The Inherent Creativity of Nature

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We humans owe a great deal of our success as a species to our talent of making things. So, our intuitive reaction to seeing something that appears to have a purpose and works well is that someone made it. It's the old story of the watch showing the existence of the watch maker, and it has been argued many times that the existence of the World with all its marvelous creatures means that it must also have a Creator. We have named the Creator: God, and concluded that the very magnificence of the universe demands that this God be immensely strong and wise. Most of the Worlds major religions promulgate this concept and further attribute human characteristics to God.

Over the past few hundred years, progress in science has greatly altered our concepts about the nature of the World and has also raised many questions concerning our traditional beliefs about God and religion. Numerous phenomena, originally ascribed to mystical or supernatural causes, turn out to have perfectly natural explanations. For example, thunder-storms and lightning were believed to be manifestations of the devil, and most diseases were laid at his feet or considered to be punishment for a person's sins. Pope Pius V ordered that all physicians must call in a "physician of the soul" before starting their treatment and must end their treatment after three days if the patient did not confess his sins to a priest. The physician's right to practice would be revoked if he failed to do so.

But naturalistic/scientific explanations still do not address the "why" question: why do we find ourselves in such an amicably structured universe. Indeed, the big bang theory of its origin depicts the early universe as a chaotic mix of photons and elementary particles. It would seem that there would be a vanishingly small probability that such a disordered state could ever give rise to the order that we see in our world. Therefore it is hard to avoid the conclusion that some form of creativity must have been at work.

Last year I gave a talk here on the subject of emergence. Briefly, the idea of emergence is that matter itself is creative and that its creativity is cumulative. Emergent properties arise from the relationships that occur when subsets of matter are combined in a proper environment. For example, the interactions between water molecules give rise to liquid water and even the elegant structures of snowflakes. Interactions between neurons create memory and consciousness.

The Institute on Religion in an Age of Science, or IRAS, is a multidisciplinary society of persons who seek to understand and reformulate the theory and practice of religion in the light of contemporary science. Each year it holds a weeklong conference that focuses on a single topic and addresses it from many different perspectives, both scientific and religious. This year, the subject was on emergence. My talk will summarize the major findings of the conference.

A large part of the conference was devoted to presentations by nine scientists who described emergence as it is manifest in their fields of study. Collectively, they painted a picture in which order arises in a series of levels. Each level provides a foundation for and allows the emergence of a new type of order. Last year, I described the first step as the stellar synthesis of all our known elements and their subsequent dispersal throughout the universe by supernovas.

At this years conference, geologist Michael Wysession, described how the Earth, started 4 ½ billion years ago as a ball of this space dust and transformed itself into a complex structure, comprised of many interconnected systems having intricately layered rocks, oceans and an atmosphere. The primary driving force for this transformation was and is the generation of heat in the core and its dispersal into outer space. Besides supporting life, the world is also profoundly impacted by it. The earth and the life on it are so well integrated that a number of people have proposed that it can be considered a superorganism and have given it the name "Gaia." (I don't want to get into the question of the validity of the Gaia hypothesis, but just to note how structured the world is.)

The main point, of course, is that the world provided an environment that was conducive to the emergence of life. Life is matter behaving in completely novel ways, and there were several sessions devoted to our current understanding of how it emerged from inert matter. Although our understanding of life's origins is imperfect—no one has been able to artificially create life and there are several competing theories about how it might have occurred—many scientists believe that life arose spontaneously on Earth and that it will arise on any planet where the conditions are suitable. This is such an exciting prospect that NASA is conducting or sponsoring numerous studies of Mars in order to find if life existed there before it lost its atmosphere.

An important aspect of life is "agency." By this we mean that all living things, from bacteria to CEOs act in their own behalf. Bacteria can detect and move towards food sources. CEOs have more complex strategies, but they can be much more rewarding. In any event, no example of agency has ever been found in the non-living world, and so it is a good example of an emergent phenomenon. Out of agency come our concepts of meaning and value.

Although most people think of the creation of life as a single event, cellular biologist Ursula Goodenough pointed out that life developed in at least two stages. For about three billion years, all life on Earth consisted entirely of single cell organisms and they still comprise a vast majority of the organism on earth. Such organisms were and are very adaptable and are able to do some rather amazing things. But the very fact that a single cell organism has to provide all the functions needed to support its life severely limits the ways in which it can develop. For example, one only has to think about the enormous sophistication and complexity of an eye, to understand that a single celled organism could only manage very primitive vision.

Multi-cellular organisms emerged about 600 million years ago,. Cells somehow learned to cooperate and this cooperation enabled cells to specialize and form

incredibly complex organisms. Some cells provide structural elements and so allow organisms to become much larger. Some provide motion. Some provide signaling, and ultimately intelligence. With this flexibility, many different organizations could and were tried, and have lead to the enormous diversity that we now see in the biosphere.

As a consequence, however, the organisms became mortal, that is their deaths became inevitable. Because it was no longer practical for these collections of specialized cells to reproduce by dividing, reproduction was assigned to special germ cells known as gametes. The mass of the elaborate organism, known as the soma, was doomed to die. Dr. Goodenough identified the core irony: "our sentient brains are uniquely capable of experiencing deep regret and sorrow and fear at the prospect of our own death, yet it was the invention of death, the invention of the germ/soma dichotomy, that made possible the existence of our brains."

Stuart Kauffman talked about the creativity of the biosphere and how extraordinarily different it is from the classical model based on Newton's laws of motion and gravitation. That model led people to the believe that if one could only determine the position and motion of every particle in the Universe, then one could then completely compute its future evolution; everything would be predestined. Of course, it is well known that quantum mechanics undercuts that idea. The uncertainty principle established the impossibility of making the initial determinations of position and motion to the required accuracy.

But, Kauffman goes much further. He emphasized that life has persistently invaded what he calls the "adjacent possible." By this, he means that organisms frequently discover in the environment entirely new uses for an organ or other part that they already possess; one can say that they are "preadapted" for their new capabilities. One example is the evolution of a fish's swim bladder into the lung. The organ evolved as a simple way to control buoyancy, but became an essential element in the transformation of fish into terrestrial animals and hence opening up an entirely new realm of life forms.

Another example is humans' development of speech through the adaptation and reutilization of the larynx and vocal cords. These organs originally evolved to permit breathing and ingesting food through the same passage. This remains their function in all mammals, but humans have sacrificed some of their functionality to gain the much greater articulation of sounds needed for language. As a consequence, we are the only mammals who cannot simultaneously drink and breathe.

Kauffman brings us to a radical conclusion: because there is no effective way to identify all possible selective environments, in the Darwinian sense, we cannot predict, or even scope, what new features may come into existence. Thus, the biosphere has been and continues to be extremely creative.

Over the past 30 years there has been tremendous progress in understanding genetics and in embryonic development. It used to be assumed that the more complex an organism, the more genes that would be required to define it. So, it

came as a great shock to learn that we humans have only about 30,000 genes, only slightly more than primitive flat worms. It also was assumed that the more different two creatures are, the more different their genomes would be. Surprise, it turns out that many of our most fundamental genes are almost identical to those of a fruit fly and other "simple" creatures. Scientists have replaced the genes in a fruit fly that control the generation of its eye with similar genes from a mouse. Remarkably, the fly develops a normal "fruit fly" eye. It turns out that many of these developmental genes were "invented" hundreds of millions of years ago, and nature just continues to use them. As they say, if it ain't broke, don't fix it.

These genetic findings seem enigmatic because it has been generally assumed that the role of the genes is to specify the structures of a mature organism's body. Terry Deacon pointed out that it is becoming clear that this is not their role; genes primarily create developmental biases and constraints. Most of the structural and functional order emerges from interactions between cells during the development of the embryo that are controlled by small switches found in the DNA. This means that major structural, functional and behavioral changes can result from quite small changes in the genome.

In his book, Deacon discusses the emergence of language and symbolic thinking in humans, something that has not been duplicated by any other species. These capabilities, of course, are why we are here tonight, why humanity has mushroomed up to six billion individuals and why the total environment of our planet has been fundamentally changed.

What did it take? Many authors have described the enormous complexity of language, citing the many ambitious attempts to make computer emulations that have failed, and the paradoxical fact that all normal children readily learn language, largely on their own. Attempts to explain this phenomenon often resort to assuming massive genetic changes and corresponding specialized brain structures.

Deacon argues that mega mutations were not necessary and the actual biological changes to the brain were rather minor. Instead, language skills resulted from new synergistic interactions between brain systems that, in other species, serve other, unrelated functions. He also argues that language itself undertook much of the evolutionary journey. Humans tried many different ways of communicating; those of which proved to ill adapted to the human brain were hard to learn and so were rapidly eliminated. Those, which were well adapted to being learned by children, flourished and evolved into our modern languages.

Stuart Kauffman summarized: "in wondrous ways, our universe, biosphere, econosphere, and culture are ceaselessly creative and emergent. The two cultures, science and humanities, stand united in this worldview. Meaning and value have a scientific base. And ethics? At the IRAS meeting, we heard more than one lecture on animal emotions and the sense of fairness in chimpanzees. Group selection, we were told, is now making its way into evolutionary biology. With it, natural selection can get its grip on behaviors that are

advantageous to the group, like fairness, so it emerges. Far from evolution being anathema to ethics, evolution is the first source of human morality."

As science teaches us more and more about the nature of the Universe we live in, the traditional concepts of a human-like God the Creator has been found to suffer from numerous complications and contradictions. Rather than the compact, stable structure envisioned in the Bible, our world is now understood to be highly dynamic, yet only a minute speck in an incomprehensibly enormous and ancient Universe.

The concept of emergence is playing an integral part of this re-visioning. Its essential message is that matter and nature are in themselves creative, and the world, as we know it, is a product of this creativity. No external creator was necessary.

Gordon Kaufman (no relation), a theologian at Harvard, proposed that our theological values and meanings can be made consistent with modern cosmological and evolutionary theory by replacing "God the Creator" with the idea that God is manifested as the ongoing creativity of the Universe. In his view, "Creativity is not an explanation of why and how new things come into existence: it is, rather, simply the name we give to this profound mystery: the mystery of complex things coming into existence from things less complex, the mystery of the universe's apparently coming into being from nothing."

The idea of God as creativity has much to recommend it. It is both consistent with current science and the core principles expounded by the great religions of the world. It avoids the perils of worshiping an anthropomorphic God and does not lead to the perpetuation of worldviews when they are found to be false or made obsolete by new findings in science.

Further Reading

2006 IRAS Conference Book, "Emergence: Nature's Mode of Creativity"; can be downloaded at: http://www.iras.org/pastconf.html

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