamental concepts, such as a major reconceptualization of causality. This development has been discussed from the point of theism in a recent Vatican Observatory publication (Russell, 1995). One result of this change may be that some of the major points at issue between theistic and naturalistic outlooks may well have become moot. In connection with this type of development, this paper discusses a novel approach to the origin of life, and to development of biological order and diversity, and explores, in a very preliminary way, possible relationships between this approach and some contemporary philosophical theologies of creation.

Clearly, Richard Dawkins should be counted as a naturalist rather than a theist .Even though he did make what might be called a "theological" contribution regarding "God's Utility Function" (Dawkins, 1995), he has been engaged in an extended polemic against standard theistic interpretations. Dawkins most recent popular work, *Climbing Mount Improbable* (Dawkins, 1996), is mainly a refutation of arguments put forward, over the years, by various distinguished physical scientists, who have asserted that biological evolutionary change by natural selection is intrinsically unreasonable, using arguments from probability theory. Dawkins claims that those objections falsely assume that evolutionary change necessarily involves major, abrupt alteration of a preexisting situation, analogous to a foolhardy mountain-climber essaying a leap straight up the face of a sharp precipice. Dawkins claims that what actually occurs is incremental change, analogous to a more cautious climber's slow assent up a long, but gentle, slope around the back of the same cliff. As in his earlier books, Dawkins places heavy emphasis on the level of the gene. For him, by far the most important aspect of biological nature is the ability of certain stretches of DNA to engender faithful copies of themselves under conditions that prevail. In earlier work, Dawkins did note that there are other entities in the world, in addition to genes, that have the property of self-replication ---units of cultural transmission (memes), for instance. In his more recent work, Dawkins has narrowed his focus to the level of the gene. On the basis of his gene-centered cosmology, Dawkins continues his direct and oblique attacks on theism with great vigor and skill.

In his recent book (1995), Dawkins mentions, in passing, that he had visited New Mexico for an early conference on "artificial life" and there met Christopher Langton, one of the pioneers of that fairly-new field. Curiously, Dawkins does not much discuss the work of Stuart Kauffman, a prominent colleague of Langton at the Santa Fe Institute. In 1993, Kauffman published a major work, *The Origins of Order: Self-Organization and Selection in Evolution,* dealing with basic mechanisms of evolutionary change. (Dawkins does include a reference to Kauffman s more popular 1995 work, *At Home in the Universe.*) Kauffman, like the eminent physicists Dawkins cites, regards the standard understanding of evolutionary change by natural

selection as radically unsatisfactory, but his argument has a quite different structure from the ones that *Climbing Mount Improbable* refutes.

Kauffman was trained as a physician. He gave up medical practice to study fundamental questions in biology.

"I entered biology because the magnificent wonder of cell differentiation overwhelmed me." (Kauffman, 1995, p. 94).

To understand biological morphogenesis better, he took up computer-modeling, and joined the Santa Fe Institute, a private not-for-profit research institute dedicated to the study of complex natural systems, in physics, biology, and economics, that had spun-off from Los Alamos National Laboratory. *The Origins of Order: Self-Organization and Selection in Evolution* (Kauffman, 1993), contains rather detailed accounts of computer simulations of designed to illuminate a wide range of problems of fundamental biological interest, ranging from the origin of life to the development of mammalian embryos. The more recent (Kauffman, 1995) book, *At Home in the Universe,* covers much the same ground in a less-technical manner, and extends arguments based in biology to questions of wider interest, such as the place of humans in the cosmos. As the title of the work indicates, Kauffman concludes that we are integral parts of evolutionary nature, rather than intrinsically outsiders -- as others, some theists and some naturalists, have held.

Kauffman states the opinion that the present general understanding of evolution by natural selection is inadequate.

"...Where, then, does this order come from, this teeming life I see from my window: urgent spider making her living with her pre-nylon web, coyote crafty across the ridge-top, muddy Rio Grande aswarm with no-see-ems (an invisible insect peculiar to early evenings)? Since Darwin, we turn to a single, singular force, Natural variation, selection-sifting. Without it, we reason, there would be nothing but incoherent disorder. I shall argue in this book that this idea is wrong. For, as we shall see, the emerging sciences of complexity begin to suggest that the order is not all accidental, that vast veins of spontaneous order lie at hand. Laws of complexity spontaneously generate much of the order of the natural world. It is only then that selection comes into play....." (Kauffman, 1995, pp.7-8)

Kaufman holds that, in addition to dealing with natural selection, any adequate theory of evolution must also account for the spontaneous generation of coherence, what he calls order for free . One of Kauffman's main points is well illustrated by his discussion of the origin of life. The best known researchers in the field of proto-biology (Manfried Eigen and Leslie Orgel, for instance) have focused on the currently-prevalent apparatus of biological organization and reproduction--the complex networks of DNA, RNAs, and proteins that constitute present-day biological organisms. In good reductionist fashion, these scientists have attempted to understand basic principles that operate in current biological organisms, and to infer (or imagine) what simpler states of affairs might have preceded what we now observe. Eigen's approach (Eigen, 1992) envisions self-reproducing cycles of catalytic and auto-catalytic chemical reactions (hypercycles) that undergo modifications that lead to other more-complicated self-reproducing networks of interaction (larger hypercycles). In this view, the predominant direction of evolutionary development is from simpler states of affairs to more complex ones. Enlargement of a hypercycle to produce a larger hypercycle requires that a number of new chemical species come into play. In order for the new hypercycle to function well enough to replace the old one, these new molecules must each possess quite specific catalytic and autocatalytic functions--this puts very severe restrictions on their structure and composition. This stringency seems to provide considerable ground for the type of probability-based anti-evolutionary argument that Dawkins refutes in *Climbing Mount Improbable*. It is hard to see how Eigen's hypercycle-shift mechanism can fit under the gradual-change description that Dawkins advances there. Kauffman has an alternative and quite non-standard approach to the question of the origin of life that does not seem to be subject to objections that can be made against the approach taken by Eigen.

Kauffman rejects the assumption that life began with simple catalytic cycles, such as Eigen envisions. He consider the type of chemical melange that is likely to have arisen from strictly-chemical pre-biotic evolution. Any aqueous solution that contains a large number of chemicals must necessarily give rise to an even more complicated set of reactions between and among those chemical molecules,, giving rise to yet more chemical types. On the pre-biotic Earth, there must have been vast numbers of locations, including many energy-rich ones, where such complex reaction-systems existed. Kauffman argues that, given a sufficiently complex network of reactions, eventually a self- replicating cycle must necessarily arise. That is, if enough different reactions are going on, sooner or later some collection of chemicals must undergo a series of chemical changes that generates a set of conditions much like the original situation.

Such a self- replicating cycle would resemble Eigen's hypercycle, in that it would be a closed network of catalytic and autocatalytic processes, but the kind of cycle that Kauffman envisions is highly complicated--not at all initially simple, as most workers in the field tend to assume. The new view holds that the initial closure of a self-replicating cycle was a necessary consequence of the complexity of the situation produced by prior evolution, and the cycle that was thus produced was surely large and ungainly. For Kauffman, an important part of evolutionary advance must have been simplification of such initially complex cycles, gradual elimination of ineffective and redundant steps. On this view, once upon a time, someplace on Earth, there was a warm soup of molecules-- including many carbon-containing ones. Many of these molecules were catalysts, each one facilitating one or more reactions of a wide variety of types, each of which reactions yielded still other molecules, some of which were catalytically effective in novel ways. It eventually (necessarily) happened that some large set of these reactions produced a closed cycle that had the property of regenerating (more or less) the original catalysts and reactants. This cycle would keep on going (since it generated its own starting conditions) while other reaction sequences that were not cyclical would quickly play themselves out. Over time, the compounds that were parts of the successful cycle would come to make up larger and larger fractions of the chemicals in the solution. Once established, such a cycle could change by simplification taking short-cuts around unneeded steps. Kauffman proposes that combination of such cycles is a likely way to produce larger cycles.

According to the prevailing view, the plethora of biological forms that now exist have evolved through transitions from simpler autocatalytic reaction-networks to more complex ones. According to Stuart Kauffman; the origin of life--and other major evolutionary change--starts from a relatively confused and disorderly state, one involving entities of many types, each one a result of previous evolution. Since there are many entities in interaction, there will be very many ways in which they can interact, and all those interactions will have consequences. If the situation is complicated enough, there is a high degree of probability that networks of autocatalytic interactions will close--that some novel dissipative structures (a term due to UTA's Ilya Prigogine) will come into existence. Once produced, the sets of interconnected changes will persist and grow, and crowd out non-cyclical processes.

A homely example (Bruckstein, 1993) may clarify how such networks would be expected to become simpler with the passage of time, as unnecessary steps drop out. If a sugar-cup is placed near an ant-hill, eventually a roaming ant will stumble onto it. To get back to the nest, the happy explorer will retrace the route used to make the discovery; this route will be a long and winding one. Additional ants will be recruited to exploit the newly discovered resource by following the trail of the first ant. Each subsequent ant will follow the path taken by the ant ahead of it, but each will cut corners in doing so. After a fairly short time, the trail from the ant-hill to the food will be as straight as if it had been laid out with a ruler. The final trail is quite different from the tortuous route the initial insect had used. In Kauffman's view, the first achievement of any new coherence is likely to be messy; simplicity will only be approached over time as efficiencies, such as the ant shortcuts, are stumbled upon.

Kauffman's thesis is that growth in complexity eventually, and ineluctably, leads to a situation where coherence on a new level emerges. Once this new type of organization has come into being, progressive simplification is to be expected. Kauffman provide results of experiments done with computer-models of various types, dealing with biological structure-generation on many diverse levels to support this conclusion. Strictly speaking, there is no scientific point at issue between Dawkins and Kauffman, the question is one of evaluation: which is more important, the individual replicator (the gene) or the pattern

generated by the action of a myriad of genes? With regard to the gaudy colors of certain male maniken birds of the tropics, Dawkins would point to the efficacy of replication of the genes, Kauffman might well observe that the pattern of reproductive behavior (lekking) characteristic of that species of tropical bird has more to do with the nature of the genes that bird carries than the nature of those genes causes that pattern of behavior. The coherence and efficacy of the macroscopic behavior-pattern (lekking) needs to be taken into account in any adequate understanding of the behavior of those birds. Clearly, this is a contemporary version of medieval nominalist-realist controversies.

The whole process of spontaneous generation of organization is described by Kauffman as "order for free" . Kauffman joins in the proclamation of post-modern science: "Nature is Self- Organizing" (e.g. Wilson 1989). We need not discuss Kauffman's other main points (such as that evolution invariably leads to "the edge of chaos") since order for free may already be sufficient to connect him (however tenuously) with some theistic traditions.

Howard J. Van Till (Van Til, 1996) recently discussed the relationship of scientific doctrines of "self-organization" to the Christian tradition, particularly to the writings of St. Basil of Caesarea (330- 379) and St. Augustine of Hippo (354-430). Van Till's conclusion is that those ancient authors clearly understood that nature has the intrinsic capability to generate novel forms of coherence, and were well able to incorporate this understanding into their theistic philosophies. Van Till describes their view as "the doctrine of creation's functional integrity" . The idea (widely held until recently) that matter is intrinsically inert (as opposed to self-organizing) is widely recognized as stemming from the late Renaissance (Leclerc, 1990). To the extent that this is the case, part of contemporary divergence between theistic and naturalistic approaches may be understood to arise from overly-complete internalization (by both naturalists and theists) of the cosmology that resulted from the scientific revolution of the seventeenth century, a cosmology that is now rapidly being replaced by one that draws attention to the form-generating capabilities of concrete entities (Earley, 1994, 1995).

To examine to what extent the divergence between Dawkins and Kauffman approaches may be related to the naturalist/theist discussion, we briefly note some recent contributions to the theology of creation. As part of a larger work, Robert Sokolowski (1993) presented a concise summary of "the Christian understanding of the world as created and God as Creator" . He points out a major difference between Christian and "pagan" or "natural" ideas of God. For the later, God is part of the world , In contrast, for the Christian;

" God is hidden not just because of human psychological limitations, but because he is not one of the things of the world (p 52).

Charles Hartshorne, Lewis Ford, John Cobb, Schubert Ogden, David Tracy, Marjorie Suchocki, and others have developed theological approaches based, more or less, on the writings of Alfred North Whitehead. For Whitehead, God is involved in each event, in the concrescence of every actual entity. God is the source of the form of definiteness, the subjective aim, of each occasion. Lewis Ford (Ford, 1990) develops this idea:

."..Our freedom lies in the power of the present to select and organize that which we receive from the past. In the absence of direction, however, such freedom would merely effectuate random combinations of the past. Freedom is responsibly exercised in the light of future possibilities, which become lures in so far as they are valued. Thus we may describe free actualization as the bringing the past into the present by the power of the present responding to the lure of the future. The future is just as causally effective as the past, though each in its own way..... The particular valued possibilities which shape our actions come from many sources, but ultimately, Whitehead argues, they derive from the creative activity of God. God is the ultimate power of the future, rescuing the world from degeneration into chaos by the relentless provision of everlasting new creative possibilities for the world to actualize."......(p 36)

A related, but rather different, approach has been adopted by Robert Neville (1990), influenced by Paul Weiss, by Eastern thought, and by John Smith and the American pragmatist tradition. Although quite familiar with process philosophical theology such as Ford's, Neville rejects much of it:

"My own alternative is that God is the creator of everything determinate, creator of all things actual as well as of things possible Apart from the relative nature the divinity gives itself as creator in creating the world, God is utterly transcendent.... God is the immediate creator of the novel values or patterns by which an event is constituted as the harmonizing of a multiplicity. Since the real being of an occasion is the becoming of a harmonized integration of the multiplicity, its components stem either immediately from God or from what it prehends; since what it prehends are other occasions, themselves analyzable into novel and prehended features, it can be suggested that every feature at some time in the present or past is or was a spontaneous novel pattern or value immediately created by God. Thus God is the creator of every determinate thing, each in its own occasion of spontaneous appearance." (p. 8)...

Neville maintains that God transcends the world but is related to each created thing as the creator of that thing:

"Another kind of relation, however, obtains between two things, one of which is the creator of the whole being of the other... The created thing would have no integrity over against the creator, since against the creator it would have no being, but it would have the integrity of being exactly what the creator creates it to be... "p82

Although Neville differs from traditional Christian theistic doctrine in important ways (such as dealing with the personal nature of God), he asserts transcendence in a way that Ford does not seem to do, and describes his approach as creation *ex nihilo*. (It is not clear that everyone would agree that this designation is appropriate for the Neville approach, as described in the quotation above.)

Kauffman's understanding of evolution seems much more conducive to theistic understanding than is Dawkins' approach. The dipolar deity of process theology, as developed, for instance, by Lewis Ford, appears to fit rather well with Kauffman's, "order for free" . Intrinsically new coherences arise from chaotic antecedents at many levels in the course of the development of every biological organism, and ecological community. Kauffman calls attention to the importance of understanding this sort of spontaneous order-generation and its causes. Much of what Ford says about "the lure of God" can, it seems to me, be transferred into Kauffman's conceptual scheme. Sokolowski clearly would regard Ford's approach as excessively "naturalistic" , a characterization that Neville also makes. Neville claims that his system preserves both the divine transcendence that Sokolowski insists upon and also the intimate relationship between creature and creator that Ford's system provides.

Each of these three theistic authors is engaged in a difficult but necessary task, the attempt to craft a conceptual scheme adequate to *the full range* of contemporary human experience, while still giving appropriate attention to the valuable insights of theistic traditions that have long histories. As scientists, both Dawkins and Kauffman rightly focus more sharply on their biological and modeling data, but--as they both realize-- their work is relevant to more general human concerns, even theistic ones.

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