Foreword

Joseph L.R. Bélanger, FMS

Urbain Jean Joseph LeVerrier (1811-1877), French mathematician and astronomer, was asked to explain the planetary perturbations in Uranus observed in 1845. He sat at his table in Paris one day with paper and pencil and calculated the masses and distances of the known planets, but was puzzled by them. They simply could not be in their present configuration unless another mass was at the appropriate distance to counterbalance them. This is what was causing the perturbations. So, he calculated mathematically the necessary position and mass of this unknown planet and announced them on 31 August 1846. Shortly thereafter, on 18 September, basing himself on these calculations, the German astronomer Johann Gottfried Galle [1812-1910] discovered the planet Neptune. Later, LeVerrier's good friend, the British astronomer John Couch Adams [1819-1892], announced his own discovery of Neptune. For the first time science proved conclusively that everything and everybody are interdependent. It was the beginning of a new era in cosmology, ecology, and sociology.

Pierre Teilhard de Chardin, SJ (1881-1955), paleontologist, spent his life studying the origins of life on earth and philosophizing on how and why life develops and what its goal might be. He accepted fully Le Verrier's interdependence of everything and everybody, on earth and in our cosmos, but he also meditated long and deeply on the end, or purpose, of life. On Holy Thursday, 7 April 1955, he wrote the final words in his diary, the words of Saint Paul in 1Cor 15:25-28: everything, even death, will be subject to the Son and the Son will be subject to the Father, "so that God may be all in all." Teilhard believed firmly in "the spiritualization of Matter," the progressive transformation of all-Matter into all-Spirit. The first fruits of this spiritualization is the Resurrection of Christ, dead body become living person. It was fitting that Teilhard died that Easter, 10 April 1955, his ailing body unable to withstand any longer the electrifying pulsations and intimations of divinity.

The papers presented here give us a good grasp of the life and thought of this daring, visionary scientist and priest who most preeminently in our day exemplified the convergence of Science and Religion.

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The Spiritual Power of Matter: Evolution and Incarnation in Teilhard's *The Divine Milieu*

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Introduction

Early in *The Divine Milieu*, Teilhard sets forth two major questions that would trouble anyone who takes seriously both evolution and theology prevalent during the early twentieth century. His first question is this: is Christ "capable of still embracing and still forming the center of our prodigiously expanded universe"? (DM 2). Or, in other words, now that we know about the enormity of the universe in space and time as well as something of the dynamic processes at work in matter, is Christ of the Gospels large enough? His second question concerns the value of work. Is there a cosmic purpose to evolution? Is it going somewhere? Does what we do matter and does our work contribute to the ongoing process? Teilhard never questions his belief in God nor the necessity of religion. Instead, he questions some of the facets of theology that are based on an outdated and static picture of the cosmos. What he does contribute is an attempt to rework some core insights of Christianity, especially those involving the Incarnation, within an evolutionary paradigm. He also develops an evolutionary spirituality which models the divine gesture of Incarnation, a gesture that is reenacted in the sacrament of baptism.

In this paper, after a brief introduction to both evolution and Incarnation, I will consider how, on the one hand, the mystery of Incarnation sharpens the role of divine activity within the evolutionary cosmos and, on the other hand, how the theory of evolution provides profound insight into the power of the Incarnation. Next, I will discuss Teilhard's synthesis of evolution and Incarnation as the basis for his spirituality. Finally, I will explore with you what Teilhard means by the spiritual power of matter.

Seeds of Teilhard's struggle to develop an integrated spirituality are already present during his childhood. Though he was a devout child, he loved nature more than the study of religion. Particularly captivated by the hardness and durability of rock, he eventually pursued the study of geology and paleontology. During his prolific scientific career, he spent his days searching for and classifying fossils and chipping away at the rock that covers the landscape of Europe, Asia, and Africa. This hands-on experience of Earth heightened his sensitivity to the evolutionary nature of the cosmos. Yet Teilhard's devotion and deep love for God, fostered from childhood, also attracted him to the religious life and to a vocation as a Jesuit priest. During his religious formation, he was encouraged to see God in all things, in every aspect of his life. This would ultimately include seeing God at the heart of the evolutionary cosmos. In fact, he devoted his life to the synthesis of his ardent love for Earth and its dynamic unfolding within the mystery of Christ.

Each of Teilhard's two major works treats one of the two phases of this synthesis. *The Human Phenomenon* (formerly known in English as *The Phenomenon of Man*) leads the reader through evolutionary history and assigns Christ the primary role in cosmic evolution; *The Divine Milieu*, on the other hand, guides the reader through the stages of spiritual and psychological development and connects individual growth to cosmic evolution. Together these works provide a unified vision of God's action in the world.

Purpose of The Divine Milieu

Teilhard was introduced to the theory of evolution while he was studying theology early in his life as a Jesuit. This initial encounter affected him profoundly. He was awestruck by the unfathomable depths of time and space (see D 1) that the evolutionary picture presents and with the interconnectedness that it implies. Unlike those who find evolution disturbing because of what might at first seem to be a contradiction with the biblical stories of creation, Teilhard recognized in evolution a more dynamic way of explaining God's action in the world. Viewed from the correct angle, he says, evolution actually enriches and ferments religious thought (see D 1). His evolutionary perception provides an alternate way of looking at matter and spirit and suggests novel ways of reading scripture, particularly the letters of Paul and the gospel of John. It made all the difference in the way he lived his life and in what brought him joy. This motivated him to share his insights especially with those who are initially more attracted to the story of the cosmos than to the story of Christ in the Gospel.

Teilhard was quite concerned about the lack of interest that he experienced among Christians of his day regarding human progress (see D 27). Instead of trying to build a better life here on Earth, they seemed content to await their heavenly reward. Teilhard hoped that a clearer understanding of the dynamics of evolution and God's place in this process would encourage a zest for life and a desire to make conscious contributions to the ongoing evolution. Most of all, Teilhard wanted to share his profound experience of the divine presence that pervades every atom of the cosmos and his sense of a world saturated with God.

In *The Divine Milieu*, he outlines a spirituality that depends heavily on the fact of evolution. He describes his spiritual path and charts the stages of his journey into God. In order to understand Teilhard's spirituality, it is important, first of all, to have at least an overall sense of what Teilhard understood by evolution and by Incarnation, and how he synthesized the two.

Evolution

Today most people know something about the theory of evolution, both the evolution of life on earth through the process of genetic mutation as well as the cosmic evolution of matter and energy. They realize that the universe is probably almost 14 billion years old and that it most likely began with a primordial flaring forth which is popularly called the Big Bang. They know that simple particles such as protons and electrons created from the energy that burst forth from the primeval fireball began clustering in clumps due to gravitational attraction and eventually formed stars. They have some sense that the extremely high temperatures found within the stellar cores allow these stars to forge the more complex elements such as carbon, oxygen, and nitrogen that are needed for life. They realize that after some millions of years, when giant stars finally lose their ability to make new elements, they explode as supernovas, scattering their waste material into space for the benefit of new star systems. They recognize that our Sun, with its planets, moons, asteroids, and comets, was formed from these supernova remnants. And, finally, they understand that life on Earth has evolved from simple-celled organisms into more and more complex life forms and that the human species is a latecomer in Earth's almost 5-billion-year history.

But, at the time when Teilhard wrote *The Divine Milieu*, the theory of evolution, as we know it, was still developing. Although Darwin's theory of natural selection was well established by this time, the so-called Big Bang theory had not yet been formulated and the mechanisms involved in genetic change were still unknown. Still, news of the theory of evolution was already in the process of turning the world upside down. Evolution challenges a literal interpretation of the biblical six-day creation story and refutes the idea of a once-lost paradise. It underscores the unfinished nature of the cosmos, its gradual development through billions of years and highlights the fact that we are part of this great cosmic process both in our origin and in our development as a human species. To believe in evolution requires a change in viewpoint from a static and stable world to a highly dynamic one, from a view of life that is human-centered to one that is cosmic. Therefore it should come as no surprise that evolution impacts theology profoundly.

Incarnation

Rene Hague, one of the several English translators of Teilhard's many essays, has identified about 20 scripture texts that have had significant influence on Teilhard's synthesis. These cosmic-sounding passages from the epistles of Paul and the gospel of John become the lens that allows Teilhard to view evolution in Christian terms and Incarnation in cosmic terms. Images such as creation groaning and creation as the Body of Christ fit well with a more process-oriented cosmology. If not taken too literally, these images lend support to an evolutionary worldview and enhance previously held notions of the Christian mysteries of Creation, Incarnation, and Redemption. However, they also open both science and theology to some radically new interpretations.

Most people consider the three major Christian mysteries, Creation, Incarnation, and Redemption, as logically independent from one another, three separate functions of the Godhead. In an effort to provide the more universal, dynamic, and process-oriented religious context needed for the evolutionary picture, Teilhard describes the great Christian mysteries as ongoing operations (see D 20) rather than as one-time events. He realizes that for Christ to be immanent, to be present in all things at all times, he must first have descended into the disorganized and disparate matter and energy of the beginning. In order to create, which for Teilhard always means bringing into union, Christ had first "to immerse himself in the multiple, so that he [could] incorporate it in Himself" (TF 196). In other words, Christ "could penetrate the stuff of the cosmos, could pour himself into the life-blood of the universe, only by first dissolving himself in matter, later to be reborn from it" (S 60). Thus, at the beginning of time, Christ plunges into matter, goes down into its "deepest depths" (D 19), penetrates to its very heart. Through the Incarnation, then, Christ becomes intimately connected to creation both materially and spiritually, there to remain its unifying principle and guide. With an evolutionary context, Christ, who had previously been confined in space-time to the Mediterranean world of the early Christian era, is suddenly found everywhere in the cosmos. In this way, Incarnation becomes inseparable from the mystery of Creation.

Embedded within the emerging cosmos, the Incarnate God guides creation as it ascends from one critical point to another along its path to integration (see CE 75), as it encounters the shadow side of creation, the failures, evil, and death that must accompany a cosmos in process of unification (see CE 182-183). Through the ongoing mystery of Redemption, Christ continues to suffer with creation, exerting continual effort to guide creation away from evil and to encourage it to overcome its inherent resistance to unification. The Cross of Calvary is a sign of Christ's continual willingness to plunge into the fire, to engage in the purifying battle, not only to expiate sin, but still more to surmount and conquer evil (see CE 85). The Cross becomes a sign of hope since it couples our struggle to overcome evil and pain with Christ's attempt to draw all things into final unification. Redemption, then, is also very closely linked to Creation and Incarnation.

Furthermore, since Christ is the principle of evolutionary unification, he must be transcendent. In fact, for Teilhard, Christ is the force behind evolution that, like a magnet, draws it onwards. Not only immersed within the cosmic dust that continues to complexify, Christ also hovers at the edge of space-time alluring creation toward higher levels of convergence. The Risen Christ of the Gospels becomes Christ Omega, the Cosmic Christ, who resides up ahead of creation, in the future, drawing all things forward into a unity of spirit, encouraging greater novelty and complexity. He is the impetus for the complexification that has been occurring over billions of years, the one who effects an eventual unity within the mass of cosmic space-time fibers. As Paul pictures so graphically in his letter to the Romans, all of creation is groaning as it awaits the coming of Christ (see Romans 8: 22), as it gradually advances from inert matter, to life, to thought, and, ultimately, to ultra-personhood. The cosmos experiences "a continuum of progressively more centered experiences" (King, 195) as it gropes its way toward wholeness.

These mysteries, Creation, Incarnation, and Redemption, represent three phases of a single cosmic movement toward the Pleroma, the fullness of time of which Paul speaks. They converge for Teilhard into a single mystery that he calls Pleromization, that is, a "synthesis of the created and uncreated in the Mystical Body of Christ" (Cowell 159). Teilhard extrapolates this hope-filled expectation of a final synthesis not only from Paul's references to the fullness of time but also from the very processes of evolution. At every level of the cosmic hierarchy, something new emerges whenever two entities come together to form a whole. Teilhard generalizes this process. He extrapolates it into the spiritual realm, and calls it creative union. As Teilhard uses the term, creative union is a process whereby disparate matter and spirit go through a series of "increasingly higher centrations that cause the appearance of increasingly wider and better centered wholes" (Cowell 205). Creative union is Teilhard's name for the Great Work that is being accomplished within the cosmos, a work that will bring about the Pleroma, that is, the final synthesis of all the elements of the world in Christ (D 84).

Teilhard considers the dramatic gesture of the baptismal ritual as an expression and re-enactment of the Great Work needed to drive creation toward the Pleroma (see D 70). At the beginning of his public ministry, Christ plunges into the waters of the Jordan. He expresses his desire to become one with all of Earth just as he had done when he was inoculated into matter at the beginning of time. As he sinks down into Earth to redeem it (see D 66-67), "the power of the Word Incarnate penetrates matter itself; goes down into the deepest depths" (D 61-62). Then after immersing himself in matter, he rises from the bowels of Earth, reaches up to the heavens (see S 64), elevating, blessing, and energizing "the whole world with the water [that] runs off his body" (D 70).

Spirituality

This twofold baptismal gesture, also symbolic of the kenotic cycle that Paul describes so beautifully in his letter to the Philippians (see Phil. 2, 5-8) and the Paschal mystery of Christ's life, death, and resurrection, is key to Teilhard's spirituality. It forms the double movement of his life in God: activity and passivity, "immersion and emergence, participation in things and sublimation; possession and renunciation; crossing through and being borne onwards" (D 70). Teilhard also reenacts this double movement. In *The Divine Milieu*, he shows us how to descend into our deepest self, into what seems a bottomless abyss (see D 37), to explore "the roots of our being" (D 17). In *The Human Phenomenon*, he leads us on a similar journey, this time back to the beginning of space-time itself. In both instances, he experiences concretely the Great Work of creative union that is gradually being accomplished within himself and within the cosmos. He finds that disparate matter, present at the beginning of both the cosmos and his own individual life, is organizing itself into more complex entities, weaving the magnificent universe that thrills our hearts and minds. The complexification of the spiritual in the human has resulted in the gift of consciousness. This gift places us at the forefront of the evolutionary project where we share deep responsibility for its ongoing development. Participation in this Great Work, by immersing oneself in the energies of Earth and then rising to conscious action in the world, is a vital aspect of Teilhard's spirituality.

The Great Work

Because of the profound connection that he experiences between his inner and outer journeys, Teilhard finds, in physical evolution, a model for the Great Work that he must do, hand in hand with God. In fact, he describes his spirituality in language that resonates with the language of the evolutionary biologist of his day. He compares the human species to an endangered species searching for survival. We must continually search for new ways to effect the communion that we desire. We must be willing to try everything as we grope our way toward fuller life, toward the building up of the spirit of Earth. The task is a slow one. Union is not accomplished all at once. Rather it is like the assiduous labor of seaweed that concentrates the rich minerals of the sea in its tissues or like the work of bees that make honey from nectar collected from a field of flowers (see D 18). What a star does in its core as it fuses nuclei, what the organic chemist does in the lab as she synthesizes molecules, provides us with an external view of the Great Work going on within the heart of matter that we must emulate. We can become one only by taking steps, little by little, toward reconciliation and mutual understanding.

Like the evolutionary road pursued by the rest of creation, the road of personal and spiritual development (see D 28) is also a climb toward greater fitness and greater adaptability. Matter can be seen as a ladder or, better still, as a mountain on which we make this climb. Like the mountain climber, we grope our way, often in the dark, toward fuller life, toward the Divine. It is a difficult road, much like the way of the Cross. Christ's journey up the hill to Golgotha is symbolic of the evolutionary struggle of matter to complexify, the spiritual struggle to advance toward fuller consciousness, and the creative struggle to produce a world in harmony with the Divine dream, a struggle that "brings with it an interior torment which prevents those who face its hazards from sinking into the quiet and closed-in life in which grows the vice of egoism and attachment" (D 29).

The Spiritual Power of Matter

Another important aspect of Teilhard's spirituality is the way he integrates matter and spirit. In his view, matter and spirit are not dualistic opposites. Instead, they are so interwoven that they become almost inseparable. Matter, understood in this holistic way, becomes a matrix on which spirit can be synthesized and unified. Because of the Incarnation, matter is permeated with the divine, imbued with a spiritual power that allows it "to be penetrated and progressively transformed by unitive energy" (Cowell 113). For Teilhard, matter is "the . . . milieu . . . in which we live" (D 66). Due to the indwelling presence of the divine, matter becomes transfigured from within, bathed in an interior light. However, this way of seeing does not modify the apparent order of things. Instead it is subtle and often missed by those with a materialist bend. For those who know how to see, the world becomes transparent and Christ is there at its center (see D 92-93). A *milieu* both formidable and charming, it is a holy place, a divine *milieu*. Within the depths of matter, the divine is everywhere, especially beneath our groping efforts, synthesizing all the elements of the world and leading the entire cosmos back to God (see D 84).

Conclusion

A cosmic sense came naturally to Teilhard the paleontologist, who even as a young child had a deep love for Earth. However, his encounter with the theory of evolution enhanced his understanding of the dynamic processes at work in the cosmos and helped him to appreciate the tremendous activity that is going on continually within the expanding universe. His faith tradition, on the other hand, provided him with another set of clues that allowed him to probe the cosmos at an even deeper level, at the level of spirit. His sensitivity to cosmic processes kept him alert for new possibilities for growth and development. His synthesis of evolution and Incarnation suggests that there is something more profound happening at the heart of matter than humans had been able to observe before his time. This synthesis sheds light on the dramatic power at work within the continuing creation.

Teilhard's two-phased spirituality of immersion and emergence follows from the insights he gained from this synthesis. The Baptismal gesture, that gesture that Teilhard connects with creative union, is its apt symbol. These insights required a major shift in Teilhard's understanding of both Incarnation and evolution, as they were understood in the early twentieth century. To accomplish this shift, he needed to distill the features that are truly significant from both a belief system that had lost its vitality and its ability to inspire and from a science that had lost its ability to see beneath the surface of phenomena. He had to break through to the core of his faith and his science to bestow on them a new vitality. This is what Teilhard accomplished for himself and what he yearned to share with others. His love for the church and its potential to be a light in the darkness motivated him to continue his work even in the midst of painful rejection. His was a lived spirituality, one that has given us "a God who makes himself cosmic and an evolution which makes itself person" (AE 381).

Works Cited

Cowell, Sion. *The Teilhard Lexicon: Understanding the language, terminology and vision of the writings of Pierre Teilhard de Chardin*. Portland: Sussex Academic Press, 2001.

King, Ursula. *Towards a New Mysticism: Teilhard de Chardin and Eastern Religions*. London: Collins, 1980.

List of Abbreviations for the Works of Teilhard Cited in This Essay

AE *Activation of Energy*. (Rene Hague, Trans.) New York: Harcourt Brace Jovanovich, Inc., 1970.

CE *Christianity and Evolution*. New York: Harcourt Brace Jovanovich, Inc., 1969.

D *The Divine Milieu*. (Bernard Wall, Trans.) New York: Harper & Row, Publishers, 1960.

HP *The Human Phenomenon*. (Sarah Appleton-Weber, Trans.). Portland, OR: Sussex Academic Press, 1999.

S *Science and Christ*. (Rene Hague, Trans.) New York: Harper & Row, Publishers, 1968.

TF *Toward the Future*. (Rene Hague, Trans.) New York: Harcourt Brace Jovanovich, Inc., 1975.

W *Writings in Time of War*. (Rene Hague, Trans.) New York: Harper & Row, Publishers, 1967.

The Future of Evolution

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Analogies

First, I must apologize to the audience and to the organizers of the meeting for not talking about Teilhard de Chardin. The reason why I did not choose to talk about him is simple. Most of you certainly know more about him and his writings than I do. Most of what I know about him, I learned from listening to the other talks today. I have great respect for him, but it is a respect based on ignorance rather than on knowledge. I prefer not to display my ignorance.

I was asked to talk about the Future of Evolution. This is an enormous subject and would take a historian to do it justice. I am not a historian. I am a scientist with a smattering of knowledge about history. I prefer to talk about things I know. I shall be telling stories rather than digging deep into the sources of historical truth. I shall talk about astronomy and biology, which are easier to understand than physics. I shall use the recent history of astronomy and biology to illustrate some evolutionary themes, which may or may not be valid when extended to the future.

My approach to evolution is based on analogies between biology, astronomy and history. I begin with biology. The chief agents of biological evolution are speciation and symbiosis. In the world of biology these words have a familiar meaning. Life has evolved by a process of successive refinement and subdivision of form and function, that is to say by speciation, punctuated by a process of bringing together alien and genetically distant species into a single organism, that is to say by symbiosis. As a result of the work of Lynn Margulis and other pioneers, the formerly heretical view, that symbiosis has been the mechanism for major steps in the evolution of life, has now become orthodox. When we view the evolution of life with an ecological rather than an anatomical perspective, the importance of symbiosis relative to speciation becomes even greater.

As a physical scientist, I am struck by the fact that the borrowing of concepts from biology into astronomy is valid on two levels. One can see in the sky many analogies between astronomical and biological processes, as I shall shortly demonstrate. And one can see similar analogies between intellectual and biological processes, in the evolution and taxonomy of scientific disciplines. The evolution of the universe and the evolution of science can be described in the same language as the evolution of life.

Speciation in the Sky

In the context of astronomy, speciation occurs by the process of phase-transition. A phase-transition is an abrupt change in the physical or chemical properties of matter, usually caused by heating or cooling. Familiar examples of phase-transitions are the freezing of water, the magnetization of iron, the precipitation of snow from water vapor dissolved in air. In many of these transitions, the warmer phase is a uniform disordered mixture while the cooler phase divides itself into two separate components with a more ordered structure. Such transitions are called order-disorder transitions. The transition from warm humid air to cold dry air plus snowflakes is a typical order-disorder transition. Snowflakes are a new species, with a complex crystalline structure that was absent from the humid air out of which they arose. Also, by action of the earth's gravity, snowflakes spontaneously separate themselves from air and fall to the ground. At all stages in the evolution of the universe we see order-disorder transitions with the same two characteristic features, first the sudden appearance of structures that did not exist before, and second the physical separation of new-born structures into different regions of space.

Another name for the process of phase-transition from disorder to order is symmetry-breaking. From a mathematical point of view, a disordered phase has a higher degree of symmetry than an ordered phase. For example, the environment of a molecule of water in humid air is the same in all directions, while the environment of the same molecule after it is precipitated into a snowflake is a regular crystal with crystalline axes oriented along particular directions. The molecule sees its environment change from the greater symmetry of a sphere to the lesser symmetry of a hexagonal prism. The change in the environment from disorder to order is associated with a loss of symmetry. Sudden loss of symmetry is seen in many of the most important phase-transitions as the universe evolves.

In the earliest stages of its history, the universe was hot and dense and rapidly expanding. Matter and radiation were then totally disordered and uniformly mixed. One of the greatest of all symmetry-breakings was the separation of the universe into two phases, one phase containing most of the matter and destined to condense later into galaxies and stars, the other phase containing most of the radiation and destined to become the intergalactic void. The separation happened as soon as the universe became transparent enough, so that large lumps of matter pulled together by their own gravitation could radiate away their gravitational energy into the surrounding void. As a result of this transition, the universe lost its original spatial symmetry. Before the transition, it had the symmetry of uniform space. After the transition, it became a collection of lumps with no large-scale symmetry. The same process of symmetry-breaking was then repeated successively on smaller and smaller scales. A single lump of the first generation was a huge mass of gas, locally uniform and locally symmetrical. The local uniformity of the gas was then broken when it condensed into the second-generation lumps which we call galaxies. The gas in a local region of a galaxy cooled further until it condensed into the third-generation lumps which we call giant molecular clouds. Finally, the gas and dust in a local region of a molecular cloud condensed into the fourth-generation lumps which we call stars and planets.The universe in this way became a hierarchical assortment of lumps of various shapes and sizes. The formation of lumps was at each stage driven by gravity and assisted by phase-transitions allowing the physical separation of matter in different phases. Each separated lump was an individual member of a new species of object.

The processes of astronomical speciation did not stop after the stars and planets were formed. After the earth had condensed out of the interstellar dust, a new world of opportunities opened for separation of phases and growth of structures. First came the separation of the interior of the earth into its main components, core, mantle and crust. Next came the separation of the earth's surface into land, ocean and atmosphere. This is a continuing process, with water constantly circulating from the ocean into the atmosphere, onto the land and back to the ocean. The third process transforming the earth is the division of the crust into plates and the formation and destruction of the crust at the plate boundaries, the process known as plate tectonics. Plate tectonics is a powerful force constantly giving the earth new structures. But the fourth process creating structure and order on earth is the most powerful of all. The fourth process is life. Life appeared here between three and four billion years ago and gave the concept of speciation a new meaning.

The transition from dead to living was a phase-transition of a new type. It was a transition from disorder to order, in which the ordered phase acquired the ability to perpetuate itself after the conditions that caused it to appear had changed. There are many theories of the origin of life, and there is no direct evidence to decide which theory is true. All that we know for sure is that a complicated mixture of organic chemicals made the transition to an ordered phase that could grow and reproduce itself and feed on its surroundings. And then, after the ordered phase was once established, it possessed the flexibility to mutate and evolve into a million different species. Life has given to our planet a richness of structure that we see nowhere else in the universe. But the diversification of new forms of life on the earth is in many respects similar to the diversification of new celestial species, galaxies and dust-clouds and stars and planets, in the universe as it was before life appeared. The evolution of life fits logically into the evolution of the universe. Both in the non-living universe and on the living earth, evolution alternates between long periods of metastability and short periods of rapid change. During the periods of rapid change, old structures become unstable and divide into new structures. During the periods of metastability, the new structures are consolidated and fine-tuned while the environment to which they are adapted seems eternal. Then the environment crosses some threshold that plunges the existing structures into a new instability, and the cycle of speciation starts again.

Symbiosis

Phase-transitions are one of the two driving forces of evolution. The other is symbiosis. Symbiosis is the reattachment of two structures, after they have been detached from each other and have evolved along separate paths for a long time, so as to form a combined structure with behavior not seen in the separate components. Symbiosis played a fundamental role in the evolution of eucaryotic cells from procaryotes. The mitochondria and chloroplasts that are essential components of modern cells were once independent free-living creatures. They first invaded the ancestral eucaryotic cell from the outside and then became adapted to living inside. The symbiotic cell acquired a complexity of structure and function that neither component could have evolved separately. In this way symbiosis allows evolution to proceed in giant steps. A symbiotic creature can jump from simple to complicated structures much more rapidly than a creature evolving by the normal processes of mutation and speciation.

Symbiosis is as prevalent in the sky as it is in biology. Astronomers are accustomed to talking about symbiotic stars. The basic reason why symbiosis is important in astronomy is the double mode of action of gravitational forces. When gravity acts upon a uniform distribution of matter occupying a large volume of space, the first effect of gravity is to concentrate the matter into lumps separated by voids. The separated lumps differentiate and evolve separately. They become distinct species. But then, after a period of separate existence, gravity acts in a second way to bring lumps together and bind them into pairs. The binding into pairs is a sporadic process depending on chance encounters. It usually takes a long time for two lumps to be bound into a pair. But the universe has plenty of time. After a few billion years, a large fraction of objects of all sizes become bound in symbiotic systems, either in pairs or in clusters. Once they are bound together by gravity, dissipative processes bring them closer together. As they come closer together, they interact with one another more strongly and the effects of symbiosis become more striking.

Examples of astronomical symbiosis are to be seen wherever one looks in the sky. On the largest scale, symbiotic pairs and clusters of galaxies are common. When galaxies come into contact, their internal evolution is often profoundly modified. A common sign of symbiotic activity is an active galactic nucleus. An active nucleus is seen in the sky as an intensely bright source of light at the center of a galaxy. The probable cause of the intense light is gas falling into a black hole at the center of one galaxy as a result of gravitational perturbations by another galaxy. It happens frequently that big galaxies swallow small galaxies. Nuclei of swallowed galaxies are observed inside the swallower, like mouse-bones in the stomach of a snake. This form of symbiosis is known as galactic cannibalism.

From our human point of view, the most important example of astronomical symbiosis is the symbiosis of the earth and the sun. The whole system of sun and planets and satellites is a typical example of astronomical symbiosis. At the beginning, when the Solar System was formed, the sun and the earth were born with different chemical compositions and physical properties. The sun was made mainly of hydrogen and helium, the earth was made of heavier elements. The sun was physically simple, a sphere of gas heated by the burning of hydrogen and shining steadily for billions of years. The earth was physically complicated, partly liquid and partly solid, its surface frequently transformed by phase-transitions. The symbiosis of these two contrasting worlds made life possible. The earth provided chemical and environmental diversity for life to explore. The sun provided physical stability, a steady input of energy on which life could rely. The combination of the earth's variability with the sun's constancy provided the conditions in which life could evolve and prosper.

Tools and Concepts

The evolution of science is in many ways similar to the evolution of life and the evolution of the universe. The major events in the history of science are called scientific revolutions. There are two kinds of scientific revolutions, those driven by new concepts and those driven by new tools.These are analogous to biological revolutions driven by speciation and by symbiosis, or to astronomical revolutions driven by phase-transition and by gravitational binding. When a field of science is overturned by a new concept, the revolution starts from the inside, from an internal inconsistency or contradiction within the science, and results in a phase-transition to a new way of thinking. When a field of science is overturned by new tools, the revolution starts from the outside, from tools imported from another discipline, and results in a symbiosis of the two disciplines. In both types of revolution, the final outcome is usually a new sub discipline of science and a new species of scientist, specialized in the new ideas or in the new tools as the case may be.

Thomas Kuhn in his famous book, "The Structure of Scientific Revolutions", talked almost exclusively about concepts and hardly at all about tools. His idea of a scientific revolution is based on a single example, the revolution in theoretical physics that occurred in the 1920's with the advent of quantum mechanics. This was a prime example of a concept-driven revolution. Kuhn's book was so brilliantly written that it became an instant classic. It misled a whole generation of students and historians of science into believing that all scientific revolutions are concept-driven. The concept-driven revolu-tions are the ones that attract the most attention and have the greatest impact on the public awareness of science, but in fact they are comparatively rare. In the last five hundred years we have had five major concept-driven revolutions, associated with the names of Copernicus, Newton, Darwin, Einstein and Freud, besides the quantum-mechanical revolution that Kuhn took as his model. During the same period there have been about twenty tool-driven revolutions, not so impressive to the general public but of equal importance to the progress of science. I will not attempt to make a complete list of tool-driven revolutions. Two prime examples are the Galilean revolution resulting from the use of the telescope in astronomy, and the Crick-Watson revolution resulting from the use of X-ray diffraction to determine the structure of big molecules in biology. Galileo brought into astronomy tools borrowed from the emerging technology of eye-glasses. Crick and Watson brought into biology tools borrowed from physics. The effect of a concept-driven revolution is to explain old things in new ways. The effect of a tool-driven revolution is to discover new things that have to be explained. In astronomy there has been a preponderance of tool-driven revolutions. We have been more successful in discovering new things than in explaining old ones.

Moore's Law in Biology

Up to this point, I have been talking about evolution that has happened in the past. From this point on I will talk about evolution that may happen in the future. I will be telling stories about attempts to predict the future. I have four [three] stories to tell. [One of them is about a prediction that turned out to be right.] One is about a prediction that turned out to be wrong. The other two are about predictions that might be right and might be wrong. Most of the time, we cannot tell what is going to happen. The moral of the stories is, life is a game of chance, and science like life. Most of the time, science too cannot tell what is going to happen.

[My first story is about a prediction made by somebody else, not by me. The prediction is called Moore's Law and was made by Gordon Moore, the founder of the Intel Corporation, forty years ago. Of all the tools created by twentieth-century technology, the most spectacularly successful is the integrated circuit, a little chip of silicon with a fabulous array of electronic circuits etched into its surface. It was the integrated circuit that made the domestication of computers possible. For forty years the performance of integrated circuits has improved with time according to Moore's Law. Moore's Law says that their speed doubles every eighteen months, or increases by a factor of a hundred every decade, without much increase in cost. Computers today can do about a hundred million times as many operations per second as they could when Moore announced his law forty years ago, while the cost of a computer has remained roughly constant. Moore's Law is a spectacular example of a successful prediction. It is one of the rare cases in which a prediction running more than twenty years into the future turned out to be accurate.]

[I am proposing now to hijack Moore's prediction and apply it to biology. Moore's Law is sometimes true for biology. Consider for example one of the central tools of biology, the sequencing of DNA. Fred Sanger sequenced the first complete virus genome with five thousand base-pairs in 1977, and the human genome with three billion base-pairs was sequenced twenty-five years later. Theoutput of base-pairs followed Moore's Law, but the cost of sequencing did not. The human genome cost a great deal more than the virus genome. The sequencing machines that now exist are marvels of ingenuity, but they are cumbersome and expensive. They handle DNA molecules in bulk, using the methods of wet chemistry. The chemical reagents cost as much as the machines. What biologynow needs is a single-molecule sequencer that can handle one molecule at a time and sequence it by physical rather than chemical methods. A single-molecule machine could be much cheaper as well as faster than existing machines. It might be as small and convenient as a lap-top computer, zipping along a molecule of DNA as quickly as a polymerase enzyme, reading out base-pairs into computer memory at a rate of a thousand per second. At that speed, a single machine could read out a complete human genome in a month. I now venture to make another prediction. With plenty of hard work and a little luck, we shall evolve single-molecule sequencers that extend Moore's Law into the future, increasing thespeed of sequencing and decreasing the unit cost by a factor of a hundred every decade. If this prediction turns out to be as accurate as the original Moore's Law, we shall have in thirty years a portable sequencer that costs a few hundred dollars and sits on an office desk next to the personal computer and the printer and the DNA synthesizer.]

[What will this mean for biology? Up to now we have sequenced genomes of about a hundred species, most of them microbes, with a total of about ten billion base-pairs. The biosphere of our planet contains about ten million species, and their genomes contain altogether about ten quadrillion base-pairs. If Moore's Law remains valid for sequencing DNA, we can sequence the entire biosphere in about thirty years, at a cost not much greater than the cost of the human genome. In the language of computer science, the genomes of all the species on Earth add up to a few petabytes of data. This would be a data-base comparable in size with other data-bases that already exist. It would be about as big as the information contained in all books in all languages. Perhaps it is a coincidence, or perhaps it is evidence of some deeper connection, that the sum total of our cultural heritage stored in literature is about equal to the sum total of our biological heritage stored in genomes. We already know how to store and search electronic data-bases of this size. But before the genomes can be sequenced, the biosphere must be explored and the species identified. The biosphere genome project will bring us to the beginning of a deep understanding of the biosphere, just as the human genome project has brought us to the beginning of a deep understanding of human biology. The sequencing of ten million species will be a good beginning, both for the understanding and for the preservation of the biosphere. If we understand what is there, we shall have a better chance of preserving it.]

The Domestication of Biotechnology

My second [first] story is about the domestication of biotechnology. I am serving on a committee of the National Academy of Sciences with the ponderous name, "Committee on Advances in Technology and the Prevention of their Application to Next Generation Biowarfare Threats". We discuss with all due seriousness the doomsday scenarios that biological weapons and other abuses of biotechnology may bring about. The following remarks are taken from a paper that I wrote for the committee, to lighten the tone of our discussions. I am not expecting the committee to agree with it, and I am not expecting it to appear as part of our official report.

Fifty years ago in Princeton, I watched the mathematician John von Neumann designing and building the first electronic computer that operated with instructions coded into the machine. Von Neumann did not invent the electronic computer. The computer called ENIAC had been running at the University of Pennsylvania five years earlier. What von Neumann invented was software, the coded instructions that gave the computer agility and flexibility. It was the combination of electronic hardware with punch-card software that allowed a single machine to predict weather, to simulate the evolution of populations of living creatures, and to test the feasibility of hydrogen bombs. Von Neumann understood that his invention would change the world. He understood that the descendants of his machine would dominate the operations of science and business and government. But he imagined computers always remaining large and expensive. He imagined them as centralized facilities serving large research laboratories or large industries. He failed to foresee computers growing small enough and cheap enough to be used by housewives for doing income-tax returns or by kids for doing homework. He failed to foresee the final domestication of computers as toys for three-year-olds. He totally failed to foresee the emergence of computer-games as a dominant feature of twenty-first-century life. Because of computer-games, our grandchildren are now growing up with an indelible addiction to computers. For better or for worse, in sickness or in health, till death do us part, humans and computers are now joined together more durably than husbands and wives.

What has this story of von Neumann's computer and the evolution ofcomputer-games to do with biotechnology? Simply this, that there is a close analogy between von Neumann's vision of computers as large centralized facilities and the public perception of genetic engineering today as an activity of large pharmaceutical and agribusiness corporations such as Monsanto. The public distrusts Monsanto because Monsanto likes to put genes for poisonouspesticides into food-crops, just as we distrusted von Neumann because von Neumann liked to use his computer for designing hydrogen bombs. It is likely that genetic engineering will remain unpopular and controversial so long as it remains a centralized activity in the hands of large corporations.

I see a bright future for the biotechnical industry when it follows the path of the computer industry, the path that von Neumann failed to foresee, becoming small and domesticated rather than big and centralized. The first step in this direction was already taken recently, when genetically modified tropical fish with new and brilliant colors appeared in pet-stores. For biotechnology tobecome domesticated, the next step is to become user-friendly. I recently spent a happy day at the Philadelphia Flower Show, the biggest flower show in the world, where flower-breeders from all over the world show off the results of their efforts. I have also visited the Reptile Show in San Diego, an equally impressive show displaying the work of another set of breeders. Philadelphiaexcels in orchids and roses, San Diego excels in lizards and snakes. The main problem for a grandparent visiting the reptile show with a grandchild is to get the grandchild out of the building without actually buying a snake. Every orchid or rose or lizard or snake is the work of a dedicated and skilled breeder. There are thousands of people, amateurs and professionals, who devote their lives to this business. Now imagine what will happen when the tools of genetic engineering become accessible to these people. There will be do-it-yourself kits for gardeners who will use genetic engineering to breed new varieties of roses and orchids. Also kits for lovers of pigeons and parrots and lizards and snakes, to breed new varieties of pets. Breeders of dogs and cats will have their kits too.

Genetic engineering, once it gets into the hands of housewives and children, will give us an explosion of diversity of new living creatures, rather than the monoculture crops that the big corporations prefer. New lineages will proliferate to replace those that monoculture farming and industrial development have destroyed. Designing genomes will be a personal thing, a new art-form as creative as painting or sculpture. Few of the new creations will be masterpieces, but all will bring joy to their creators and variety to our fauna and flora.

The final step in the domestication of biotechnology will be biotech games, designed like computer games for children down to kindergarten age, but played with real eggs and seeds rather than with images on a screen. Playing such games, kids will acquire an intimate feeling for the organisms that they are growing. The winner could be the kid whose seed grows the prickliest cactus, orthe kid whose egg hatches the cutest dinosaur. These games will be messy and possibly dangerous. Rules and regulations will be needed to make sure that our kids do not endanger themselves and others.

If domestication of biotechnology is the wave of the future, fiveimportant questions need to be answered. First, can it be stopped? Second, ought it to be stopped? Third, if stopping it is either impossible or undesirable, what are the appropriate limits that our society must impose on it? Fourth, how should the limits be decided? Fifth, how should the limits be enforced, nationally and internationally? In considering each of these questions, it would be helpful to keep in mind the analogy between computer technology and biotechnology. The majority of people using domesticatedbiotechnol ogy to cause trouble will probably be small fry, like the young computer hackers who spread computer viruses around on the internet. Young people possessing bio-hacker skills may also be helpful in tracing and reporting any larger-scale illegitimate activities to national or international authorities. In the long run, as biotechnology spreads over the world, our best chance of avoiding large-scale bioterrorism will be to share the benefits ofbiotechnology as widely and as openly as possible.

That is the end of my input to the biowarfare committee. As you see, it raises more questions than it answers. And it all depends on predictions. I am predicting right and left, using the future tense with great freedom. I tell my story as if it were true. I leave it to you to decide how much of it you want to believe.

The Darwinian Interlude

My third [second] story was suggested by Carl Woese, the world's greatest expert in the field of microbial taxonomy. He explored the ancestry of microbes by tracing the similarities and differences between their genomes. He discovered the large-scale structure of the tree of life, with all living creatures descended from three primordial branches. He recently published a provocative and illu-minating article with the title, "A New Biology for a New Century". It appeared in the June 2004 issue of Microbiology and Molecular Biology Reviews. His main theme is the obsolescence of reductionist biology as it has been practiced for the last hundred years, and the need for a new synthetic biology based on communities and eco-systems rather than on genes andmolecules. Aside from his main theme, he raises another profoundly important question: When did Darwinian evolution begin? By Darwinian evolution he means evolution as Darwin understood it, based on the competition for survival of non-interbreeding species. He presents evidence that Darwinian evolution did not go back to the beginning of life. The comparison of genomes of ancientlineages of living creatures shows evidence of massive transfers of genetic information from one lineage to another. In early times, the process that he calls Horizontal Gene Transfer, the sharing of genes between unrelated species, was prevalent. It becomes more prevalent, the further back you go in time.

Whatever Carl Woese writes, even in a speculative vein, needs to be taken seriously. In his "New Biology" article, he is postulating a golden age of pre-Darwinian life, when horizontal gene transfer was universal and separate species did not exist. Life was then a community of cells of various kinds, sharing their genetic information so that clever chemical tricks and catalytic processes invented by one creature could be inherited by all of them. Evolution was a communal affair, the whole community advancing in metabolic and reproductive efficiency as the genes of the most efficient cells were shared. Evolution could be rapid, as new chemical devices could be evolved simultaneously by cells of different kinds working in parallel and then reassembled in a single cell by horizontal gene transfer. But then, one evil day, a cell resembling a primitive bacterium happened to find itself one jump ahead of its neighbors in efficiency. That cell, anticipating Bill Gates by three billion years, separated itself from the community and refused to share. Its offspring became the first species, reserving its intellectual property for its own private use. With its superior efficiency it continued to prosper and to evolve separately, while the rest of the community continued its communal life. Some millions of years later, another cell separated itself from the community and became another species. And so it went on, until nothing was left of the community and all life was divided into species. The Darwinian interlude had begun.

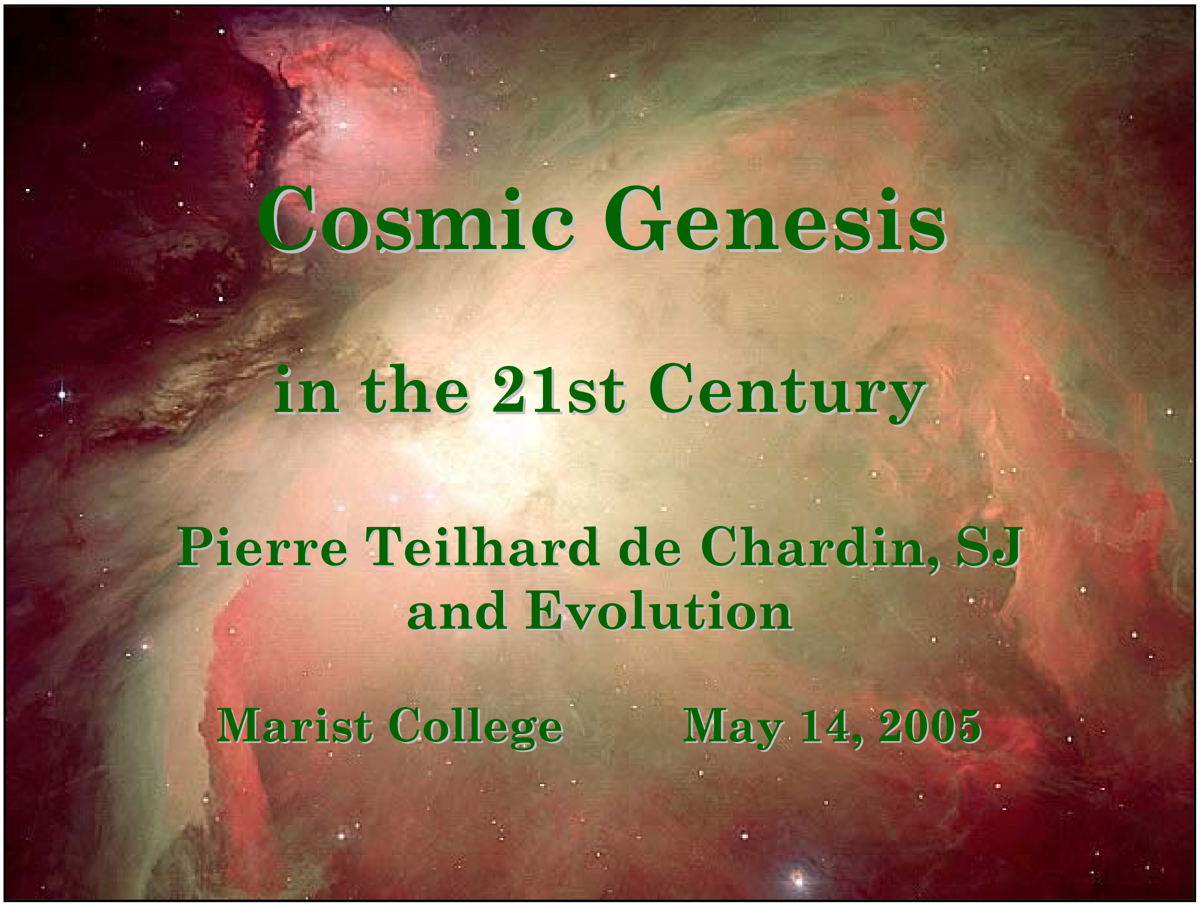
The Darwinian interlude has lasted for two or three billion years. It probably slowed down the pace of evolution considerably. The basic biochemical machinery of life had evolved rapidly during the few hundreds of millions of years of the pre-Darwinian era, and changed very little in the next two billion years of microbial evolution. Darwinian evolution is slow because individual species once established evolve very little. Darwinian evolution requires established species to die and become extinct so that new species can replace them. Three innovations helped to speed up the pace of evolution in the later stages of the Darwinian interlude. The first was sex, which is a form ofhorizontal gene transfer restricted to operating within species. The second innovation was multicellular organi-zation, which opened up a whole new world of form and function. The third was brains, which opened another new world of coordinated sensation and action, culminating in the evolution of eyes and hands. All through the Darwinian interlude, occasional mass extinctions due to volcanic outbursts or asteroid impacts helped to open opportunities for new evolutionary ventures.

Now, after three billion years, the Darwinian interlude is over. It was an interlude between two periods of horizontal gene transfer. The epoch of Darwinian evolution based on competition between species ended about ten thousand years ago when a single species, Homo Sapiens, began to dominate and reorganize the biosphere. Since that time, cultural evolution has replaced biological evolution as the main driving force of change. Cultural evolution is not Darwinian. Cultures spread by horizontal transfer of ideas more than by genetic inheritance. Cultural evolution is running a thousand times faster than Darwinian evolution, taking us into a new era of cultural interdependence which we call globalization. And now, in the last thirty years, Homo Sapiens has revived the ancient pre-Darwinian practice of horizontal gene transfer, moving genes easily from microbes to plants and animals, blurring the boundaries between species. We are moving rapidly into the post-Darwinian era, when species will no longer exist, and the evolution of life will again be communal. That is the end of my third [second] story.

Bad Advice to a Young Scientist

My last story is about a prediction that I made almost sixty years ago, when I was young and arrogant. It is an extreme example of wrongness, perhaps a world record in the category of wrong predictions. The story is about Francis Crick, the great biologist who died a few months ago after a long and brilliant career. He discovered, with Jim Watson, the double helix. They discovered the double helix structure of DNA in 1953, and thereby gave birth to the new science of molecular genetics. Eight years before that, in 1945, before World War 2 came to an end, I met Francis Crick for the first time. He was in Fanum House, a dismal office building in London where the Royal Navy kept a staff of scientists. Crick had been working for the Royal Navy for a long time and was depressed and discouraged. He said he had missed his chance of ever amounting to anything as a scientist. Before World War 2, he had started a promising career as a physicist. But then the war hit him at the worst time, putting a stop to his work in physics and keeping him away from science for six years. The six best years of his life, squandered on naval intelligence, lost and gone forever. Crick was good at naval intelligence, and did important work for the navy. But military intelligence bears the same relation to intelligence as military music bears to music. After six years doing this kind of intelligence, it was far too late for Crick to start all over again as a student and relearn all the stuff he had forgotten. No wonder he was depressed. I came away from Fanum House thinking, "How sad. Such a bright chap. If it hadn't been for the war, he would probably have been quite a good scientist."

A year later, I met Crick again. The war was over and he was much more cheerful. He said he was thinking of giving up physics and making a completely fresh start as a biologist. He said the most exciting science for the next twenty years would be in biology and not in physics. I was then twenty-two years old and very sure of myself. I said, "No, you're wrong. In the long run biology will be more exciting, but not yet. The next twenty years will stillbelong to physics. If you switch to biology now, you will be too old to do the exciting stuff when biology finally takes off." Fortunately, he didn't listen to me. He went to Cambridge and began thinking about DNA. It took him only seven years to prove me wrong. The moral of this story is clear. Even a smart twenty-two-year-old is not a reliable guide to the future of science. And the twenty-two-year-old has become even less reliable now that he is eighty.

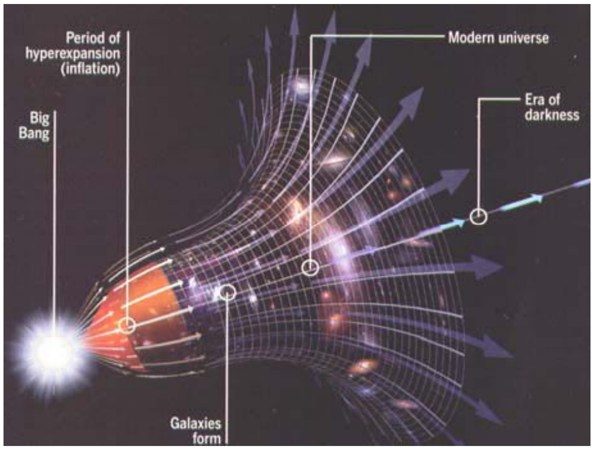


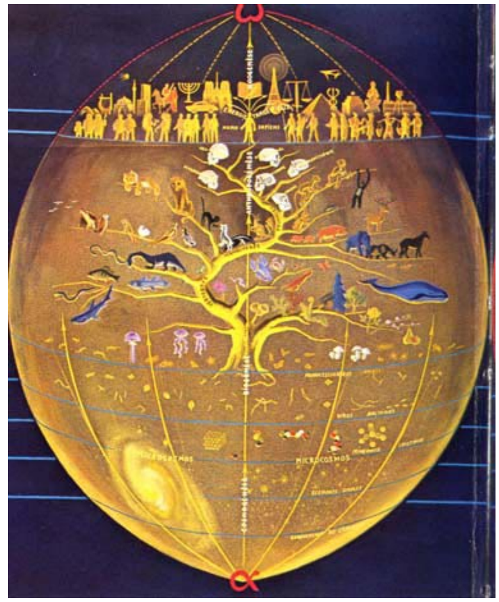
Cosmic Genesis in the 21st Century

Arthur Fabel

- 2005: In Between an Old and New Universe
- An Introduction to Teilhard's Genesis Vision
- The Perspective of a Worldwide Knowledge
- An Organically Developing Universe
- New Theories of an Emergent Evolution
- The Sciences of Universal Complex Systems
- A Cosmic Copernican Revolution?

2005
A Tale of Two Universes





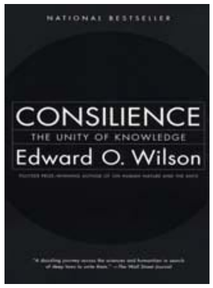
Accelerating Expansion **Convergent Genesis**

As the outline notes, this presentation will introduce and survey a new scientific conception of a genesis universe just coming together that accords well with Teilhard's prescient vision. By its holistic scope, an emergent evolutionary advance of complexity and consciousness oriented toward its human phase becomes evident.

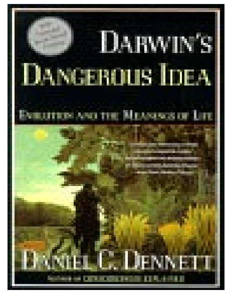
In this regard, we seem to be in the midst of a Copernican revolution of cosmic proportions. The 20th century version finds an indifferent universe flying apart at an increasing rate. Planets with sentient life may flicker into existence but they are an accidental tangent, fated to perish without notice. Organisms evolve but without direction or drive.

But a novel Teilhardian alternative is lately gaining credibility. Rather than random happenstance, life and intelligence arise and flourish because the universe is inherently organic in kind. In this view, reflective human beings are an intended phenomenon who can recognize and participate in a convergent cosmos growing in vitality, knowledge and spiritual selfhood.

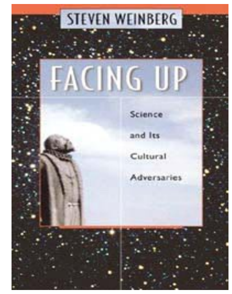
A Current Mechanical, Materialist Pessimism



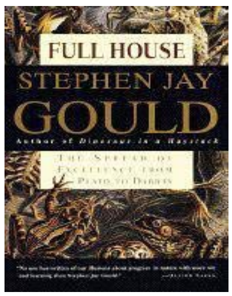
…the universe was not made with human beings in mind.



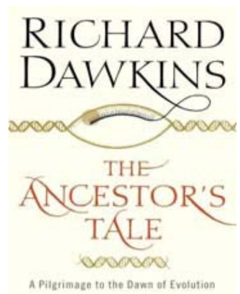
Natural selection is the only formative force at work



A comprehensible but pointless universe



People are unintended and not to appear again



A happenstance evolution without design or purpose

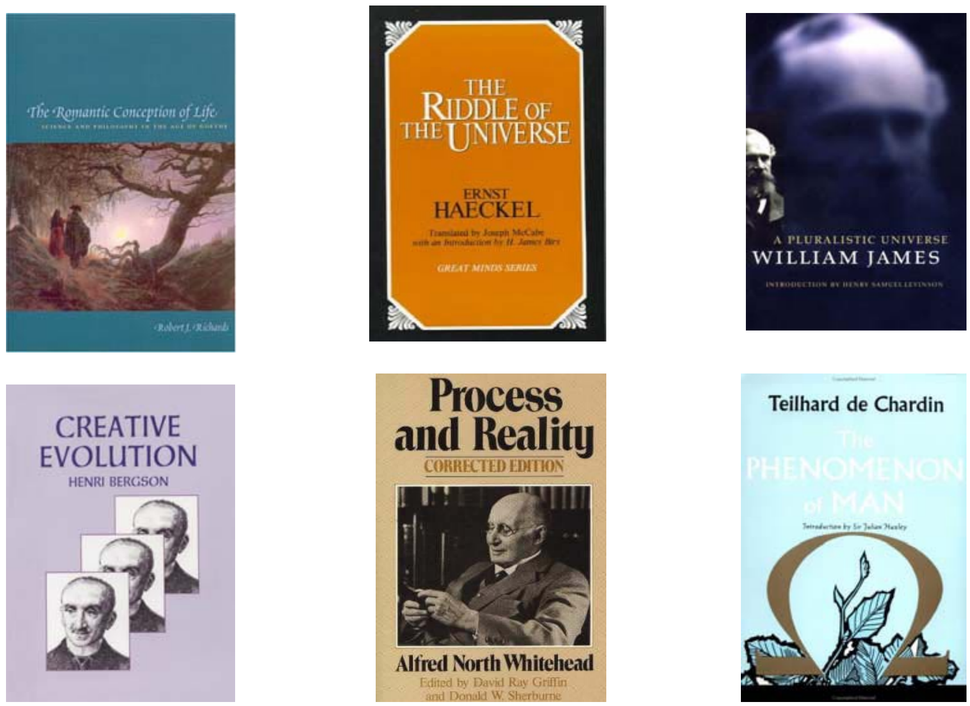
The Earth Machine 2004

Yet the old model is established in the popular press. *The Ancestor's Tale* says it is by "conceit of hindsight" that people think they are evolution's goal. Nobel laureate Steven Weinberg famously claims that we need "face up" to a meaningless cosmos. Even the American Museum of Natural History has chiseled into its wall that evolution has no preferred path or intent.

Philosopher Daniel Dennett (1995 above) argues that the "acid" of Darwinian selection will corrode any sense of value and hope. But his 2002 *Freedom Evolves* (not shown) is about an increase in intentional sentience. We note that when such opposite views are in contention, a major conceptual or paradigm shift is often about to take place.

The renowned conservationist E. O. Wilson proposes a consilient unity of science by a reduction to chemistry and physics, which then loses life along the way. And surely the living biosphere is not a "machine."

The Natural Philosophy Tradition



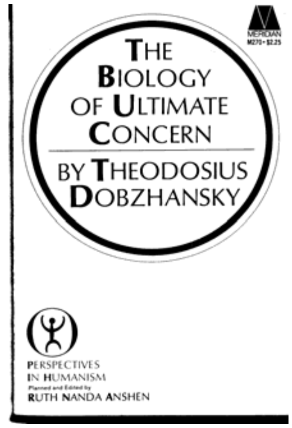
An Evolutionary Genesis of Life, Mind, Selves and Spirit

The materialist, mechanical, almost Ptolemaic scheme where life is an anomaly can appear as an exception to a long alternative tradition to which Teilhard belongs. From Romantic sensibilities before Charles Darwin (*The Romantic View of Life* by Robert Richards above) to the earlier 20th century, nature was viewed as spontaneously animate, a creative, embryonic gestation. A good example is Alfred North Whitehead (1861-1947) whose process philosophy of a biologically developing cosmos is often aligned with Teilhard's. In this talk, we will try to situate a 21st century realization of such a genesis universe in its necessary historical context.

In the 1960's and 70's, Teilhard's vision was endorsed by two world class scientists, as per the next two slides. Theodosius Dobzhansky, a co-founder of the modern evolutionary synthesis, disagreed with its aimless life course and wrote that an awakening advance could just as readily be seen. Joseph Needham went on to locate Teilhard within the venerable natural philosophy we have noted, which then converges with ancient Chinese wisdom.

Theodosius Dobzhansky

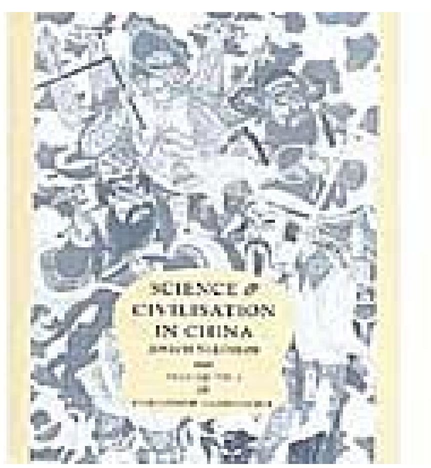
American Teilhard Association President, 1970



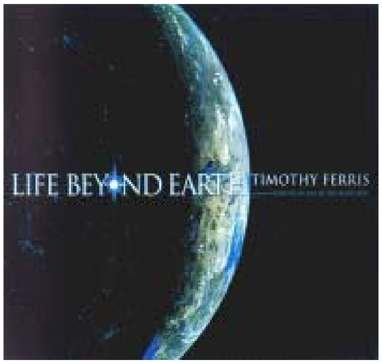
The premier geneticist and evolutionary biologist endorsed Teilhard's vision of a progressive emergence of life, mind, and morality which proceeds as a developing, oriented embryogenesis.

Joseph Needham Biochemist, historian, author

President of the British Teilhard Association



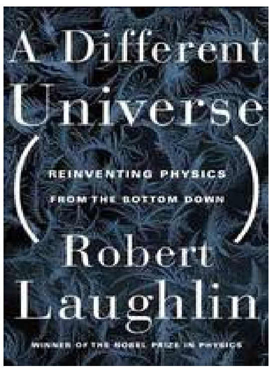
Teilhard is a brilliant and unorthodox Jesuit who is the latest advocate of an organic naturalism whose roots go back to ancient China.



Timothy Ferris. *Life Beyond Earth.*
Simon & Schuster, 2000

Is intelligent life merely an accident? Popular accounts of science often say so, claiming that life and intelligence are trivial…a cosmic afterthought.

But there's a new vision on the horizon, one that sees intelligence as an emergent property, apt to appear on any planet that has a sufficiently complex biological system.



Robert Laughlin. *A Different Universe.*
Basic Books, 2005

I *think a good case can be made that science has now moved from an Age of Reductionism to an Age of Emergence, a time when the search for ultimate causes of things shifts from the behavior of parts to the behavior of the collective.*

These recent works are examples of a radical rethinking underway. Science writer Timothy Ferris contrasts a sterile, expiring cosmos with one that grows richer in life and mind. Freeman Dyson, who has long been an eloquent advocate of this view, is given the last word in its affirmation.

A book just published by Nobel laureate Robert Laughlin makes a significant break with an older physics which reduces everything to particles and strings. In its stead, a new emergent universe is described which is knowable more from what and whom it is organizing itself into than bottom level theories.

A Cosmic Copernican Revolution?

Property	20th Century Paradigm	21st Century Vista
Universe Model	Material Machine	Organic Genesis
Perspective	Down in Matter, Back in Time	Teleological Development
Reference	One Theory of Everything	Creative Systems Everywhere
Method	Particulate Reduction	Integral Synthesis
Cosmic Fate	Expand and Expire	Quickening Life and Mind
Mind in Matter	Spurious, Secondary	Primary, Ascendant
Evolution Drive	Vicarious Selection	Emergent Self-Organization
Evolution Axis	None – Branching Bush	Nested Cells to Societies
Human Persons	Insignificant Interlopers	Phenomenal Participants

Environmental Ethics and the Question of Cosmic Purpose

(Fall 1994) We cannot have a living earth in a dead universe.

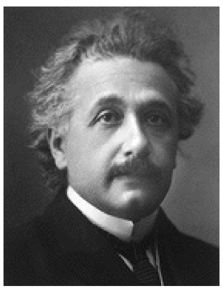
At this point it is helpful to tabulate the opposite conceptions of a mechanical or a biological reality. Of course, Thomas Berry has been saying this for years – we are suspended in between old and new cosmologies and stories. These polar options are much conflated today and unless sorted out deep confusions will remain over the meanings and conduct of science, evolution, religion and the consequent societies.

A 1994 paper of mine in *Environmental Ethics* argued that the reigning moribund model will ultimately undercut our efforts to attain a humane, sustainable earth. Some ten years on, a life and human friendly cosmic creation seems to be gaining sufficient evidence and understanding for a case to be made.

World Year of Physics

January 2005 Lead Article

Earth is an insignificant speck in a vast and overwhelmingly hostile universe. There is nothing to suggest that human beings have a special role to play in this universe.



These spiritual scientists of the earlier 20th century had a quite opposite conviction.

However can this dichotomy be resolved?

March 14, 1879 – April 18, 1955

May 1, 1881 – April 10, 1955

The dichotomy is apparent in this World Year of Physics to celebrate the 100th anniversary of the publication of Albert Einstein's three papers on quantum and relativity theory that revolutionized science. An inaugural article in the above journal states that the universe found by physical reduction is indeed without design or purpose.

These towering intellects of the 20th century had much in common, and passed away within a week of each other. Einstein and Teilhard would quite disagree with this conclusion. Each in their way were convinced of a comprehensible, significant nature (*God does not play dice.* AE) wherein earthly human life has a valuable place and role. But how might a resolution be found? Such will be our next proposal.

Fittingly, among our speakers today, geologist Fr. James Skehan met Teilhard on several occasions and physicist Freeman Dyson worked with Einstein at Princeton in the early 1950's.

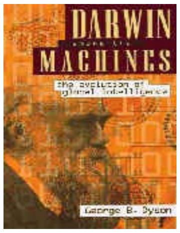
The Formation of a Noosphere 1947 - 2005

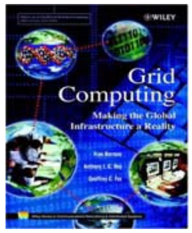
A Learning Planet at its Threshold of a Collective Knowledge

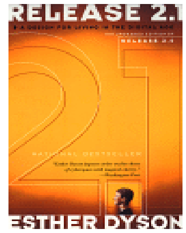
"The significant problems we face cannot be solved at the same level of thinking we were at when we created them." **Albert Einstein**

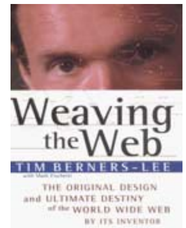
In the 1947 article noted above, published in *The Future of Man,* an evolutionary sequence of nested spheres of intricacy and sentience implied to Teilhard a further stage of planetary dimension. Out of the viable biosphere would arise, due to the compression and merging of human persons by its finite surface, a realm of mind and reason, the noosphere. Today such a super-organic phase seems in full manifestation through our global civilization. These panoramic views of earth show the intensity of evening illumination.

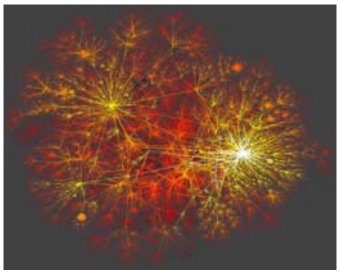
A salient component is the worldwide computer network and its billions of interlinked websites. Many observers find strong parallels with a human brain, as the next slide records. But a step not taken is to imagine that a cerebral humankind could be attaining its own knowledge. This composite perspective could join the myriad and often competing scientific theories and findings into a single scenario which can reveal an organically developing genesis not apparent otherwise.



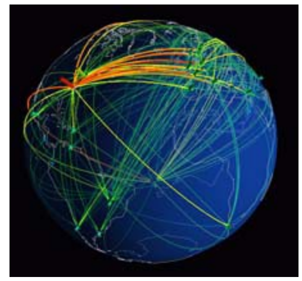


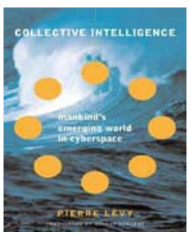


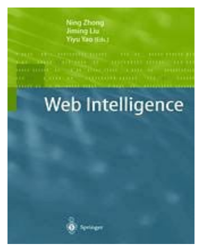




A Worldwide Intelligence arises from interconnected networks that take on a brain-like capability.

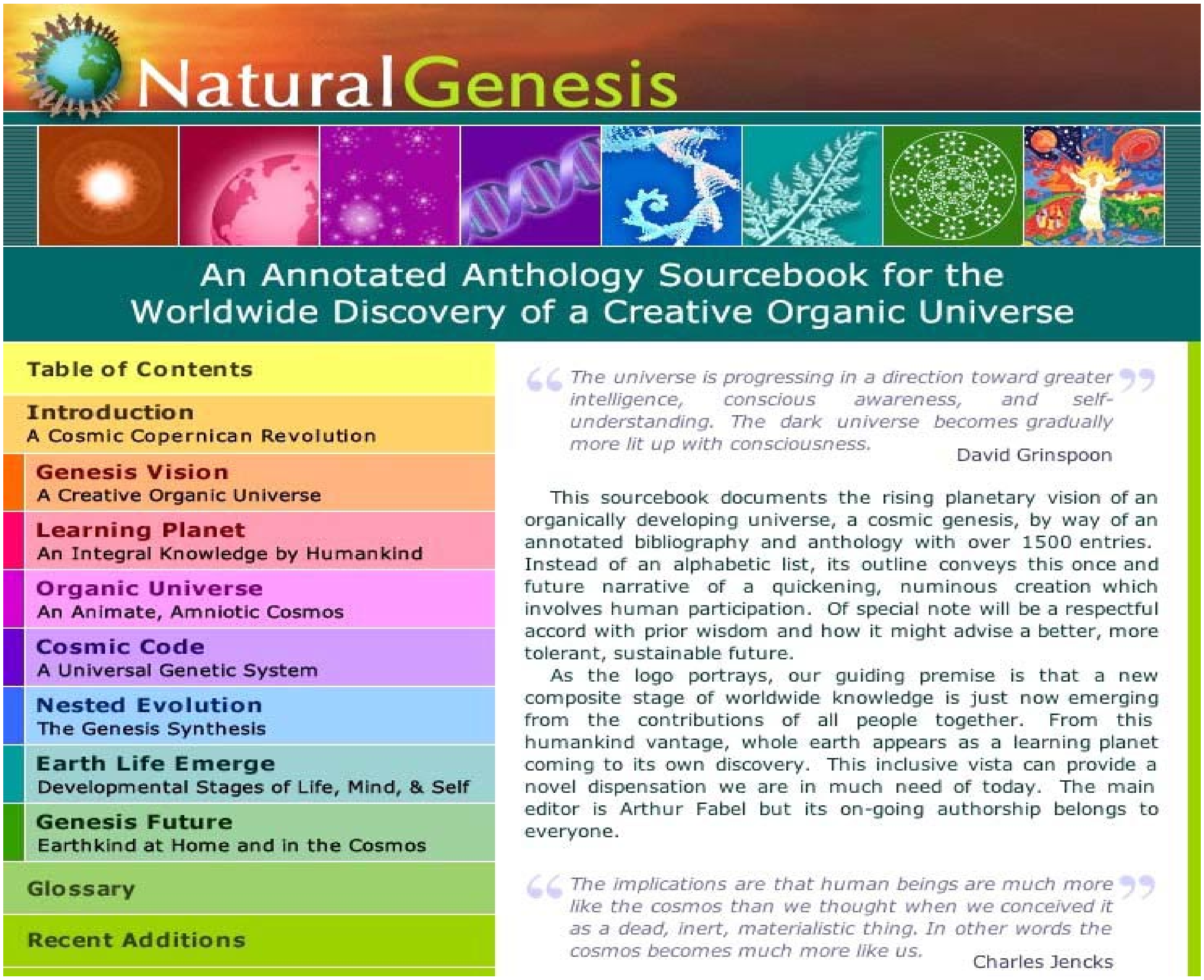






A huge endeavor and industry is now exploring and implementing every capacity of this worldwide envelope of electronic interconnections, as these works illustrate. Grid Computing, Web or Collective Intelligence, Global Brain, Semantic Web, Wireless Broadband, and so on, are some of its attributes. Of great interest is that the same neural scale-free architecture and layered networks that grace a human brain are reproduced for this planetary sphere.

This approach will form a basis for the rest of the paper. By its holistic, inclusive scope we will consider the frontiers of a biological cosmology, a quickening evolution distinguished by the rise of intelligence and wisdom, some vital historic roots and its real relevance for a kinder, gentler future.



As one contribution, a sourcebook website has been posted by me with the title of Natural Genesis: **www.naturalgenesis.net.** With over 1500 annotated references, many with quotations, it offers resources from Quantum Cosmology to Complementary Civilizations in support of a organic universe of which human beings are a central phenomenon. The title phrase is chosen to bridge two worldviews now at odds. Until circa 1875, schools of natural philosophy and natural law, rooted in scripture, prevailed. As Darwinism grew in influence, a capricious evolution by natural selection took hold. Natural genesis implies a 21st century vista of a biological cosmos which develops in animate intricacy and personification.

The summary table of contents on the home page above contains 55 subsections. A Cosmic Code presents a range, depth and consensus for the new sciences of creative complexity. Similarly, Nested Evolution reports on many advances, which when gathered within a noosphere perspective, describe not a random drift but a directional rise of intelligence and community.

III. Organic Universe: An Animate, Amniotic Cosmos
B. An Organic Cosmos

The Great Nebula in Orion is an immense, nearby starbirth region. It is here seen through ultraviolet and blue filters augmented with three exact colors specifically emitted by hydrogen, oxygen, and sulfur. In addition to housing a bright open cluster of stars known as the Trapezium, the Orion Nebula contains many stellar nurseries. It spans about 40 light years and is located about 1500 light years away in the same spiral arm of our Galaxy as the Sun.

A continuous thread seems to link together the events of the history of the Universe, from the Big Bang to the advent of Homo sapiens. The striking continuity of the general pattern of evolution suggests that the Universe was pregnant with life since beginning, and the biosphere was right from the start pregnant of mankind. Francesco Gaeta

The natural earthly realm, which became separated from a physical basis in the 19th century, has lately regained roots in a cosmic substrate increasing seen as biological in kind. At the start of the 21st century a sequential continuity is now filled in from a singular point of origin to humankind's worldwide sentience. This is an epochal but largely unrecognized achievement. These composite advances now reveal and substantiate a spontaneously life-friendly universe.

Cosmic Evolution. ***www.tufts.edu/as/wright_center/cosmic_evolution***. A panoramic and informative website created by astrophysicist Eric Chaisson and hosted by Tufts University Wright Center for Science Education which graphically tracks through seven stages the flight of the cosmological arrow of life and planetary culture.

This slide depicts a typical introduction to a topical section. Over 300 entries are included in Part III amongst eight sections: Quantum Cosmology, An Organic Cosmos (above), An Informational Source, Intelligence and Consciousness, A Thermodynamics of Life, Fractal Spacetime, The Anthropic Principle and Astrobiology. Each contain an introduction along with journal, book and website citations. Altogether they convey the growing scientific verification and credibility of a different universe which by its own nature creates life, cognition and selfhood wherever possible.

1. Evolution of the Cosmos
2. The Prebiotic Earth
3. The Early Evolution of Life
4. Evolution of Advanced Life
5. The Future

NASA Ames Research Center Website

Here we include an evolutionary panorama from cosmic origins to human and technological phases. It is available is more detail at the NASA educational site:

http://cmex-www.arc.nasa.gov/VikingCD/Puzzle/Evolife.htm.

Entitled "The Origin and Evolution of Life: A Product of Cosmic, Planetary, and Biological Processes," it presents the standard museum version. But there is little imagination of anything intentional going on, the question is not asked. A real need exists for graphical, artistic images of a spontaneous cosmic gestation as it develops into life, consciousness and persons in community on fertile bioplanets. A central issue is how does life evolve, which is in the midst of an historic revision, our next topic.

Modern Evolutionary Synthesis
(1950's – present)

+

=

Descent with Modification

Blind Variation and Selective Retention

Charles Darwin — **natural selection**

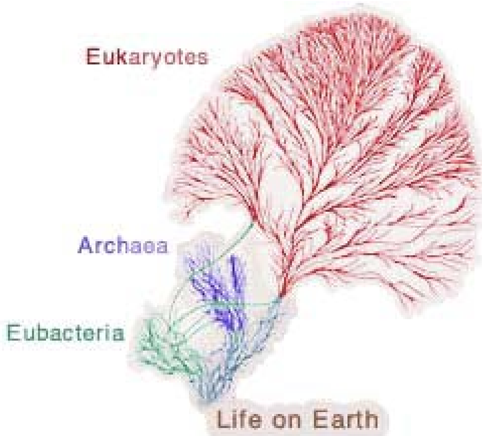
Gregor Mendel — **gene mutations**

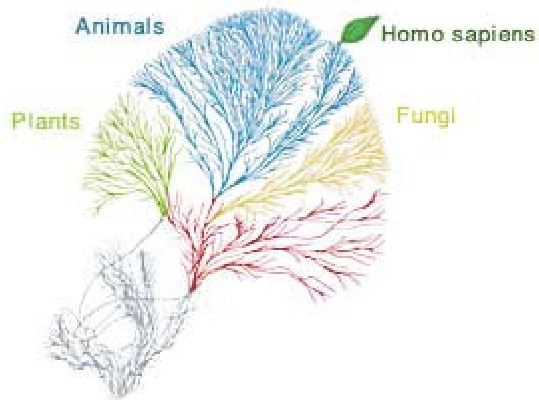
- **No other generative agency or oriented direction**
- **A religion (Creation) vs. evolution standoff**
- **Neither Darwin or Mendel would approve**

In the mid 20th century, a genetic basis for the kind and form of organisms was joined with natural selection to create the Modern Synthesis, aka Neo-Darwinism. But this led to a narrow, incomplete version that persists today. In its compass, anatomical change arises from random mutations within a population (trilobites, tarsiers) which are then selected by the relative environment (predators, climate). This surely occurs but scientists are now learning that much more is going on.

But this vested evolutionary model sparks a fierce debate. Religious fundamentalists, under the banner of Creationism or Intelligent Design, contend that evolution did not happen or that the theory is so flawed and should not be taught in schools. Polls show the majority of Americans feel this way. On the other hand, defenders of evolution rightly say it is founded on millions of observations and experiments, subject to peer review. But they often make unwarranted claims (Richard Dawkins, et al) that it is devoid of any value or purpose, and it is more this aspect that is unacceptable to believers. A 21st century cosmic genesis as seen by humankind could offer a salutary resolve.

The Evolutionary Tree of Life



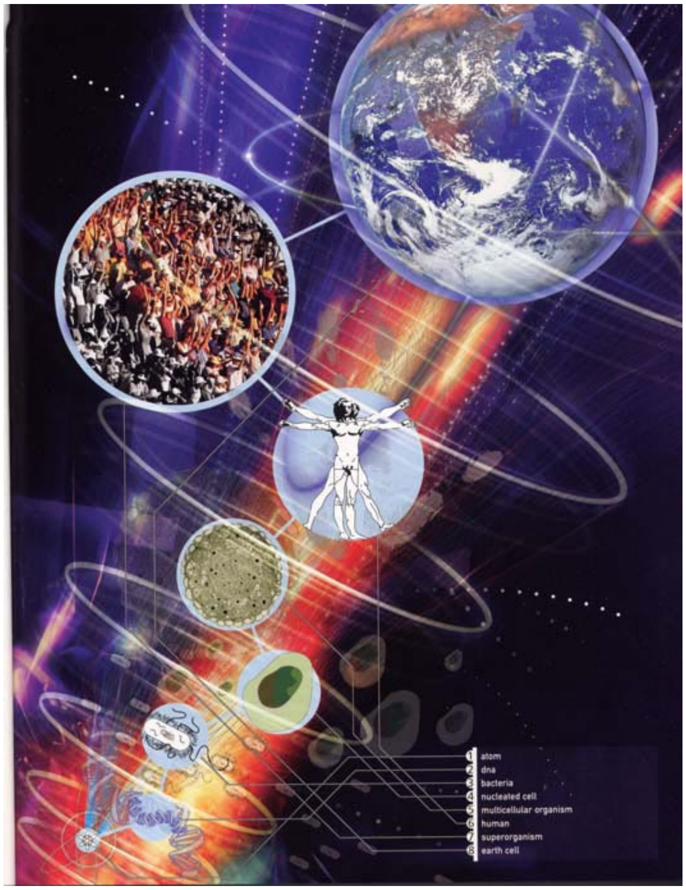


TREE OF LIFE PROJECT **Genes and Taxons (Species)**

An example of current evolutionary theory is an effort to characterize every creature from bacteria to vertebrates to humans in a branching relation traced back to a "last common ancestor." This approach known as Systematics largely bases its studies on genes and species alone. A website called the Tree of Life Project, www.tol.org, serves to collect and communicate the project.

But what kind of tree – a willowy maple or a conical fir? To only look at DNA and taxons excludes what is really going on such as a vectorial increase in brain complexity and capacity. By its limited analysis, homo sapiens appears as one more arbitrary twig, which is anathema to religious convictions.

Teilhard conceived an "orthogenesis," an evolution which by its inner essence and energy converges toward enhanced cerebral and personal qualities. He surely recognized a tree of life but with a central trunk or axis of "complexification and cerebralization." Although a founder of the modern synthesis, it is this view that Theodosius Dobzhansky preferred.



A Nested Emergence

Sentient Earth

Superorganism

Human Persons

Multicellular Organism

Nucleated Cell

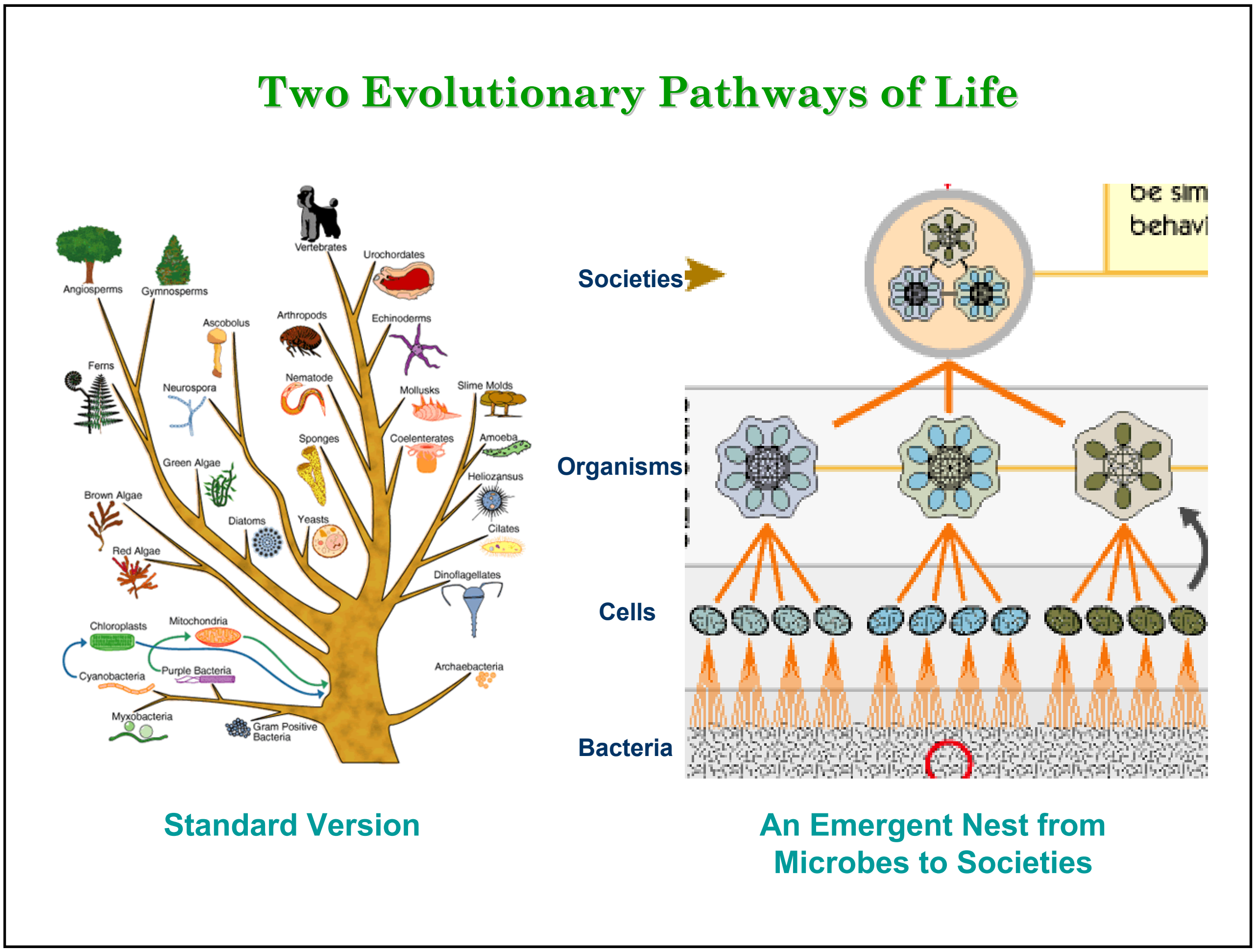
Bacteria

DNA Genetic Code

Atom

But is the tree metaphor appropriate? Teilhard wrote in ***Man's Place in Nature***: *I shall try to show how it is possible, if we look at things from a sufficiently elevated position, to see the confusions of detail in which we think we are lose, merge into one vast organic, guided, operation in which each one of us finds a place.* By this vista a nest of spheres becomes visible from geological and molecular relams to the cellular, cognitive and social, as shown above. Some seventy years later this alternative version is at the forefront of evolutionary thought. Life's ascent is seen to proceed by a hierarchy of wholes within wholes from prokaryotic microbes and eukaryotic cells to modular organs and metabolic processes on to organisms, groups, cities and a viable planet.

This illustration is from an article by holistic biologist Elisabet Sahtouris in the journal *What is Enlightenment?* Spring 2003. Her website contains several papers which describe and advocate an organic cosmos. Again we are in much need of depictions which can illuminate the new genesis theories.



Along with a Copernican revolution on a cosmic scale, a breakthrough in understanding how life evolves is newly evident. As shown above, an arbitrarily branching bush is replaced by a skeletal sequence of microbes within cells, organisms and communal assemblies. The next two slides, condensed from Part V: The Genesis Synthesis of the website, gather together its many aspects. For example, each stage is composed of a symbiotic union of simpler elements – diverse bacteria combine into nucleated cells. Embryological development and evolutionary biology, initially a single subject but apart for most of the 20th century, have reunited into an evolutionary developmental biology.

But the feature that Teilhard emphasized was how somatic form serves the procession of cerebral, personal and social qualities. An axial path of encephalization and relative knowledge is traced as brains grow in size, capability and sentience. As a result, an individuality arises as animals, primates, hominids and humans grow in active awareness. A strong parallel then reappears between ontogeny and phylogeny as earth life, mind and selfhood, now of global proportions, takes on the image of an embryonic gestation.

A Genesis Synthesis by Humankind I

New sciences of complexity. An innate dynamics is at work prior to selection which serves to form a self-organized scale of modular wholes.

Hierarchical expansion. This evolutionary drive generates a nested emergence of multiple, sequential levels from genes to groups.

Fractal-like self-similarity. The same repetitive patterns and processes are expressed at each stage of speciation and ecosystem.

Punctuated equilibrium. Species remain fixed for a long period and change suddenly, rather than by a gradual transition.

Modularity. Anatomy and metabolism evolves by way of semi-independent, specialized subunits from microbes and cells to organisms and groups.

Novel Organisms. New species are not be explained by genetic drift alone and require epigenetic influences such as dynamical self-organizing systems.

Evolution & embryology. An evolutionary developmental biology (EDB) reunites individual ontogeny with the paleological radiation of organisms. (aka Evo-Devo)

Symbiosis. How specialized bacteria cooperatively merged into nucleated cells, which then went on to evolve multicellular organisms and societies.

A Genesis Synthesis by Humankind II

Developmental systems theory. Epigenetic inputs from organism-environment interactions complement the molecular code = DNA/AND.

Altruistic cooperation. More prevalent than competitive conflict in the formation and maintenance of animal and human societies.

Behavioral influences. Organisms are not passive but act on environments which impacts genetic programs. (aka Baldwin effect or niche construction)

Brain complexity. A relatively linear increase in functional modules and neocortex size defines an advance of encephalization and intelligence.

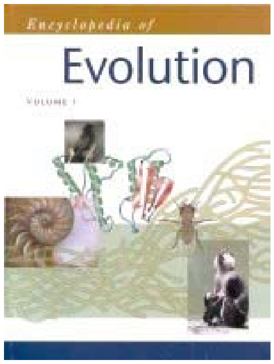
Animal intelligence. A continuum is now admitted for the rise of stored representations, cognitive abilities and reflective consciousness.

Major transitions. An evolutionary scale from gene and cell to human society employs a similar code or template from molecules to language.

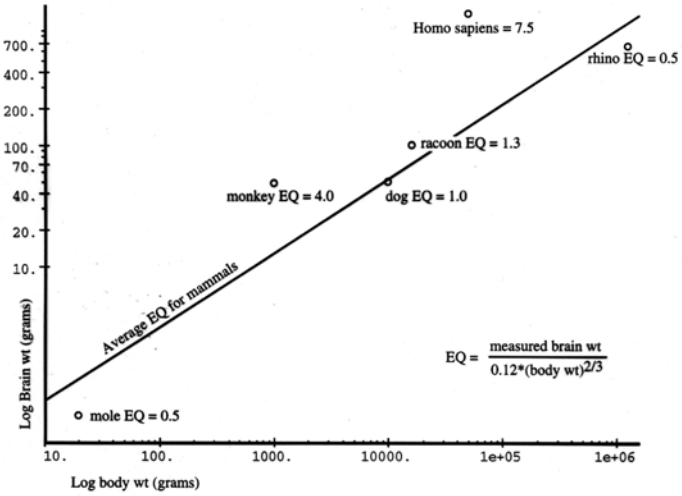
Emergent Individuality. At each stage complex, autopoietic systems create distinct bounded entities, which is seen as a self-making process.

Ontogeny and phylogeny. A recapitulation not only for embryonic form but cognitive ability, motor skills, behavior and language learning.

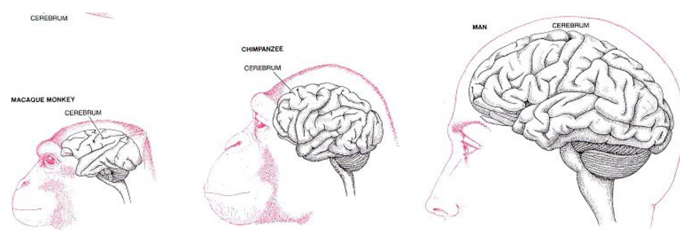
It's the Brain, not stupid



Brains get 4 pages



Evolution as Encephalization

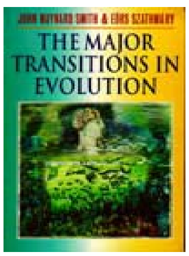


But these various scientific specialties mostly remain fragmented without a common project, and an exclusive, contentious evolutionary theory persists. It is not wrong but inadequate, the complete story is much more. Newtonian physics was not replaced by relativity and quantum theories but much embellished. A large, two volume work such as the 2002 *Encyclopedia of Evolution*, (or a typical textbook), gives scant notice to brains because they do not leave fossils.

Whereas a tree of life based on genes and bodily forms has no preferred axis, a steady increase in cerebral volume, functional modularity and represented memory, known as emcephalization, is now verified by neuroscience. Much documentation is recorded in Part VI: The Rise of Sentience and throughout the Natural Genesis website.

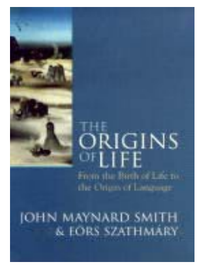
An Emergent Genetic Information

Stage	Process	Carrier
Atomic	chemical compounds	amino acids
Molecular	genomic system	deoxyribonucleotides
Cellular	symbiotic communication	eukaryotic cells
Organism	epigenetic dynamics	animal metabolism
Neuronal	neural networks	CNS and brains
Primate	signal protolanguage	chimpanzees
Humankind	language and knowledge	people



John Maynard Smith & Eors Szathmary

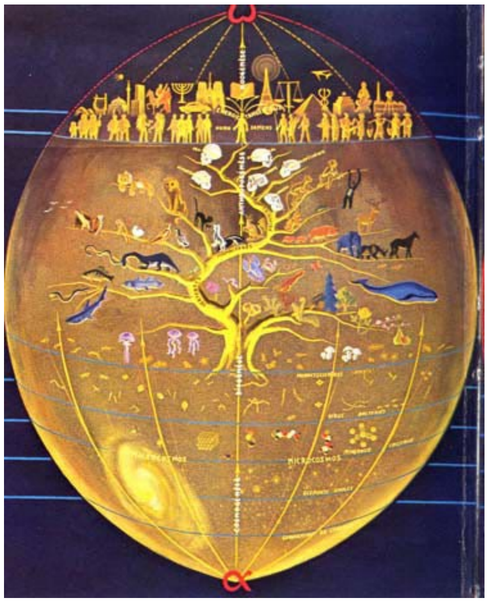
A genetic-like template arises through evolution from molecular configurations to human linguistic cognition.



By a worldwide perspective, another emergent quality is apparent. From bodies and brains accrues the learned contents of intelligence, an informational knowledge. A prime finding of the past half century is that every organism possesses two aspects, genotype and phenotype. From a genetic program springs an animal's corporeal form and cognitive behavior. But as now understood, molecular genes do not determine, they are subject to contingent environmental, topology, metabolic and other influences. A better acronym might be DNA/AND.

In an evolutionary genesis, a prescriptive, lately cognitive component then proceeds from elemental and molecular phases to human language. The above table from the books noted describes a sequence of "major transitions in evolution." Another volume just published is *Evolution in Four Dimensions* (genetic, epigenetic, behavioral, symbolic) by Eva Jablonka and Marion Lamb (MIT Press). *Our basic claim is that biological thinking about heredity and evolution is undergoing a revolutionary change. What is emerging is a new synthesis, which challenges the gene-centered version of neo-Darwinism.*

An Evolutionary Quickening of Body, Mind and Spirit



Complexity **Consciousness**

But how to theoretically explain an organically developing nature?

In a biologically fertile cosmos we can now add a ramifying consciousness to the earlier image of convergent complexity. Teilhard generally noted these complements as tangential and radial energies. (These rare paintings are from a 1970 book in French on Teilhard.) Altogether we might perceive a grand learning process, a universe intent on discovering and creating itself.

A dynamic source for this nested gestation, not known to Darwin or the modern synthesis, is now understood through the new sciences of complex systems. The next two slides cite many disparate contributions as an example of how a planetary noosphere might collect and identify a singular, unified impetus. From a generative thermodynamics of life to network, fractal, modular, synergistic and neural qualities, the same universal pattern and process is found at work everywhere in nature's animate organization.

The New Sciences of Complexity I

Nonequilibrium Thermodynamics. A theory of energy and information flow, usage, bifurcation and dissipation for open living systems.

Complex Adaptive Systems. Many agents (neurons, people) locally interact, guided by rules or agreed norms, to create a higher entity and order.

Self-Organization. As these systems proceed without centralized direction or program, they arrange into a nested scale of whole entities.

Modularity. Complex systems in evolution and development form modular, symbiotic components and processes from genes to societies.

Universality. The same self-organized, complex dynamics and network structures are found from atoms to galaxies.

Autopoiesis. Integral, bounded systems (cells, people) maintain themselves by referring to their own internal description.

Self-Organized Criticality. Complex dynamic systems are often poised at the edge of order and chaos.

Cellular Automata. A computational process based on simple, algorithmic rules which gives rise to a repetitive emergent order.

The New Sciences of Complexity II

Fractal Geometry. Nature is characterized by the same shapes and topologies with fractional dimensions at every scale.

Scale-Free Networks. Elemental nodes are interconnected in similar hierarchical levels from cellular metabolism to ecosystems and the Internet.

Synergetics. A more physically based theory of a universal self-organization.

Artificial Life. Digital computer simulation of molecular, genetic, organic, social and economic societies and their evolution.

Neural Networks. Brains are composed of hierarchies of neurons, synapses and axons in constant flux due to weighted inputs and experience.

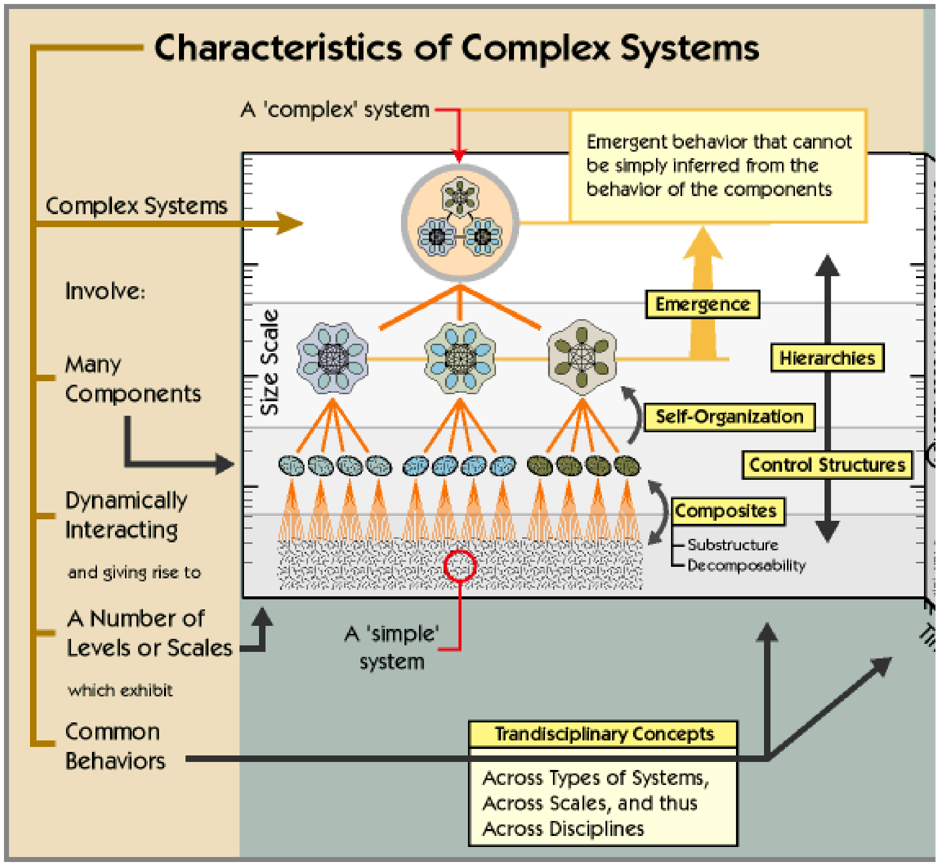
Connectionism. How neurons compute and process cerebral information, also known as parallel distributed processing or artificial neural nets.

Synchronicity. Phenomena from electrons and fireflies to planetary orbits synchronize in unison, which gives rise to a spontaneous order.

General Systems Theory. The pioneer witness of dynamic natural and social realms most characterized by holistic interconnections.

Masculine Yang

Feminine Yin

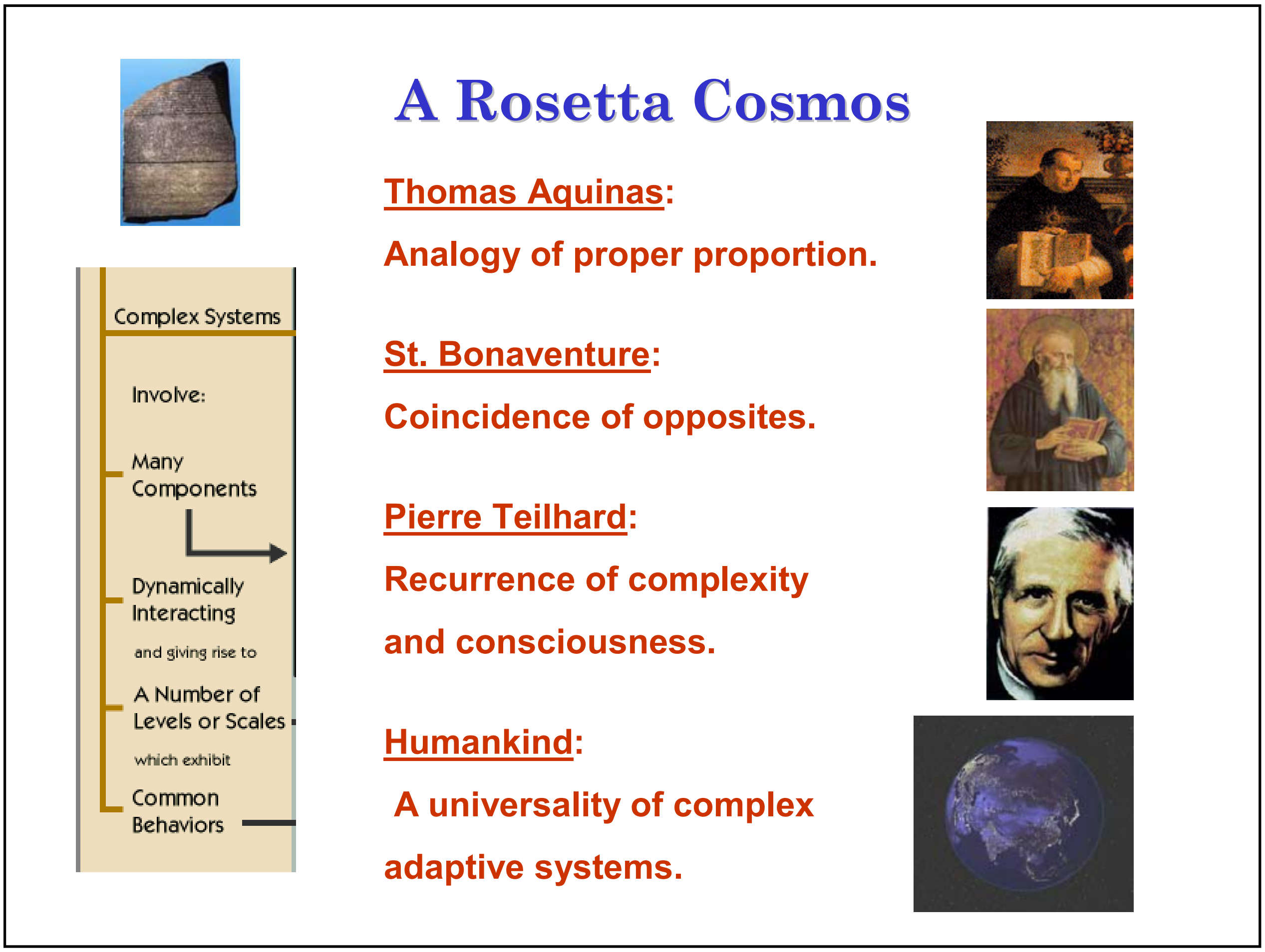


Source: New England Complex Systems Institute www.necsi.org

From these theories can be translated and distilled a generic activity known as a 'complex adaptive system' whereby many separate entities interact with each other and their environmental niche, guided by common rules, from which arises a new whole stage of organization, often unbeknownst to those who created it. A reciprocal interplay of *free agents* and *local interrelations*, autonomy and network, can be identified in each case.

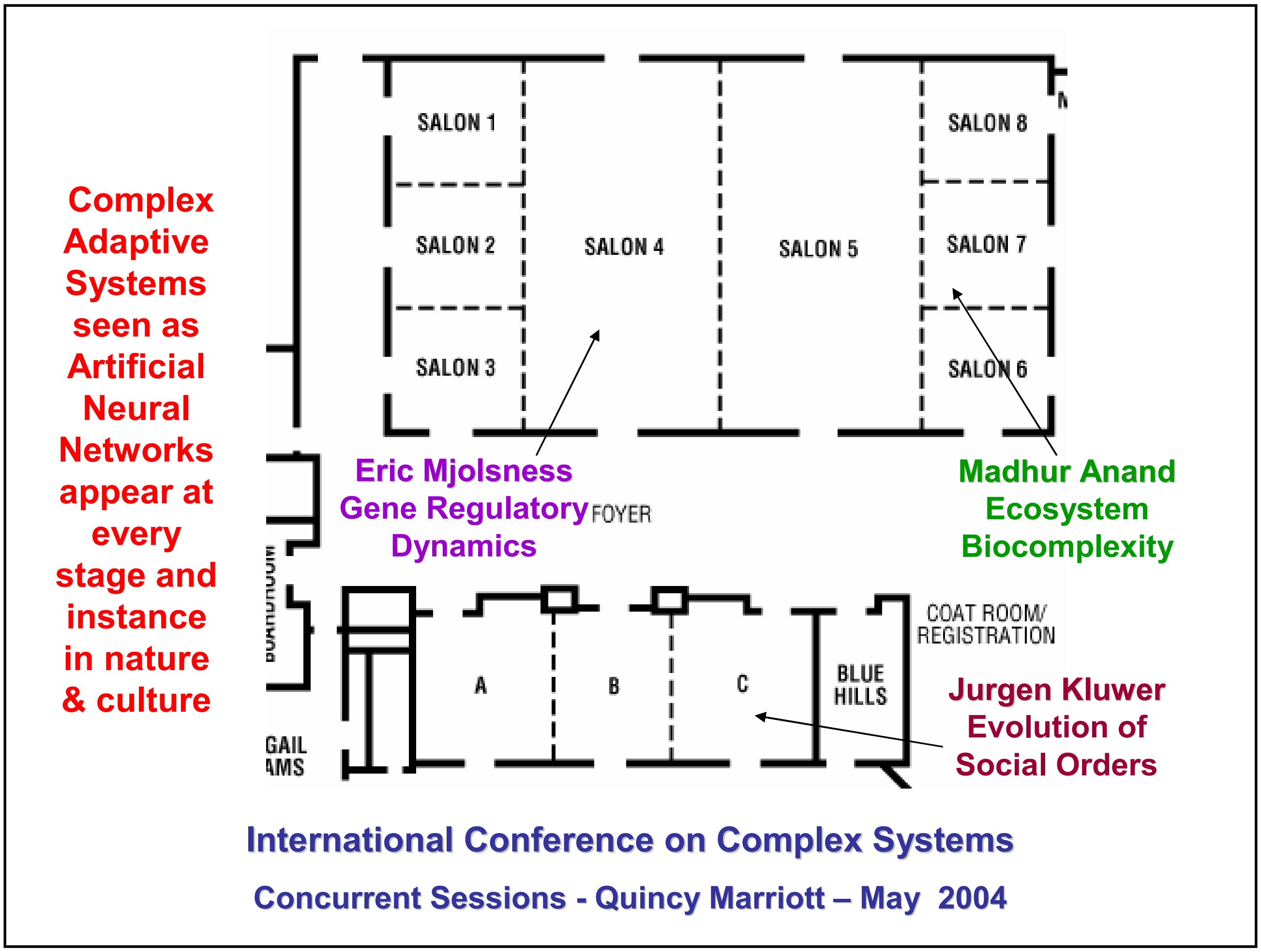
By their dynamic activity, these complements define a ubiquitous developmental cycle. When many elemental agents (cells, people) propagate to fill a habitat, a degree of specialization or division of labor sets in. Close neighbors communicate whether by chemicals, electrical potential or language. As densities increase, association succeeds over dispute. At a critical threshold of convergence, a new sphere of self-identity is achieved.

Personal attributes of this constant spiral can help narrate a natural genesis. Living systems strive to maintain a bounded integrity by a recursive, fed back reference to their own internal description. Such an 'autopoietic' process is involved in 'self-making', a distinct individuality at each stage. (See website Part IV for more explanation.)



After this survey of an internal spontaneity just being articulated, which Teilhard called the "within of things," a more familiar ground and context is vital. There is much need for exegesis and translation, for every testimony, whether by science, philosophy, theology or literature, necessarily reflects the one, same reality. As often intimated, a singular creative system, with essential feminine and masculine complements, seems present at each evolutionary phase and instance.

In retrospect, a witness can be recognized in Aquinas and Bonaventure above, as examples of a perennial wisdom. Today its latest version via humankind is broached in terms of self-organizing complex adaptive systems. As tradition has long taught, the world comes with a providential code for human dispensation, being discovered anew on a planetary sphere. (See Part II of the website has many more references.)



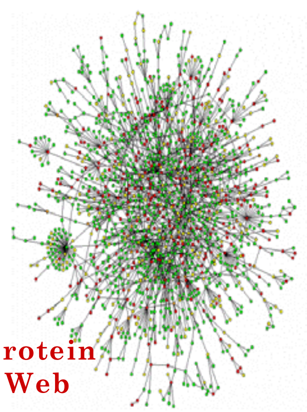
For another case in point, at a conference I attended last year widely different areas of study from genetics to societies were each using the same complex system model based on neural networks, still another realm. Prof. Madhur Anand from Laurentian University in Canada (check her website via Google for more info) proposed that the health of an ecosystem could be evaluated by how well it resided in a state of self-organized criticality. Altogether these projects seem to portend a 21st century revolution. Rather than a reality reduced to and governed by particles and laws alone, a creative complementarity is seen to emerge everywhere from galaxies to Gaia.

Another illustration is how the still isolated scientific disciplines are employing these new sciences to achieve a heretofore elusive theoretical basis. Again an array of arcane terms inhibits interdisciplinary synthesis. But from biomolecules to human maturation and fractal cities, a common pattern and process is in effect. The next two slides convey firstly the technical approaches that various fields have adopted and their visual, graphic display.

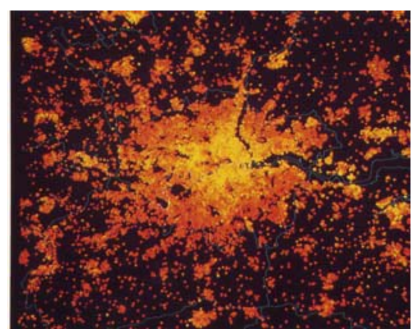
A Planetary Learning Experience in Need of Translation

Urban Geography	Cellular Automata, Synergetics
Econophysics	Self Organized Criticality, Scale-free Networks
Linguistics	Complex Adaptive Systems
Neuroscience	Neural Networks, Connectionism
Child Psychology	Connectionism, Dynamic Systems Theory
Applied Anthropology	Agent-based, Nonlinear Dynamic Systems
Archeology	Complex Adaptive Systems
Ecosystems	Artificial Neural and Scale-free Networks
Evolutionary Theory	Dynamic and Developmental Systems Theory
Microbiology	Fractal, Emergent Self-organization
Genetics	Artificial Neural Networks

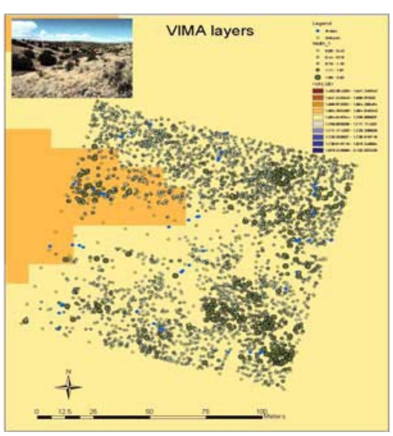
The new complexity sciences inform many diverse fields of study. Each applies a certain approach which involve free entities that locally interact by agreed norms or protocols which then self-organizes an emergent order.



Protein Web

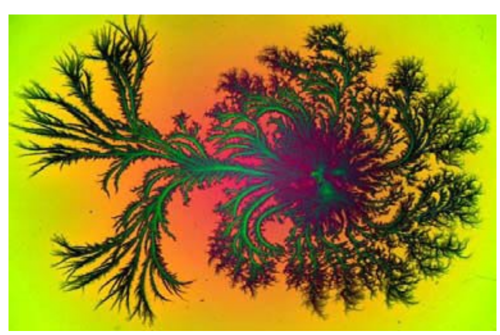


Fractal London



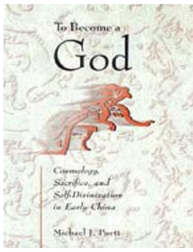
Ecosystem

Microcosm
Macrocosm



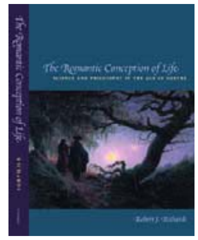
Microbe Community

The Cosmic Genesis Tradition



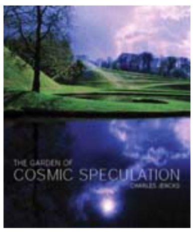
The 2nd century Chinese cosmos is a teleological self-creating organic process with theomorphic human persons.

Michael Puett



The Romantic View of Life **Robert Richards**

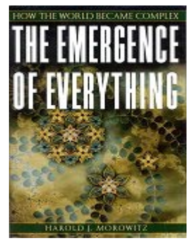
Charles Darwin reflected this popular philosophy and saw nature as an organic teleological self-organization.



The Garden of Cosmic Speculation

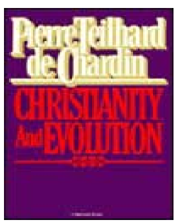
Charles Jencks

A self-organizing universal genesis exemplified by human beings.



Teilhard's view of a spiritually oriented evolutionary genesis is supported by the latest science.

Harold Morowitz



With cosmogenesis being transformed, as I said, into Christogenesis…Someone, and no longer something, is in gestation in the universe.

For more reference and bearings, (trying to be autopoietic) the intimation of an organically developing creation has an ancient history. I found it interesting that the same phrase and image of a self-emergent genesis occurs from ancient China (and Greece) to the mid 19^{th} century *naturphilosophie* that Darwin was immersed in, as these works convey. And today it is being recovered by our worldwide noosphere.

The 20th century model of a pointless, mechanical cosmos can then appear as an anomaly, surely a necessary phase of analytic reduction, but part of the story not its conclusion. The above works by architect Jencks and biologist Morowitz (available from amazon.com) are more examples that report a quite different, numinous universe. On this wider canvas we can situate Teilhard's prescient vision as he sought to reconceive the Christian epic over a temporal, evolutionary span.

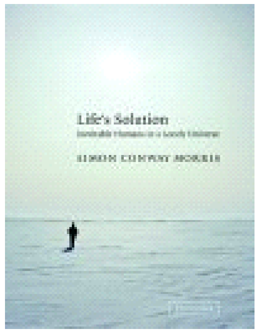
A New Convergent Evolution

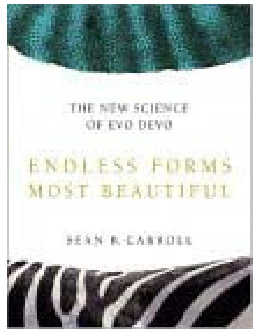
Life's Solution

Inevitable Humans in a Lonely Universe

Simon Conway Morris

2003





Endless Forms Most Beautiful

The New Science of Evo-Devo

Sean B. Carroll

2005

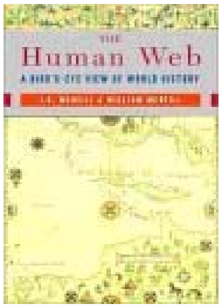
The latest study of paleontology and genetics reveals an innately oriented path for the rise of life. To Conway Morris, because animal forms are limited in kind, a central trajectory and trend occurs. Evolution will reach the same end, such as vision or intelligence, over and over.

For Carroll, an historic reunion of embryology and evolution is achieved via a genetic code which draws on the same, regulatory genes for every creature. This constant genotype will likewise result in an increase of complexity and sentience.

For additional examples, these above works by senior scientists make the case for an evolution which inherently converges toward intelligent, human-like entities. By such appreciations, the old moribund universe where life is a fleeting bloom is set aside. In an organic cosmos, by its innate nature, a progressive convergence of embodied, knowing sentience occurs. Both authors state that if evolution was rerun again on earth, intelligent awareness would once again result. But Carroll persists with machine metaphors and Conway Morris says earth life is a rare exception. So the task of consideration and synthesis remains.

Which is just what Teilhard was much earlier trying to say: a cosmic genesis will become richer in personification and intensified spirit: *everything that rises must converge.*

Community in a Genesis Future



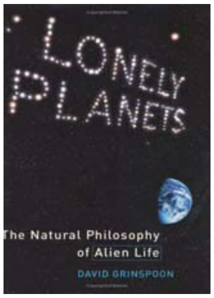
Historian William McNeill cites the new evolutionary synthesis as the same nested, symbiotic pattern repeating from bacteria to cells, organisms and onto societies. For a million years, the basic hominid group was 50 to 150 members. By these lights, a humane civilization ought to be founded on intentional, cellular, "primary communities" of similar size.

A Cohousing Ecovillage in Amherst, MA just this size is eminently self-organizing, egalitarian, diverse and economical. Rather than local vs. global, a next stage could be a worldwide net of sustainable rural and urban communities.

But these theories are of little avail if they cannot prescribe a better day. An evolution which repeats the same pattern and process over and over can illuminate and provide an exemplary model for its next sequential phase. This might be implied as intentional Sustainable Ecovillages, which Part VII of the website explains and documents. With regard to Teilhard, a further instance of the "creative union" of individual person and salutary community.

In conclusion, an epic revision and paradigm shift seems in the air about what kind of universe we might find ourselves. As material machine becomes temporally developing organism, human beings, individually and collectively, are no longer interlopers but can become phenomenal participants. The promise of a 21st century cosmic genesis is noted in the last slide. It should not pass notice that a foremost visionary for over the last three decades has been Freeman Dyson.

Cosmic Genesis in the 21st Century



Grinspoon, David

Lonely Planets

Harper Collins, 2003

The universe is progressing in a direction toward greater intelligence, conscious awareness, & self-understanding. The dark universe becomes gradually more lit up with consciousness.

Teilhard de Chardin believed in love as a cosmic principle. I find his writings meaningful, intelligent, and inspiring. I believe the phenomenon of humanity on Earth is a local example of a trend toward higher consciousness and spiritual enlightenment that transpires all over this universe.

I have found a universe growing without limit in richness and complexity, a universe of life surviving forever and making itself known to its neighbors across unimaginable gulfs of space and time.

Freeman Dyson 1979

Some Website Locations and Source Credits

NASA Astronomy Picture of the Day, Hubble Telescope Website, European Southern Observatory: Earth at Night, Cosmic Nursery, etc. (via Google)

Accelerating Universe: *Discover Magazine.* February 2004

Barthelemy-Madaule, M., et al, eds. *Teilhard de Chardin.* Paris: Hachette, 1970

Microbe Community: Eshel Ben Jacob website: http://star.tau.ac.il/~eshel/gallery.html

Fractal London: Batty, M., Longley, P. *Fractal Cities.* New York: Academic Press, 1994.

Worldwide Computer Grids - *http://www.nd.edu/~networks/gallery.htm* - Notre Dame

Dyson, Freeman. "Time Without End: Physics and Biology in an Open Universe." *Reviews of Modern Physics*. 51/3, 1979.

The Jesuit philosophical journal *Ultimate Reality and Meaning*, published by the University of Toronto Press, will feature my paper: "Natural Genesis: An Introduction to the Worldwide Discovery of a Creative, Organic Universe" in its June or September 2005 issue.

Arthur Fabel www.naturalgenesis.net artfabel@charter.net

Teilhard and Roman Catholic Orthodoxy

Donald P. Gray

The context for this paper is the well known fact that throughout his career Teilhard was persistently refused permission by his religious superiors to publish anything other than technical scientific papers. His theologically oriented works, mainly essays, were denied public scrutiny, even if they did circulate, in a limited fashion, informally. This situation obtained from the early 1920's up until the time of his death on Easter Sunday, April 10, 1955. In the early 1930's The Divine Milieu nearly reached the point of publication owing to the efforts of Teilhard's close friend Père Pierre Charles at Louvain. Jesuit censors intervened, however. In the late 1940's Teilhard made an earnest attempt to secure the publication of The Phenomenon of Man, even petitioning the Jesuit Superior General, who ultimately turned down the request. As his writings began to see the light of day in the late 1950's and early 1960's, the Vatican Holy Office expressed concern, which culminated in the Monitum issued in June, 1962, just prior to the opening of the Second Vatican Council in the Fall of 1962. Had Henri de Lubac, not only a Jesuit confrère but a longtime friend of Teilhard's, not demonstrated in 1962 the essential orthodoxy of Teilhard's thought in his masterful study, La Pensée religieuse du Père Teilhard de Chardin (ET The Religion of Teilhard de Chardin), the condemnation might well have been considerably harsher. The Monitum claimed, without details, that Teilhard's writings "abound in ambiguous statements concerning matters of philosophy and theology, and even in serious errors, that they offend Catholic doctrine." (Acta Apostolica Sedis, 6 August, 1962). Hence, the impression was created, and in some circles continues on and is propagated, that Teilhard was heterodox.

The question of Teilhard's relationship to Roman Catholic orthodoxy can not be answered without consideration of more fundamental issues. What is the nature of the relationship of any creative thinker within a tradition to an established orthodoxy, Christian or otherwise?

As I was pondering this question over the last several months, I happened upon some remarks that I found arresting because to the point. On the occasion of the fortieth anniversary of the graduate theology and pastoral ministry program at St. Michael's College, Vermont, the president of the college, Marc vanderHeyden, welcomed his audience with a challenge perfectly apposite to our topic. I quote:

> The German philosopher Heidegger made a wonderful distinction between *grund-probleme* and *grenz-probleme*, by which he sought to enlighten us about matters of gradual importance. I have used this image of *grund-probleme* and *grenz-probleme* in several settings, not in the least in explaining the real task and pursuits of a liberal education. But what is

> true in a liberal education is even truer for theology. The distinction by Heidegger invites theologians either to study, restudy, and revisit the classical perennial problems or to move to new horizons, new insights, new discoveries. In other words, we can focus in liberal education or theology on the fundamental problems – on the trunk of the tree – or we can explore and discover new insights, new fields of endeavor; we can cross boundaries, or, to use the tree metaphor, we can go out on a limb. That is what I believe contemporary theologians, particularly within the Roman church and especially within the academies of the Roman church, ought to do.
>
> I have several concerns regarding the role, the task, and the responsibilities of theologians in our Catholic colleges and universities. I would plead with them to make it a clear-cut purpose to address the other academicians in our institutions and not one another. To state it differently: In addition to addressing one another, please spend equal time in addressing the other disciplines, the other academicians, the other academies. In the latest developments surrounding the implementation of *Ex corde ecclesiae*, one of the side effects may be, unfortunately, that theologians once again will be more tempted to address the bishops and the curia, the canon lawyers and regulations, rather than addressing the *grenz-probleme* and the problems created by the other academic disciplines.

In a subsequent paragraph, in the light of these comments, it is not at all suprising that vanderHeyden should bring up the example of Teilhard de Chardin:

> We need in our time a resurgence of theologians who enjoy the freedom and the width and depth of knowledge as represented by Aquinas and Teilhard de Chardin. We certainly need new Aquinases and new Teilhards. In a fairly recent address the theologian Edward Schillebeeckx talked about the importance of moving boundaries; not removing, but the moving, the stretching in a certain sense, the dislocation of boundaries in order to achieve real results. Theologians, in dialogue with one another and with other academic disciplines, will be able to pursue deeper and wider issues. And, as a result of the questions

> raised by others, they will make new discoveries, and it is in discovery that they will advance the teachings of the church and the human spirit. It is discovery, not confirmation, that is more in line with the unfolding history of salvation. Theologians, particularly those in the academy, should always look forward to the tension between reason and faith. And should welcome it.[1]

Altogether too infrequently do we hear our church leaders today speaking in a similar vein, calling for, encouraging, and supporting creative thinkers, pioneers and pathfinders on the boundary[2] who open up lines of communication with "the other", Teilhard was indeed one of the moderni (as was Thomas Aquinas in his time), whose misfortune it was to work on behalf of the church in an historical period of intense anti-Modernism, when innovative overtures were suspect.

Teilhard, an ardent admirer and imitator of St. Paul, thought of himself as an "apostle to Gentiles" of the modern period, those especially who had long since written off Christianity as beneath their interest[3]. He was, in the best sense of the term, an apologist for the Christian understanding of reality in a way reminiscent of the apologists of the second century who sought to recommend the Christian faith to the cultured despisers of the Roman Empire. In his own way, he was a missionary to a world in need of vision, meaning, and hope, all of which Christianity offers, he believed, when translated into the idiom of a new cosmology, a new creation story. Teilhard's works represent a sustained effort over a lifetime at inculturation, in many ways similar to the efforts of Christian thinkers of the early centuries to offer a meaningful and inspiring expression of the Christian vision within the worldview of Graeco-Roman culture. This effort gives rise, in time, to the classical version of Christian belief, to what we have come to identify as orthodoxy. Orthodoxy, by its very nature, represents a culturally conditioned construction of a faith tradition, an admittedly impressive construction, forged in the past and reflective of that past. This was Teilhard's heritage and he cherished it, but he also recognized its limitations. Loyalty to this heritage, in his mind, required a reformulation, perhaps something more like a re-mythologization,[4] coherent with a new cultural circumstance. To repeat the formulations of the past would hardly serve the requirements of a new present.

Far from scrapping the long tradition behind him, Teilhard delved deeply into that tradition for resources to assist him in shaping his vision. He often mentions St. Paul and St. John as basic New Testament inspiration for him[5]. The Greek Fathers were also frequently referenced in support of his project. Teilhard remained in serious dialogue with the tradition, in its many facets, throughout his career; not in the manner of the professional theologian or biblical scholar, but as a seeker who desires to be a seer – for his own sake as well as the sake of "those who love the world," the world that God so loved he gave his only begotten son (John 3:16).

Although not a theologian by profession, Teilhard made significant contributions to contemporary theology and even to developments which took place at the Second Vatican Council[6]. His three principal contributions, in the areas of creation Christology, and eschatology, match up well with the three articles of the classic creeds of the Christian tradition, the Nicene Creed and the Apostles' Creed, clearly touchstones of Catholic orthodoxy.

Each of these traditional doctrinal areas was reinterpreted dynamically and processively by Teilhard in light of the evolutionary worldview characteristic of contemporary cultural and scientific thought.

The reinterpretation of the doctrine of creation is absolutely basic for the entire enterprise. Creation is no longer, for Teilhard, an exclusively divine act at the beginning of all things but is rather to be understood as a continuous process of becoming, novelty, and unification. The creatures themselves share in the creative advance by cooperating with the divine energizing activity according to their individual capacities and opportunities. The law of such a creation is a law of complexity and consciousness spiraling forward towards a final state of co-reflective consciousness.

If the doctrine of an evolving creation is foundational for Teilhard's worldview, the issue of a cosmic Christology is clearly central. Dominating the Teilhardian Christology is the figure of the risen Christ present in mankind's immediate experience as the commanding Divine Milieu or Center of creative unification. In his role as Activator of universal love-energy he binds the world together into his cosmic Body.

Eschatology was likewise a dominant concern of Teilhard's and his speculations in this area were especially daring. The Teilhardian eschatology is focused not so much on the fate of the individual after death, although personal immortality is unambiguously affirmed, as on the collective destiny of the evolutionary process in general and of the human species in particular. In short, Teilhard was seeking to give contemporary meaning to the biblical symbols of the Kingdom of God and the Second Coming of the risen Christ. Teilhard was particularly concerned to join together into an inescapable unity the building of the earth by man and the final introduction of the Kingdom of God. The coming of the Kingdom is in this way conditioned by the commitment of women and men to establish genuine human community across the planet as a preliminary to the end. The world cannot be transformed until it is ready, until humans have made it ready. In place of the more familiar biblical language Teilhard has substituted the term Omega which represents not only human co-reflective community at the end but also that point at which "God will be all in all."[7]

It should be noted that spirituality interests, intimately linked to doctrinal revision, were never far from Teilhard's concerns.

In the final analysis the Teilhardian reinterpretation of Christian doctrinal premises can be seen to have been guided at every point by an overriding preoccupation with the practice of the Christian life in the contemporary world. The Teilhardian spirituality stresses the need for active engagement and immersion in the world in addition to the passive and self-denying virtues; it also speaks of a necessary attachment to the world in addition to detachment from the world. Above all else the Teilhardian spirituality is a spirituality of love. It is love which inspires action in and for the sake of the world and it is also love which willingly undergoes the passivities of life. It is love which both attaches us to the world and yet detaches us from the world in its present evolving and hence unfinished form. It is love which unites and simultaneously personalizes. Love is the very energy of an evolving creation centered in the risen Christ and running on towards its high destiny at the Omega Point which is the Kingdom of God.

Teilhard was both scientist and priest. He loved both the world and the Christian community which exists to serve the final future of the world. His life was a testimony to his faith in the viability and relevance of the Christian gospel for the future of our world. He has left us a legacy of hope and an unfinished task to carry forward, Christians and humanists alike.

In conclusion, I should like to reproduce, and make my own, some reflections of J.V. Langmead Casserly, with which he concluded a talk on Teilhard at a conference held at Seabury Western Seminary in 1968. They speak directly to the issue of Teilhard and Catholic orthodoxy[8]:

I am a theologian myself, and nothing paralyzes me with horror so much as a concept of Christian orthodoxy that interprets it as something to be dredged up from the past by biblical scholars and historians. <u>For me orthodoxy is an eschatological idea</u>. All theology is oriented towards it, yet no theological formulation finally attains or comprehends it. <u>The development of theology is like evolution, it is a coinherence of continuity and novelty.</u>

The really exciting service that reading Teilhard's writings has done for me is to make me more vividly aware than I have ever been before that theology is still alive, that theology is still going on. For tradition does not mean a dead thing that is handed on by dying pedants, but rather a living thing that insists on handing itself on in an endless variety of new forms through the living minds that it possesses and dominates.

The mind of the true theologian is rather like the tomb in the Garden of Joseph of Arimathea. For it is there that the tradition rises again and again from the dead. Teilhard's mind was of this miraculous kind. When I first glanced at it I noticed only that the tomb was empty, but when I looked again I perceived with awe that the stone that separates modern man from mystery has been taken away.[9]

Footnotes

1 Dermot Lane (ed.), Catholic Theology Facing the Future (Paulist Press, 2003) VII-VIII.

2 Another notable theologian of the last century also saw his life work in terms of this metaphor. See Paul Tillich, On the Boundary. An Autobiographical Sketch (Charles Scribner's Sons, 1966)

3 See on this, Henri de Lubac's discussion in Teilhard Explained (Paulist Press, 1968). Part One, 7-37

4 See: Teilhard de Chardin: Re-Mythologization (Word Books, 1970), a collection of three essays by Robert Speaight, Robert V. Wilshire, and J. V. Langmead Casserly.

5 An indepth study of Teilhard's use of Pauline texts is provided by Richard W. Kropf, Teilhard, Scripture, and Revelation (Fairleigh Dickinson University Press, 1980).

6 Thomas King, S.F. assesses his influence since his death fifty years ago in "A Holy Man and Lover of the World", America (March 28, 2005), 7-10, especially, p.10.

7 The above comments were made, by myself, in an appreciation of Teilhard's theological contribution on the twentieth anniversary of Teilhard's death in 1975. They appeared in the Teilhard Newsletter of October, 1975.

8 Two criticisms of Teilhard's vision (and hence his orthodoxy) are often advanced: one has to do with the problem of evil and his failure to focus attention on sin and redemption, the other has to with his alleged pantheism. With regard to the problem of evil, Teilhard developed a creation-centered theology and corresponding spirituality. Sin and redemption are not ignored, but they are rendered subsidiary to the divine creation project and our co-creative role in it. In The Divine Milieu, Teilhard assumes that his audience has advanced beyond the purgative stage to the illuminative and unitive stages of the spiritual journey.
With regard to the charge of pantheism, Teilhard was, clearly, what today is called a panentheist. For him, God is in all and all is in God, in a word divine/world reciprocity. Teilhard exemplifies what Paul Tillich described as the principle of identity in contrast to the principle of detachment and separation: "God is here and now. He is in the depths of everything. He is not everything, as this much abused term 'pantheism' says. Nobody has ever said that. It is absolute nonsense to say such a thing....The principle of identity means that God is the creative ground of everything." Paul Tillich, Perspectives on 19th and 20th Century Theology, ed. by Carl E. Braaten (Harper and Row, 1967), 94-95

9 See note 4 above, p.57.

TEILHARD DE CHARDIN'S LIFE & MAJOR THEMES OF THOUGHT

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Introduction

Teilhard de Chardin is so well known today that the use of his full Christian name Marie Joseph Pierre Teilhard de Chardin is generally omitted, as will be the case in this discussion. Teilhard was born May 1, 1881 in Auvergne, a central province of France, distinguished by the presence of numerous volcanoes. These are generally considered extinct by the general public, although in my view as a geologist-volcano watcher, I have seen other not-much-eroded, "extinct," conical volcanoes come back to life. The family château, Sarcenat, is located a few miles from the provincial capital, Clermont-Ferrand.

Seeds of Teilhard's Influence

Because my paper has a two-fold focus on Teilhard as a professional geoscientist and on his "new mysticism" of action, I am much concerned to see what formative influences might be discovered in his early life and activities that may point to their later flowering. His mother, Berthe-Adèle de Dompierre d'Hornoy, was not only a devout Catholic but she read the classical writings of the Christian mystics, and transmitted her love of the Sacred Heart of Jesus to Teilhard by word and example. As Teilhard wrote in "The Heart of Matter", "At the age when other children, I imagine, experience their first 'feeling' for a person, or for art, or for religion, I was affectionate, good, and even pious: by that I mean that under the influence of my mother, I was devoted to the Child Jesus." (King, U., 1996, p. 4)

Teilhard's father, Emmanuel Teilhard de Chardin, was a trained archivist-historian, an accomplished amateur naturalist, and an outdoorsman whose love of the volcanic terrain of the Massif Central near Clermont came naturally as they walked the slopes of these volcanic craters. Teilhard reflected on his childhood interests: "I was just like any other child," (which of course he was not--fortunately). "I was interested specially in mineralogy and biological observation. I used to love to follow the course of the clouds, and I knew the stars by their names… To my father I owe a certain balance, on which all the rest is built, along with a taste for the exact sciences." (Cuénot, 1965).

An important further influence on the youthful Teilhard occurred when he was almost eleven years old. As was customary for boys at that age in the Teilhard family, Teilhard was sent off to be educated by the Jesuit fathers at a boys boarding school north of Lyons, the École Libre de Notre-Dame de Mongré at Villafranche-sur-Saône, one of the leading French educational institutions for the teaching of the natural sciences. Telhard has been characterized as "an exemplary, though rather taciturn, even self-absorbed pupil," who won many of the prizes annually. One of his teachers revealed that he "learned the secret of his (Teilhard's) seeming indifference": that his mind was transported "far away from us…a jealous and absorbing passion—stones."

In reflecting on the short- and long-term influences that may have shaped dominant aspects of Teilhard's personality and aspirations, it seems to me that Teilhard's mother and father as well as the Jesuit fathers at Mongré may have helped him at an early age to grow toward realizing the potential that millions of us throughout the world are commemorating on this 50th anniversary of Teilhard's death. In the Cuénot (p. 6) biography Teilhard wrote to his parents "At the moment when [about 1901…the Society of Jesus in France] is being so severely persecuted…I shall never forget all you have done to assist my vocation." As a result of the influence of his early mentors on Teilhard, in turn, Teilhard's influence on a broad spectrum of scientific research and spirituality must be described simply as monumental.

Teilhard the Jesuit Scholastic

A new period in Teilhard's life dawned on March 20, 1899 when he began his life as a Jesuit, having been accepted as a novice in the Jesuit house in Aix-en-Provence, not quite eighteen years old. This year was doubly significant for Teilhard because Pope Leo XIII consecrated the whole of humanity to the Sacred Heart of Jesus, a devotion that was central to Teilhard as well as to the whole Jesuit order. The Jesuit novitiate is a two-year period for the novice to become familiar with and energized by the *Spiritual Exercises* of the founder of the Jesuit order, Ignatius of Loyola.

This formative period in the young Jesuit's life includes a thirty-day retreat following prayerfully the graduated, devotional, mainly Scripture-based reflections modeled on the "exercises" of the sainted Founder. Ignatius wrote these exercises when he was undergoing his own conversion experience as he transitioned from a previously dissolute lifestyle to "lighting the fire of dedication and love for his Lord and Savior." The latin root of "ignis," in the name that Ignatius adopted, fired the imagination and served as an inspiration for the youthful Teilhard whose perspective and mission was dominated by the Ignatian charism. Teilhard took his first vows as a Jesuit on March 25, 1901.

The next phase of Teilhard's Jesuit life included studies of language and literature, notably Latin and Greek, which he obviously enjoyed and in which he excelled in creative ways. These led to his first academic degree from the University of Caen. The French government passed laws restricting the activities of religious orders. As a result Jesuit communities from Laval and elsewhere in France hastily fled France. Teilhard and fellow

Jesuit scholastics found themselves established on the Isle of Jersey where they continued their studies in philosophy.

Significantly for Teilhard's maturation as a scientist, he focused on a project that consisted of a study of the very complex geology of the Isle of Jersey. I can assure you, the reader, from my personal research studies of the complexity of the igneous geology on nearby northern Brittany and in the northern Appalachian Mountains, that Teilhard was undertaking a project of very great complexity. The attached map of the geological structure of the Isle of Jersey (Figure 1) is the product of Teilhard's research of the previous literature on the subject as well as his personal observations and interpretations of the relationships observed in the rock formations seen on the island. This geological map was published in 1919 after Teilhard had mustered out of the French military at the end of World War I. Teilhard had prudently deferred publication of his earlier observations on the geology of Jersey until after he had revisited the island to check on the perceived validity of his fledgling, but masterful, observations on the geological relationships of this complex assemblage of ancient, mainly older—more than 600 million years old--igneous rocks.

Teilhard's Growing Entourage of Friends and Colleagues

Another aspect of Teilhard's life that I consider significant in shaping the person that he became was his ever widening circle of friends. Two fellow Jesuit novices, who became close friends and, later, significant theologians, were August Valensin and Pierre Charles. Teilhard demonstrated even while he was a scholastic and before his doctoral studies that he had an intuition for focusing his energies on significant projects and had an ability to carry out paleontological and related geological investigations in the field in a manner that qualified him to publish his results in professional journals.

On the Isle of Jersey, beginning in 1901, Teilhard and Jesuit companions engaged in field studies in geology and paleontology. These years of formal as well as optional studies prepared him for teaching and carrying out research in Egypt as well as for similar theological studies later in Hastings, England, which he completed in 1912. During these years of study and notably during his study of theology in Hastings, England, Ernest Gherzi had become a friend and scientific colleague.

Gherzi, whom I came to know and enjoy after he was expelled from China and came to Breboeuf College, Montreal, in 1949, had served for many years as a distinguished and famous meteorologist at the Zi-ka-wei Observatory in Shanghai. This was during the time that Teilhard was carrying out his geological and paleontological work from Tientsin and Peking. George Barbour (1965) records that about 1928 or 1929 Father Gherzi was approached by the Director of the China Geological Survey seeking his advice for the appointment of an Honorary working Advisor to the Director. Gherzi advised him to appoint Teilhard de Chardin to that important and prestigious post, which he did in 1929, although Barbour suggests that Teilhard probably never knew the source of the recommendation for that appointment. In the 1932 brochure of the Zi-ka-wei Observatory (now in the Burns Jesuitana Archival Library of Boston College), Gherzi is listed as a member of the seismology and physics staff, although he and his meteorological colleagues may be best known for plotting the impending trajectories of dangerous typhoons and announcing these results by radio. These announcements were broadcast throughout the western Pacific to a large and grateful public engaged in marine fishing and shipping who had few, if any, other resources for avoiding the path and fury of typhoons there. Father Gherzi was one of only a handful of the most outstanding scientists who were members of the very select Papal Academy of Sciences.

Gherzi, whom I knew when he and Father Buist, S.J., Director of the Breboeuf Seismological Observatory, visited Weston Observatory in the late 1950s and early 1960s, was a tall, goateed man of immense good humor, who obviously enjoyed telling how he "saved Teilhard's life" when they were engaged in geological mapping along the chalk cliffs of the English coast while they were in Hastings for theological studies. As he told the story in mock seriousness, he recounted that while mapping, it was his job to stand back from the cliff where Teilhard was studying the rock formation and collecting fossils, and "save Teilhard's life" by shouting a warning whenever there was danger of a loose block separating from the cliff and falling on the unsuspecting geologist below. To Jesuits Daniel Linehan, Director, Francis J. Donohoe, Assistant to the Director, and myself, Assistant Director, Father Gherzi was a warm and delightful friend. When he died in Montreal in his late nineties, Fr Donohoe and I celebrated his great and fruitful life by concelebrating his funeral Mass.

Teilhard, the Science Teacher and Researcher

After his studies in Jersey Teilhard was assigned to teach physics and chemistry for three years in the Jesuit Collège de la Sainte-Famille in Cairo, Egypt. In his free time Teilhard and companions made geological excursions into the desert where he approached this work in a professional manner. His experience with mapping the complex geology of Jersey had prepared him well for reading the history locked up in the rock formations of northeastern Egypt. When they returned home with "fantastic" fossils, Teilhard studied them and published the results, including descriptions of marine fossils which were of special interest to him. One of these was recognized in the scientific literature of the Geological Society of France as the genus *Teilhardina*. A recent paper in Nature, (v.429, 65-68, 2004) identified a newly discovered primate genus as *Teilhardina asiatica*. Since Teilhard's initial discovery of *Teilhardina*, two additional species have been identified as *Teilhardina* americana and *Teilhardina* belgica. The web site for Teilhardina is http://www.sinofossa.org/mammal/teilhardina.htm.

Teilhard's expeditions to the region around Cairo and other parts of Egypt were recounted with enthusiasm in "Letters from Egypt" addressed to his father and mother. His father must have been delighted to see that the field trips, which he conducted for Teilhard as a youth in Clermont, had inspired Teilhard in his early career in Egypt. Ursula King (1996, p.25) noted that Teilhard's letters during this period were distant in tone and expressed little of the tremendous emotional impact that these years made on him. She noted also that his letters expressed a far greater interest in nature than in society, which included those to his parents, which remained formal and descriptive. "Only his essays written years later, give strong expression to his memorable experiences and reflect something of the haunting and lasting appeal that a large Eastern country had on the life of his mind."

During this time Teilhard took the initiative to make the acquaintance of a number of professional geologists in the region, some of whom took an interest in Teilhard's career as a geologist and paleontologist. This teaching and research experience in Egypt had a profound and broadening impact on Teilhard as is suggested by his statement that "The East flowed over me in a first wave of exoticism. I gazed at it and drank it eagerly." (Mortier & Aboux, Eds., 1966, p. 36).

Theological Studies and Priesthood

On Teilhard's return from Regency, as the teaching period in Egypt was called, he came back to the scholasticate in Hastings, a Medieval English Channel port with seaside cliffs of rock formations rich in fossils. During these years of study also, Teilhard was concerned in a special way with the letters of St. Paul and the cosmic hymns contained therein and the Gospel of St. John which emphasized the primacy of Christ in whom all creation is grounded. God in Nature was never far from his thoughts as he walked the countryside, as he recalled many years later:

"The extraordinary solidity and intensity I found then in the English countryside, particularly at sunset when the Sussex woods were charged with all that 'fossil' life which I was then hunting for, from cliff to quarry, in the Wealden clay. There were moments, indeed, when it seemed to me that a sort of universal being was about to take shape suddenly in Nature before my very eyes." (Teilhard, 1978, 25 sq)

Having returned to Hastings, England, for theological studies a new field of geological investigation opened up since Sussex Downs near Hastings has cliffs of white chalk studded with flint concretions and shells of Cretaceous age. Here he was reunited with his field companion Ernest Gherzi.

Barbour (1965) recounts a story which I alluded to earlier, presumably told him by Gherzi, of the role that fell to him while he and Teilhard were examining the steep chalk cliffs along the shore. "The bedrock rifts readily and a slight tremor is often enough to dislodge an unstable block and send it crashing to the base of the cliff. One resounding blow on a flint concretion may detach a heavy rockfall. When Gherzi saw Teilhard was making for a promising fossil outcrop, it was his role to step back to the water's edge and look up at the face of the cliff, in order to shout a warning of any threat of sudden death from above." It seems that Gherzi succeeded in his role because Teilhard lived long enough so that "twenty years later when Gherzi was director of the Sic Ca Wei Observatory in Shanghai, it was he who suggested his friend's name (Teilhard) to the head of the Chinese Geological Survey when the latter was looking for an expert advisor (Barbour, 1965, p. 17). Besides the fact that Father Gherzi was one of the most famous meteorologists in the western Pacific, I (JWS) know from personal acquaintance that on his return from China in the late 1950s Fr. Gherzi still had an extraordinarily vibrant sense of humor even in his mid-nineties when I knew him on his visits to Weston Observatory.

These theological studies led to Teilhard's ordination to the priesthood on August 24, 1911. Ursula King (1996) recalls that Teilhard's parents and four brothers wore black on that otherwise joyful occasion as a sign of mourning for Françoise Teilhard de Chardin who died that same year in Shanghai. King insightfully recalls a passage from "The Priest" that Teilhard wrote some years later during World War I that must have served as a theme to repeatedly strengthen him and others in time of stress and sorrow: "I shall tell those who suffer and mourn that the most direct ways of using our lives is to allow God, when it pleases him so to do, to grow within us, and, through death, to replace us by himself." (Mortier & Aboux, 44)

Stretcher Bearer Throughout World War I

In December 1914 Teilhard joined the French army and chose to serve as a medical orderly or stretcher bearer which would inevitably mean that he would serve mainly at or near the front lines of battle. His regiment has generally been referred to as composed of Zouaves and Moroccan Tirailleurs but Ursula King (personal communication, 2005) has recently verified that he served with distinction in an Algerian regiment. For his service he was made Chevalier de la Légion d'Honneur.

Between 1916 and 1919 Teilhard authored eighteen most memorable essays which contain many of the themes of his spirituality that he elaborated subsequently at various stages of his life. One essay, "The Priest", was a prayerful meditative essay which is often compared with his "Mass on the World" that Teilhard completed in 1923 while on a geological expedition in the Ordos Desert of China. These essays were transmitted from time to time to his cousin and confidant, Marguerite Teillard-Chambon for safe keeping and were eventually assembled in a magnificent volume, "Writings in Time of War." (Skehan, 2001, 26) "In commenting on Teilhard's first essay in *Writings in Time of War*, 'Cosmic Life', Marguerite noted that it represented 'in embryo all that was later to be developed in his thought" (p.13).

Bright Skies and Storm Clouds Gathering

In 1919 Teilhard was mustered out of the French Army, and within a short time after he received the PhD degree in geology and paleontology, "was appointed to the chair of Geology left vacant by the death of Professor Boussac, a position in which he would inevitably rise to the upper echelons in French academic circles." (Skehan, 27) Teilhard's potentially distinguished route to fame in academic circles took a most unexpected turn, when at the urging of a block of French bishops, the Jesuit General sent Teilhard into exile from France. This was a time, however, in which any who dared to speak on religious topics were bound to be closely scrutinized by the watchdogs of Catholic orthodoxy. Having survived religious persecution at the hands of anticlericals when they fled to Jersey two decades earlier, "men and women of religious orders were inevitably going to suffer even more from the teeth of rabid, misguided watchdogs of 'orthodoxy'." (Skehan, 2001, p.27).

Since the war Teilhard "had realized that humankind formed a single whole, a large cosmic reality that far transcended individuals and groups…like a dynamic, living organism…, a network whose threads stretched over the face of the whole earth" (King, U., 1996, 87). "For a time Teilhard called the thinking Earth the anthroposphere, but in 1925, either solely or in conversation with Édouard LeRoy and Vladimir I. Vernadsky, the trio invented the concept of the noosphere, although Vernadsky held an entirely different understanding of what it meant from that of the other two." (Vernadsky, 2000, 155) (*The Biosphere*, translation by David Langmuir with annotations by M.M. McMenamin, p.155). "Noosphere was to become one of Teilhard's key ideas. (King, 1996, 88).

It was then that Teilhard connected with the French Jesuit Scientific Mission in China to be discussed later.

A Major Source of Teilhard's Motivation

In this and other papers on Teilhard I have been especially interested in how Teilhard's kind of mysticism of action played out in, and molded, the activities of his everyday life and especially his research and writing. It is clear that Teilhard must have been motivated to an extraordinary degree not only to have accomplished his geological research in the harsh climate and terrain conditions of China, but at the same time to have written the sublime compositions that have been referred to as Teilhard's "new mysticism," a mysticism of action. Undoubtedly Telhard may have been motivated by many sources of inspiration. My opinion is that the following essay written in 1943 sums up succinctly a number of the concepts or themes at the heart of Teilhard's "evolutionary" spirituality, and which must have been strong sources of motivation that nourished his Herculean efforts in science and spirituality over the years as his thoughts matured. Teilhard refers to the passage from a 1943 essay in which he is preoccupied with our "psychological need… to love human progress before"... we "can dedicate ourselves to it completely." He underscores the point that "the source of a universal love…can only come from Christianity, which alone can teach us how to love deeply…a universe whose very evolution has been impregnated with love."

> Because everything in the universe is in fact ultimately moving towards Christ-Omega; because cosmogenesis, moving in its totality through anthropogenesis, ultimately shows itself to be a Christogenesis; because of this, I say, it follows that the real is charged with a divine presence in the entirety of its tangible layers. As the mystics knew and felt, everything becomes physically and literally lovable in God; and conversely, God can be possessed and loved in everything around us... I repeat, if the whole movement of the world is in the service of a Christogenesis (which is another way of saying that Christ is attainable in his fullness only at the end and summit of cosmic evolution), <u>then clearly we can draw near to him and possess him only in and through the effort to bring all to fulfillment and synthesis in him</u> (emphasis mine). And this is the reason that life's general ascent towards higher consciousness as well as the whole of human endeavor enter organically and by right into the preoccupations and aspirations of charity (divine love).

Teilhard goes on to further explain the core of his action-mysticism which underlies his entire thought about the relationship of the Incarnation and, implicitly, the mystery of the Holy Eucharist to all of the spheres of cosmic evolution:

> We have seen that Christ, by reason of his position as Omega of the world, represents a focus towards whom and in whom everything converges. In other words, he appears as One in whom all reality…establishes union and contact in the only direction possible: the line of centres. What can this mean except that <u>every action, as soon as it is oriented towards him, takes on, without any change in itself, the psychic character of a centre-to-centre relationship, that is to say, of an act of love</u>… At first the Christian aspired only to be able to love…*while* acting. Now he [or she] is aware of being able to love *in* acting, that is to say…can unite…directly to the divine Centre through action itself, no matter what form such action takes. In him all activity is, if I may use the expression, 'amorized'… There are those today…among whom the lived conjunction of the two ideas of Incarnation and evolution has led to the creation of a synthesis of the personal and the universal. For the first time in history [human beings] are capable not only of understanding and serving, but of *loving evolution*. (Mooney, 1964, 161-2)

Teilhard, a Mature Jesuit Geologist & Mystic

In 1923 Teilhard was sent by the Paris Museum to join the Jesuit, Émile Licent, Director of the Natural History Museum in Tientsin. He and Licent set out on a four months expedition that was so successful that he decided to extend his stay into 1924 and so allow him to undertake another expedition with Father Licent the following Spring in the high Mongolian plateau and along the fringe of the Gobi desert. The manuscript of Teilhard's 'Mass on the World" bears the notation, "Ordos, 1923" suggesting that on occasion while on the expedition in the Ordos desert Teilhard prayed his famous prayer of which what follows is but the introductory paragraphs:

> Since once again, Lord—though this time not in the forests of the Aisne [in France] but in the steppes of Asia—I have neither bread, nor wine, nor altar, I will raise myself beyond these symbols, up to the pure majesty of the real itself; I, your priest, will make the whole earth my altar and on it will offer you all the labors and sufferings of the world.
>
> Over there, on the horizon, the sun has just touched with light the outermost fringe of the eastern sky. Once again, beneath this moving sheet of fire, the living surface of the earth wakes and trembles, and once again begins its fearful travail. I will place on my paten, O God, the harvest to be won by this renewal of labor. Into my chalice I shall pour all the sap which is to be pressed out this day from the earth's fruits. My paten and my chalice are the depths of a soul laid widely open to all the forces which in a moment will rise up from every corner of the earth and converge upon the Spirit… (Teilhard, 1961, p. 11)

Crowning Years of Scientific Achievement and Mysticism

Between 1923 and 1935 Teilhard had immersed himself in the Herculean task of mastering an understanding of the Geology of China and surrounding countries of southeastern Asia both as a result of his own work and that of his Chinese and expatriate European and American colleagues. In addition he was simultaneously absorbed in developing his approach to an "action-mysticism" that motivated him to an extraordinary degree in his efforts to link his thinking and his scientific work to their longterm culmination in "Christ-Omega." He found in George Barbour a geologist with whom, in the evenings after a day of field work, he could discuss some of his latest ideas on spirituality.

In 1929 the Director of the Geological Survey of China appointed Teilhard to the position of Honorary Advisor to the Director automatically elevating him to a position of influence in China and providing him with the means to carry out significant studies in geology and paleontology. While the position was termed Honorary Advisor, Teilhard, in fact, was very influential in planning major programs of field and laboratory research in geology and paleontology throughout China. Each year Teilhard personally participated in several months of field expeditions between 1929 and 1935, and later until his heart attack on June 1, 1947 and failing health, he made a number of visits to important human paleontological sites in southeastern Asia and in Africa that produced an important body of knowledge in both of these related fields.

In the summer of 1929 Teilhard joined his close friend and collaborator, George Barbour, first on an expedition along the Yangtze River (South-central China) to the Red River Basin in Szechwan (Fig. 2) then across the Tsinling Range from the Yellow River into the Han Basin (South–central China but north of the Yangtze).

Having been appointed Honorary Advisor to the Director of the geological Survey of China, Teilhard's beneficial influence on research continued to be felt more widely. Many of the Chinese geologists and paleontologists had been trained in Europe and they appreciated the high standards of research that Teilhard maintained in his own work on fundamental aspects of stratigraphy at both the continental and local scale.

The ten volumes of Teilhard's scientific research and an accompanying collection of high quality geological maps (Nicole and Karl Schmitz- Moorman, Eds. 1971), many of them in color, attest to Teilhard's efforts to establish as rigorous control as possible on stratigraphic correlations and more precise age dating methods. This was particularly of concern for preparing maps of the various stratigraphic layers and the related determination of ages of life forms. Special interest attaches to maps of subdivisions of Pleistocene deposits over large parts of southeastern Asia and particularly to those of Early and Late Pleistocene because rock formations of these ages might be discovered to be possible sites for finding human fossils.

The geological traverses, each requiring work extending over a period of several months, were in part planned by Teilhard and carried out personally by him and with his Chinese and expatriate colleagues. These China expeditions were planned so as over a period of several years to provide reconnaissance on all major parts of China, especially along the major rivers, as well as detailed information on specific localities such as the famous Chóu-Kóu-Tien site. This is the site where the famous human fossil, *Sinanthropos pekinensis*, Peking man as he became known, was discovered.

Chóu-Kóu-Tien and Peking Man

After the teeth of Peking man were found in 1929, Dr. Davidson Black, a Canadian, spearheaded the effort to establish the Cenozoic Laboratory as a joint research project under the Chinese Geological Survey supported by the Rockefeller Foundation. Teilhard was one of Black's closest friends and collaborators. Teilhard served as advisor and collaborator working in Peking at the Lockhart Hall laboratory and at the famous cave site, Chóu-Kóu-Tien. On Black's sudden and untimely death in 1934 Teilhard was asked to serve as Acting Director of the Cenozoic Laboratory until the new Director should arrive from Frankfurt.

Between these expeditions, Teilhard visited Peking where he met a number of scientists from various countries, contacts that expanded his horizons and contacts that made it attractive for him to consider making his exile from France enormously fruitful by staying on indefinitely in China. It was during this period that he apparently came to see the vast sweep of geology in Asia in a broader perspective than was previously possible. As a result Teilhard undoubtedly saw that his ambitious dream of coming to understand the tectonic construction of the eastern Asiatic continent including the vast region of China would be substantially aided by planning and carrying out the vast traverses over some of the most difficult terrane in the habitable parts of the earth.

Discovery Site of Peking Man *(Sinanthropus pekinensis)*

With the discovery first of a single, and later of two, humanoid or possibly human teeth in the Chóu-Kóu-Tien site, Davidson Black, Chair of neurology, embryology and anatomy at the Peiping Medical College, established the Cenozoic Laboratory for exhaustive research on this site. The Laboratory was a collaborative research unit under the Chinese Geological Survey supported by the Rockefeller Foundation. Teilhard served as a trusted advisor and collaborator as he developed a most productive working relationship and a lively friendship with Black as well as with several others.

One of his closest friends was George B. Barbour, geomorphologist and stratigrapher, who had worked at the Sang-han-ho diggings as early as 1925. George was a most astute scientist, who had taught at Yenching University since 1920 and was arguably Teilhard's most beloved and respected friend and colleague after Black. He was very skillful "in analyzing successive stages of the geology of a region, at finding in it clues to the periods of erosion and of fills, and of connecting these with orogenic or climatic events."

Amadeus Grabau, also an American, former professor at Columbia University and stratigrapher, taught at the Pei-ta or National University of Peking, father of all of the institutions for natural history, including *Paleontologia Sinica*, and gregarious host of scientists. He it was who assisted V.K.Ting to establish the Chinese Geological Society and the Museum of Natural History in Peking and Wen-hao Wong his colleague, who later succeeded Ting as Director of that organization. (Barbour, p.74).

Teilhard's Stature as a "Bridge-builder" and Geologist

Teilhard's relationships with the Chinese were consistent with his biblically-based spirituality: "Do as you would have others do unto you." This was particularly important because in 1929 with rising nationalism scientific expeditions began to meet increasing resistance from Chinese authorities:

"The Chinese have become so suspicious of research by foreigners that every non-Chinese *organization* (even though established in China, like the Licent museum) is looked at askance. *Individual* foreigners on the other hand (like me) are welcome. (2 April, 1929). (Cuénot, p.76) Even the Geological Survey of China was affected to the point of feeling that it had to take rigorous precautions in dealing with foreign expeditions.

In connection with this growing nationalist feeling on the part of the Chinese there is an interesting and instructive letter by Teilhard (13 April, 1929) that shows his insight in appreciating the outlook of this people, an outlook that might well serve today to alleviate international tensions if Teilhard's words were to be heeded:

> The end of my stay in Peking has been interesting and busy. I have been to see Sven Hedin [a Swedish scientist]. We had three hours of friendly and even intimate conversation. Hedin is a "most fascinating man" who is obviously lavish with his charm....When he was getting ready to go to Turkestan in 1926, Hedin came up against Chinese touchiness about rights in scientific material, and he was the first to accept the conditions they insisted on....He was criticized at the time, I know, and disowned by even his best European friends, who accused him of going over to the Chinese. Just then I met him, and urged him to trust the Chinese and work in with them. He is still touchingly grateful to me, as though my words had kept him going during the long months that preceded his success, which is now complete. He now has the full confidence of even the most anti-foreign Chinese, and every single one of those he took with him is now his devoted friend. (Cuenot, 76)

"The reaction of the Chinese to Teilhard's enlightened attitude to cooperation between East and West was to invite him to exercise general supervision over the Geological Survey." (Cuenot, 77) Teilhard's approach to interpersonal and intercultural cooperation reminds me of the enlightened approach on the part of the first Jesuit mathematician and astronomer to be allowed entrance to China in 1583. That Jesuit, Matteo Ricci, was elevated to the rank of Mandarin and eventually invited by the Emperor to serve as the Imperial Astronomer, thus paving the way for two Jesuit astronomers to also follow in his footsteps as imperial astronomers. The Jesuit Joseph F. MacDonnell attributes Ricci's success "to his personal qualities, his complete adaptation to Chinese customs and to his authoritative knowledge of the sciences." Such examples of sensitivity to cultural diversity as these might well be cultivated today.

Additional Themes related to Teilhard's Spirituality

In his lifelong attempt at a synthesis of his progressively evolving thought and spirituality, Teilhard's "new mysticism" is focused simultaneously on love of Jesus and on love of the earth (as part of the cosmos). (Skehan, in press 2005) Teilhard wanted his twofold whole-hearted and simultaneous love of the God-man and of the earth to be the center of, and to encapsulate, his spirituality. He does so in this famous question in a letter written on April 15, 1916: "Besides a communion with God and a communion with the earth, is there not also a communion with God in and through the earth?"

In Teilhard's letter dated 15/4/1916 he reflects as follows: "I've been trying to discover what there could be that is divine so-to-speak within matter of the cosmos. Cannot the object…of our human love be transfigured, transferred into the…divine? I want to love Christ with all my strength in the very act of loving the universe… Besides a communion with God and a communion with the earth, is there not also a communion with God in and through the earth?"

Because Teilhard's writings are sometimes both poetic and abstract, the theology at times may be difficult to extract. Additionally one may wonder at the source of some of his ideas and themes. I have become convinced over the years that some of Teilhard's fundamental themes and insights are either explicit or implicit, not surprisingly in the writings of St. Ignatius, Founder of the Jesuit Order, including his *Spiritual Exercises.*

The little book of the *Spiritual Exercises* of Ignatius is one of the great spiritual classics by the founder of the Jesuit Order, a man whom Egan calls one of the greatest mystics of all time. It is not a book merely to be read but represents a prolonged series of meditations that are calculated to lead to spiritual practices based on the life of Jesus that are meant to be followed by the maturing Christian. In the receptive Christian, and especially in Teilhard, the guiding principle is "to find God in all things", a theme that is pervasive in a variety of forms in Teilhard's writings. Teilhard was perhaps one of the most receptive of Ignatius' many receptive followers, because his experiences of prayer "set him on fire" with an intense desire to accomplish great things for Jesus in the work of bringing to fulfillment His kingdom. This motivation was what spurred him on in his Herculean accomplishments in geology and paleontology and equally so in his writings on spirituality. Prayer or intimate union fueled the fire of his love and desire to excel.

The phrase, "finding God in all things" that summarizes Ignatius' mysticism and that of many members of the Jesuit Order, is a mysticism of deep desires to live a life of accomplishment looking to Christ-Omega. I believe that Ignatius of Loyola in his book, *Spiritual Exercises*, and teachings based on it are the driving force at the heart of Teilhard's motivation and that of the Society of Jesus.

"From as long ago as the Middle Ages and continuing into our own day there is a valid Christian tradition of passive spirituality that still flourishes, known as 'apophatic' or as a mysticism of unknowing. The venerable and traditional *mysticism* of unknowing is traced at least as far as to a 14th century classic, the anonymously authored *Cloud of Unknowing*."

Teilhard, on the other hand, writes about and has practiced another kind of mysticism that has its proximate roots in Ignatius' *Spiritual Exercises* and is correctly characterized as a mysticism of action, a "katophatic" mysticism if you will. (Skehan, 2005, p.199). Teilhard phrases it boldly in referring to earth not only as our nearest planet but to activities that take place on it. One of his most succinct formulations sums it up as follows: "There is a communion with God; there is a communion with Earth; is there not also a communion with God through Earth?"

Bibliography

Appleton-Weber, Sarah, ed. and trans. *The HumanPhenomenon*. Brighton, England: Sussex Academic Press, 1999.

Barbour, G.B. *In the Field with Teilhard de Chardin,* Herder and Herder: New York, 1965, 160.

Cowell, Sion. *The Teilhard Lexicon: Understanding the Language, Terminology and Vision of the writings of Pierre Teilhard de Chardin*. (Brighton, UK/Portland, OR: Sussex Academic Press, 2001, 231.

Cuénot, C. *Teilhard de Chardin: A Biographical Study*, Baltimore: Helicon Press, Inc., 1965.

De Lubac, H. *The Religion of Teilhard de Chardin*. New York: William Collins Sons, Inc., 1967. Originally published in French under the title *La pensée religieuse du Père Teilhard de Chardin*, Editions Montaigne, 1962.

Egan, S.J., Harvey D. *An Anthology of Christian Mysticism*, Collegeville, Minn., The Liturgical Press, 1991, 680 pp.

Egan, S.J., Harvey D. *Ignatius Loyola the Mystic*. Michael Glazier: Wilmington, Delaware. In Noel Dermot O'Donoghue, ODC, (editor) *The Way of the Christian Mystics,* 1987, 229 pp.

Egan, S.J., Harvey D. *The Future of a Tradition*. New York: Pueblo, 1984.

Egan, S.J., Harvey D. *What are they saying about Mysticism*, New York; Paulist Press, 1982, 134 pp.

Fleming, S.J., D.L. *The Spiritual Exercises of St. Ignatius: A Literal Translation and A Contemporary Reading,* St. Louis: The Institute of Jesuit Sources, 1978.

King, T. M. *Teilhard's Mysticism of Knowing.* New York: The Seabury Press, 1982, 154 pp.

King, Ursula. *Spirit of Fire: The Life and Vision of Teilhard de Chardin,* Maryknoll, N.Y.: Orbis Books, 181 pp.

King, Ursula. *The Spirit of One Earth: Reflections on Teilhard de Chardin and Global Spirituality.* (New York: Paragon House, 1989.

King, Ursula. *Christ in All Things: Exploring Spirituality with Teilhard de Chardin.* Maryknoll, N.Y.: Orbis Books, 181 pp.

Mooney, S.J., C.F. *Teilhard de Chardin and the Mystery of Christ.* New York: Harper and Row, Publishers, 1966.

Lonergan, Bernard J.F. *Method in Theology.* (New York, NY: Herder and Herder, 1972, 405 pp.

MacDonnell, S.J., Joseph F. *Jesuit Geometers.* St. Louis, MO: The Institute of Jesuit Sources, St. Louis University, 1989, 80 pp.

MacDonnell, S.J., Joseph F. *Jesuit Family Album: Sketches of Chivalry from the Early Society.* The Clavius Group, Fairfield University,: Fairfield, CT, 1997, 220 pp.

McMenamin, Mark A.S. *Evolution of the Noosphere.* Teilhard Studies, 42, New York: American Teilhard Association for the Future of Man, 2001.

McMenamin, Mark A.S. "The Ptychopariod Trilobite *Skehanos* gen. nov. from the Middle Cambrian of Avalonian Massachusetts and the Carolina Slate belt, USA." Northeastern Geology and Environmental Sciences, 2002, 24 (4), 276-281.

McMenamin, Mark A.S., and McMenamin, D. L. S. *The Emergence of Animals: The Cambrian Breakthrough*, New York: Columbia University Press.

Mooney, S.J., Christopher F. *Teilhard de Chardin and the Mystery of Chrtst.* Harper and Row: New York, NY, 1964, 288 pp.

Schmitz-Moorman, Nicole and Karl, Editors. *Pierre Teilhard de Chardin, L'Oeuvre Scientifique.* Ten volumes (Tomes 1-10), 4634 pp. and one volume of 39 geologic maps. Walter Verlag: Olten und Freiburg im Breisgau, 1971.

Skehan, S.J., James W. "The Role and Importance of Research and Publication in Church-Related Schools." In Brungs, S.J., Robert A. (Ed.), *Science/Technology Education in*

Church-Related Colleges and Universities. Saint Louis: ITEST Faith/Science Press, 1990, pp. 110-125.

Skehan, S.J., James W. *Place Me With Your Son: Ignatian Spirituality in Everyday Life*. Third edition, Washington, D.C.: Georgetown University Press, 1991, 165.

Skehan, S.J., James W. *Place Me With Your Son: Ignatian Spirituality in Everyday Life*. Director's Guide to Third edition. Washington, D.C.: Georgetown University Press, 1994, 83.

Skehan, James W. "Assembly and Dispersal of Supercontinents: The View from Avalon." *Journal of Geodynamics*, 23 (3/4), 1997, p. 237-262.

Skehan, S.J., James W. "Spiritual Foundations for Ethics in the Geosciences." Unpublished Keynote Address to the Geological Society of America's (GSA) Presidential Penrose Conference. *Ethics in the Geosciences*. The Welches, Oregon, 1997, 16 pp.

Skehan, S.J., James W. *Praying With Teilhard de Chardin*. Winona, MN: St. Mary's Press, 2001, 123 pp.

Skehan, S.J., J.W. "Exploring Teilhard's 'New Mysticism': 'Building the Cosmos'." *Journal of Ecotheology*, v.1, no. 1, 2005. Editor: Celia Deane-Drummond, Equinox Publishing Ltd.: London, UK.

Teilhard de Chardin, Pierre. *The Divine Milieu*. Harper Colophon Books, Harper & Row, Publishers, 1960, 160 pp.

Teilhard de Chardin, Pierre. *The Phenomenon of Man*. New York: Harper Torchbooks, Harper & Row, Publishers, 1959, 320 pp.

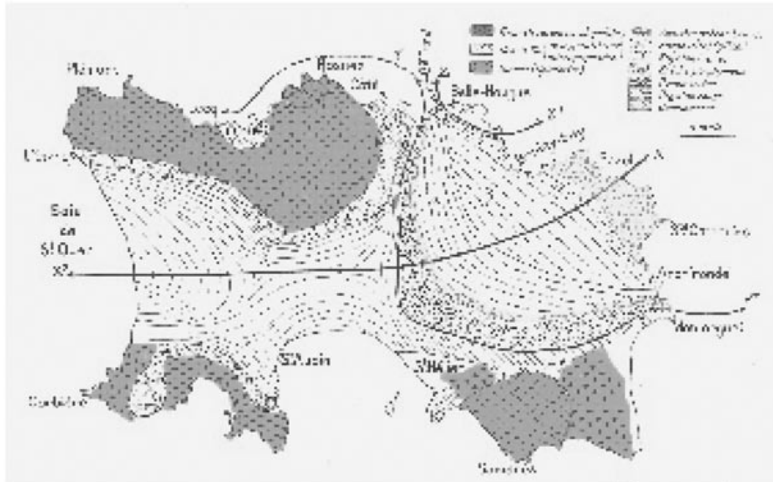
Teilhard de Chardin, Pierre. *Letters from a Traveler*. New York: Harper and Row, Publishers, 1962, 380pp.

Teilhard de Chardin, Pierre. *The Future of Man*. New York: Harper and Row, Publishers, 1964, 319 pp.

Teilhard de Chardin, Pierre. *How I Believe*. New York: Harper and Row, 1969.

Teilhard de Chardin, Pierre. "*The Mass on the World*". New York, NY: Harper and Row, Publishers, 1923, 196 pp.

Vernadsky, V.I. *The Biosphere*. Translation by David Langmuir with annotations by M.M. McMenamin, 1998, 192.



- Figure 1. The Structure of the Isle of Jersey 1919, Teilhard de Chardin Tome 1, p.201

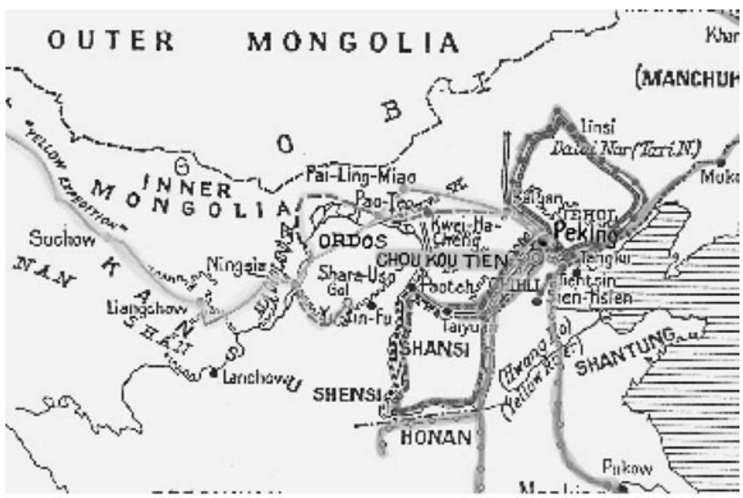


Figure 3 Map of China (cropped), King

Teilhard
the Soldier
1915
Figure 2.