NEOGENESIS

OR: MY LIFE STORY:

AN AUTOBIOGRAPHY OF SORTS

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WHO AM I?

It is a very special privilege to be alive: to maintain an individual, unique identity amidst constantly fluctuating conditions while experiencing the consciousness that is able to reflect on the nature of that identity. Who am I? “I am that I am” says One; but who “I am” depends entirely on the perspective from which “I” am inquiring.

From a strictly *egocentric* perspective, I appear to be a personality acting within a cultural context. I had a birth, then an upbringing within a family, then a maturing into adulthood, and eventually, I am told, I will disintegrate at death – in other words, I experience an *ontogeny*. I can see other personalities around me who seem to have very different conditions than my own. I feel the desire to optimize my own conditions so that I may be regarded by others as having a superior ontogeny, as defined by the values of my cultural context. This desire spawns many other desires, not the least of which is the desire to win in the competition to attract a prime mate with which to reproduce myself. The vague desire to optimize my conditions can never be fully satisfied, however, and I eventually disintegrate still full of desires, never to return again as this particular ego-personality. The egocentric perspective obviously has a very short and limited life-span: It is a seemingly valid perspective from which to act for fulfilling certain desires, but it is ultimately a very narrow view from which to describe my Life Story.

I could assume an *anthropocentric* perspective to describe who I am. In that case, I identify with my species *sapiens*, or my genus *Homo*. I see myself as a human being with a history of human development, a species development called *phylogeny*. I can reason, based on the prevailing hypothesis, that I emerged from the apes; and because of my superior brain I came to be the pinnacle of Creation – the ultimate life-form – with license to dominate, control, and utilize for functional ends all those life-forms inferior to me. Believing that I am the pinnacle of Creation (as if it were a static situation), I am fully justified in creating a world according to my own image, to meet my own needs. This may expand my perspective from a strictly *egocentric* point of view, but it too ultimately becomes limited within a larger context, for species come and go, and I can never have complete assurance that the species ‘I am’ will be the finality of evolution.

To overcome this limitation to understanding my Life Story, I can expand my perspective to a full *biocentric* point of view – identification with *all* Life, particularly Life on Earth. This could be called a *Gaian* perspective: the identity that is my "I" can then be Gaia herself.[1] From this vantage point, my extremely narrow egocentric point of view – and even my expanded, though still limited, anthropocentric point of view – becomes somewhat insignificant. These foci of identity certainly have their usefulness as bases for undertaking certain activities, but they will never be enough to describe my full Life Story, for Gaian Life has been around for 3.5 *billion* years. From a biocentric point of view, I can extend my identification to include all other life-forms on Earth. Suddenly, the bear and the deer are my brothers and sisters; the conifers and the angiosperms are my cousins; the frog and the salmon are my grandparents; and the prokaryotic bacteria are my distant ancestors. It ought to be mentioned that indigenous cultures generally hold a biocentric perspective as the prevailing worldview: It is not only scientifically valid, it demonstrates practical wisdom in the sense of long-term viability, for how could I possibly harm or eliminate one of my brothers or sisters without injuring myself?

Yet, ultimately, even a biocentric Gaian perspective can become limited, for Gaia came to life within a larger, more inclusive living system: the particular *solar* system with our Sun as the center. To begin my Life Story with the birth of the Sun would be to assume a *heliocentric* perspective. Yes, identification with the presence and profusion of Gaian life is a phenomenological achievement worthy of veneration; but even Gaia depends on *her* life with a continuous energetic infusion from the Sun. Thus, the Sun and its solar system is the greater intelligence of ordered existence.

But what could it possibly mean to assume a heliocentric perspective, to regard the Sun as the source of my 'I'? Am I then to assume that Mars and Venus are my relatives? As an integral living component of Gaia, nurtured within her folds from birth, I sentimentally hold Her dear to my heart – but she too will pass some day, as all existents must pass. The Sun someday will grow so large and so hot that biological life will not be able to persist on Earth. Concurrently, numerous other planets within the orbits of other stars in our local galaxy will arrive at just the right conditions for biological life to be initiated there. And then, of course, the Sun's destiny is to consume by nuclear fusion all the elements in its interior, ultimately exhausting itself, until such time that it explodes in a nova or dwindles into a cold dense has-been.

So, in the final cosmological analysis, even a heliocentric perspective becomes limited – though it is far more inclusionary than an egocentric or an anthropocentric or even a biocentric perspective. The Sun is an integral component of the larger living *galactic* system, a still higher or more inclusive order of intelligence. I am tempted, though hesitant, to begin my Life Story with the self-emergent birth of our galaxy, the

[1] Gaia was the Greek appellation for the Goddess of the Earth.

so-called Milky Way. I am hesitant because *that* scale of the manifestation of Life is dimensionally removed from my ability to comprehend. Still, the Life that is the source of my 'I' *must* have originated there. To be able to relate to this order of life would be to identify with the galactic center, what the ancient Maya called "Hunab Ku." In such a relation, other stars conceivably would be my relatives. Yet even galaxies – as autonomous, self-organizing, self-referencing, cognitive unities – have their own life cycles of birth, growth, and decay; and so the origin of my Life Story must even precede a *galactic* identity. I am left to conclude that the search for "Who am I," to become truly comprehensive, must become universal, pre-existing any particular material manifestation.

NEOGENESIS

Our Sun burst to life some 5 billion years ago. A star comes into being when an initial warping of interstellar space produces a focal point of gravitational attraction that is able to initiate a process of self-organization, leading to the manifestation of an individual, unique identity. Once this distinction is established from its background (and recognized as such by an observer), the interstellar focal point is able to intensify its gravitational attraction in ever increasing momentum until it reaches a stage of such ecstatic, disequilibriated chaos that it spontaneously emerges into a new level of complex order – and bursts into autonomous existence as a star. The emergence of a star from out of the void is the beginning of a new round of Life – *neogenesis*. All the subsequent Life that is the star's progeny will experience a similar process of self-organizing emergence.

Although absolutely amazing – and somewhat incomprehensible from a grounded earthly existence – this process is not all that extraordinary: new stars are being born all the time; and at a higher, more inclusive level, new galaxies of stars also experience this same self-organizing process. What *is* extraordinary is that warps in the space-time continuum of interstellar space are common; yet it takes a very special set of conditions and the appropriate context – one might say destiny – for one of these warps to take the next step of beginning the intensified self-organizing process that ultimately leads to a new star, and thus the recurring genesis of Life.

It is tempting, perhaps even useful, from a rational, seemingly objective perspective, to regard this amazing neogenesis as a random, chance event – just as the spontaneous emergence of biological life is considered to be a random, chance event, and thus an anomaly. Yet, a more timeless, all-encompassing perspective will reveal that neither the emergence of a star nor the emergence of biological life are random or chance events at all: both are inevitable when the conditions are favorable for their appearance, and when these conditions arise within an ordered, opportunistic context that can be viewed as a greater, more inclusive, nurturing whole – that is, an overarching intelligence.

Our Sun came into existence without much fanfare – a relatively modest star making its appearance at some point well into the ongoing, energetic outbreath of the so-called Big Bang. No doubt, there were many other stars birthing themselves throughout the Universe at that same time, some much larger, and others more dimunitive than the Sun.[2] Our home star appeared in a field of space clouded with fundamental universal elements, debris that was previously scattered by the explosive finale of a former star. As the Sun's gravitational field strengthened during its self-organization, it pulled all the surrounding stardust into its influence, setting up an orbit spinning in relation to the Sun's own orbit around the galactic center. Another amazing process of self-organization then occurred as ten major planets coalesced out of the orbiting stardust, creating a solar system, a family of celestial autonomous unities, each with its own personality. Some stars have no planets at all.

The first half-billion years of our nascent solar system saw the planets assuming regular, cyclic elliptical patterns around their solar center, establishing well-defined boundaries, integrating into their respective identities and densities depending on their position from the center, and beginning their own processes as self-maintaining, autonomous unities. For the third planet from the Sun, Earth, this meant geological processes: the newly formed and still half molten crust heaved and buckled in tectonic tension, heavier elements sank toward the center as lighter ones moved to the periphery, volcanoes spewed gases while new material flowed from the interior, and eventually continents formed. In concurrence with all this activity, an atmosphere was produced, a thin veil of cloud cover creating a protective membrane within which autocatalytic chemical reactions could proceed in a self-contained environment.

The Earth was situated in such a way in the early solar system that it also could experience hydrological processes: the Earth was positioned in that comfortable thermal range where water can endure in its liquid state. With the creation of a protective atmosphere, outgassing water from the interior could be held within the chemically active zone close to the surface. The outgassing water held in the atmosphere mixed with sulfurous clouds spewing from volcanic activity, and condensed into rain. The rain fell for millions of years until great oceans were formed. Once a planet is able to maintain standing water within a protective membranous atmosphere, the spontaneous emergence of biological, carbon-based life is virtually ensured; these are the conditions and context favorable for its appearance; and, it has happened repeatedly.

[2] Why is it that other stars have formal names while the only way to address our star is as 'the Sun'? Is this cultural specific?

NEOBIOGENESIS

The Sun and its solar system have a life expectancy of some 8 billion years. After 1.5 billion years into its evolution, or 3.5 billion years ago, the stage was set for the appearance of biological life. Earth at that time was quite a dynamic, fertile setting: well-defined lithosphere, atmosphere, and hydrosphere were interacting, blending, and intermingling with one another, exchanging elements and creating increasingly complex chains of chemical compounds, telluric arrangements of recycled stardust. Diurnally energized by solar radiation and intermittently hyper-energized by electrical flashes, these complex chemical chains occasionally would find themselves in conditions far from equilibrium, where they would be thrust into configurations not possible in more stable, un-energized states. Of particular importance for neobiogenesis were the patterns and structures created by the hyper-energized states of complex *carbon*-compound chains: amino acids, proteins, and associated enzymes. During hyper-energized conditions, these molecules have the ability to catalyze each other, perpetuating and prolonging their excitatory state, forming and maintaining unlikely closed-loops and self-referring rings according to their geometry (especially the geometry, and atomic number and weight, of the carbon atom). By sustaining their improbable patterns of ordered relationships for extended periods, before dissipating back into their amorphous background, these complex, autocatalytic rings made indelible impressions upon their environments by the morphological memory of having come into existence.

This relationship between the new structures and the immediate environments in which they occur is extremely vital; in fact, it is mutually defining. Once an impression has been made, the next time similar conditions appear, there is already a 'mental' model for the new structure to align with. New structures can form more quickly and sustain their patterns for longer periods, because there is a precedent of recursive mutual interaction impressed into the environment from what has come before. This is the initial emergence of 'mind,' and the commencement of an evolutionary procession. Eventually, these improbable, pre-organic patterns of complex carbon rings are sustained long enough so as to appear as distinct autonomous unities distinguishable from their background (as perceived by an observer). As seemingly independent unities, with enclosed boundaries, and the ability to autocatalyze, these rudimentary structures are the precursors to the simple cells that mark the beginning of biological life.

That crucial distinction between living and nonliving, that once again amazing and almost incomprehensible phenomenon, that very fine line that demarcates the miracle of Life is crossed when one of these rudimentary structures begins sustaining *itself*, as a cooperative network of interacting constituents, in an act of *self*-making, or "autopoiesis" (Maturana and Varela, 1973).

Autopoiesis is at once also an act of cognition: it creates an embodied unity acting autonomously within and standing in relief from a background environment, learning from its actions by adjusting its behavior with feedback, the sole intention being the continued maintenance of its autopoiesis, or self-organization. "Living as a process is a process of cognition" (Maturana and Varela, 1987). By maintaining its self-organization, the embodied unity can then act in relationship with its environment *as if* it were an independent entity, transmitting and receiving objective information. The independence is ultimately illusory, however, because the autonomous unity that is the biological structure can *only* exist coupled to the environment of which it is a part – it does not exist otherwise. Its entire identity is a history of ongoing structural coupling to that environment. The autonomous unity that is the biological structure is completely composed of elements from its environment; it is a complete reflection and focused concentration of its environment. The two exist and continue to develop side-by-side as a concerted, symbiotic expression of co-evolution.

The autonomous unity that is a biological structure can only sustain itself and maintain its definitive pattern of autopoiesis by perpetuating highly energized conditions far from equilibrium. To accomplish this, it must import highly ordered material from its surrounding environment, digest the material in the process of metabolism, and then discharge highly entropic waste material back into its environment. Such conditions can only exist with the continual influx of high quality energy from the environment. If the high quality energy is depleted, the autonomous unity that is a self-organizing biological structure must eventually dissipate and fade back into its amorphous background, which of course has an order of its own.

These then, are the three qualities essential for Life (as outlined by Capra, 1996): 1) a *pattern* of autopoiesis, or self-organization; 2) a *process* of cognition, or effective embodied action structurally coupled to a reciprocating environment; and 3) the *form* of a dissipative structure, or an autonomous unity operating in an energetic condition far from equilibrium. These three qualities are present in all systems that can be characterized as living systems.

The prototypal living systems of the early Earth were carbon-based single cells living in a water medium – living systems as self-reproducing organisms. Nature worked and reworked this same basic configuration in countless ways for 2 billion years, experimenting with new forms and methods of reproduction and metabolism, yet always maintaining the same fundamental pattern. As the Earth came alive, these unicellular ‘prokaryotes,’ or bacteria, filled every available niche, turning the oceans into a rich soup teeming with the Dance of Life. And since living systems act upon their environment in such a way that the two become one singular process of co-evolution, the physical condition of the Earth was being modified by the profusion of Life. First, the chemical composition of the oceans and seas was altered as they were hosting and interfacing with metabolizing living systems, with smaller shallow pools becoming micro-environments of novel viscosity and consistency. And then, eventually, the ubiquitous global presence of the bacteria began to act upon and influence the atmosphere.

The earliest biotechnology for digesting food was fermentation – an anaerobic process of absorbing and breaking down complex carbon chains into usable forms for energy. At some point, well into the first 2 billion years of wild experimentation, a line of cells was produced that learned to use energy directly from the Sun. This line of cells, cyanobacteria or blue-green algae, developed the biotechnology of photosynthesis. It was a remarkable achievement: the necessary vital carbon could then be sequestered directly from the dense CO2 concentration in the atmosphere, then combined with water to be converted into usable sugar-food. These cyanobacteria, the forerunners of green plants, were about to start a revolution. The output of the chemical process of photosynthesis is oxygen, O2. Free oxygen is a highly reactive gas, a catalyst capable of accelerating chemical activity; and for the cells that had lived so long in anaerobic conditions, oxygen was very much a poison. As the cyanobacteria proliferated and expanded their photosynthetic operations, free oxygen began to accumulate in the atmosphere. Earth would never be the same again – this was a planetary crisis!

The single-celled prokaryotes had lived a very simple life up to this point: eating each other or each others’ wastes, occasionally exchanging information, no need to be very social. Now they would need to learn to cooperate. As the caustic oxygen level increased, some unicellulars attempted to find refuge by invading and living inside the membranes of others. This must have been quite a chaotic period, demanding the leap to a new level of complexity and organization. If the invading members destroyed their hosts, they would ultimately perish anyway; while if those being invaded learned to assimilate, they could increase their chances for survival. What worked best for all was learning to live together symbiotically. This began the evolution of the ‘eukaryotic’ cells: unicellulars with numerous cooperating sub-components called organelles, centered upon a nucleus capable of storing and passing on hereditary information, with the whole living system capable of using oxygen respiration as a source of energy by the incorporation and activity of specific organelles called mitochondria. Through cooperation, the poison was turned into a resource.

SECOND-ORDER BIOGENESIS

The emergence of the eukaryotes 1.5 billion years ago was a momentous period in the evolution of Earthlife. Here was the second prototypal organic living system, more complex than the previous simple cells and thus capable of expanded cognitive potential, yet nonetheless composed of the same basic elements and configurations that could be traced in a direct line of descent all the way back to those first pre-biotic carbon rings. And, these second-order, organic living systems maintained the three essential qualities enumerated by Capra: 1) they were self-organizing; 2) they operated in energetic conditions far from equilibrium; and 3) they lived and sustained themselves by a process of cognition, a feedback exchange of effective action within a living, evolving medium.

It is very important to note that this pattern of structural organization that developed at the eukaryotic cell stage 1.5 billion years ago is the same identical pattern used by organic living systems today. In fact, there is only one more prototypal stage of organic living system to have developed: that of third-order *metacellulars*; yet, all metacellulars, from human beings to broccolis and beyond, are still just more complex configurations of the same basic pattern created at the eukaryotic stage. All metacellulars are just that: many of these individual eukaryotic cells bundled and integrated together, obtaining emergent properties of increased capabilities by their being larger, more inclusive wholes, and thus more cognitive. It is also significant to realize that the huge leap in self-organization represented by the eukaryotic stage was achieved by cooperation, synthesis, and a willingness to come together to overcome a crisis – the crisis of changing conditions necessitated the shift to a higher, more inclusive and all- encompassing perspective.

Life is very conservative – it persists with what works. That's why the world is still full of the same simple bacteria having their origin 3.5 billion years ago, these prototypal cells living all that time without changing. At the same time, Life is continually reaching out, diversifying, complexifying, testing new possibilities just because it can. This is the direction and trajectory of evolution. But each new stage of the branching process is entirely, completely, irreversibly a result of what has been, what has gone before. There is an intimate, direct line of ascension and descension; new biological life-forms do not suddenly appear out of nowhere – they are progressively built up from previous structures, patterns, and configurations. All metacellulars today are direct descendants of that first eukaryotic cell that was able to integrate itself, incorporating other components into its system in cooperative mutual-interdependence, and beginning its existence as a new kind of autonomous, self-organizing unity capable of reproduction. It is just not possible for any species, no matter how advanced in the progression, to emancipate itself from Nature, to become separate or superior – Nature is a highly interactive, mutually-interdependent, holarchical Web of Life. Each component of the system is intimately connected with all other components; the well-being of each enhances the well-being of all. Notions like separation, emancipation, or superiority occur entirely within an ideational, noetic, or linguistic domain. From a biological or ecological perspective, just as the mystics have always proclaimed, all Life is One.

The experimentation and synthesization that led to the cooperative social arrangement that is the nature of the eukaryotic cell proved to be a major success, with far-reaching adaptive advantages. Each cell, like a self-contained settlement, could produce the materials it needed internally; it was informationally *closed* – a self-referring, self-maintaining, self-repairing, self-organizing, organic living system. Yet, to sustain its organization as an autonomous unity operating far from equilibrium, it was necessarily *open* to the flow of materials, energy, and information. These it transformed or transmuted for its own purposes – the primary two being the maintenance of its autopoiesis and the insurance of its reproductive capacity. *The eukaryotic cell was a cognitive system structurally coupled to an environment*. It would shape its immediate environment for its own needs, and upon receiving feedback from the environment, it would learn and thus modify its behavior to perpetuate its ongoing pattern of organization, its ability to remain *self*-organizing. For half a billion years, the eukaryotic pattern tested, modified, and perfected itself. It was so successful at adapting to and synchronizing with its immediate environment that it was soon ready for emergence into a higher level of complexity and order – that of the metacellular, or a conglomeration of these single cells joining together and acting as a cooperative unity.

THIRD-ORDER BIOGENESIS

The time was approximately 1 billion years ago, or 4 billion years into the life-cycle of the Sun, half of its life-expectancy expired. Life had been a process on Earth for almost 2.5 billion years, long enough for it to maintain homeostatic conditions of comfort and stability favorable for its continuation. Despite a quarter-fold increase in the Sun's radiation output since its inception, life-processes kept the thermal range constant. A highly improbable, chemically unstable atmosphere of 21% oxygen, 78% nitrogen, .03% carbon dioxide, and many trace gases was established and stabilized, whose consistency would be maintained up to the present day. Oceans covered 70% of the surface of the globe, with moving, floating continental plates topping off the remaining 30%. Dynamic weather patterns cycled materials from the landmasses into the waters; thick, slimy mats of unicellular organisms would form in shallow waters. To an observer, planet Earth would have appeared quite alive – a massive, self-regulating, self-organizing living system: Gaia (Lovelock, 1979).

The first multicellular organisms were seaweeds, chains of photosynthetic eukaryotic cyanobacteria strung together, united by the unique advantages offered by cooperative union. As a long chain, they could be swept to and fro, transported by the currents, thus interfacing with a greater variety of food sources. Their options for structural coupling increased, and thus their cognitive capacities were enhanced. After successive generations in cooperative union, some of the cells would begin to specialize: some would take over motor functions, others respiration and energy production, still others would specialize in reproduction, and some would find a way to anchor the multicellular organism to a fixed spot; everybody, it seems, would come to have a role to play in the maintenance of the greater whole.

It cannot be overstated what a tremendous leap of potential these first metacellular prototypes afforded. The direction and trajectory of evolution toward ever increasing diversity, complexity, and collaboration could now advance exponentially, as each new multicellular form created could become the structural basis for more evolved forms. The learned ability to come together in cooperative collectives, where the primal directive of self-maintenance and self-organization could be extended to include the preservation of the whole collectivity, marked a quantum advancement in the creative potentialities of individual organisms, and marked a maturing of cognitive capabilities in the larger Gaian suprasystem.

The proliferation of the metacellular pattern assumed a momentum of its own. Soon, major leaps in life-forms or life-processes would be measured in the *millions* of years, as a rapid evolutionary radiation spanned the globe. The first multicellular animals appeared 700 million years ago, small worms whose expanded mobility was so much more purposeful than any of the previous life-forms. The animals also brought with them sexual reproduction, the sharing and transfer of genetic information spanning generations, where each new generation was required to begin its ontogeny as a single cell, and then grow into reproductive maturity before finally fading in advanced age. A trend toward increasing specialization was producing ever more specialized animals as well as ever more specialized cells, and this increasing complexity was organizing itself into subsystems within systems. For example, within the first 200 million years of the appearance of the animals, primitive nervous systems with embryonic brains arose; protective shells and skeletons were formed; digestive tracts were developed and formalized; and skeletal systems appeared. Each new development would build upon the ones that preceded it, and in turn would provide the foundation for further advancement. This bounteous elaboration of metacellular systems would often run into detours and dead-ends, but those organisms and forms that could prove themselves viable by maintaining their autopoiesis were projecting and sustaining a direct lineage that could be traced all the way back to that first prototypal eukaryote. These metacellular experiments, these ever more heterogeneous amalgamations, were nothing more than complex arrangements of that same, initial eukaryotic pattern – a collectivity of cooperating cells, self-organized and unified into ever greater, more inclusive wholes.

COLONIZATION

By 450 million years ago, Life was beginning to move out of the sea and onto dry land; for over 3 billion years Life had been exclusively an aquatic phenomena. This major advancement into the terrestrial realm required the development of many new and novel structures, patterns, and processes. It must be remembered that these autonomous unities moving onto the land were organisms, and as such, they were self-organizing, self-creating, self-maintaining, self-repairing, organic living systems. Any new innovations that arose were entirely produced internally by processes of the living system itself, resulting from feedback received during cognitive activities as structurally coupled unities in interaction with an environment. In no way was there an outside designer or authority. It is also significant that the innovative changes that were the product of evolution occurred within, and by the accumulated historical actions of, specific individuals. In no way is evolution the product of species transformations. Particular species exist only in the linguistic domain of an observer, as a categorization for formality of description and convenience of discussion (Maturana and Varela, 1987).

The first life-forms to settle ashore (multicellular life-forms that is, for the bacteria had completely covered the globe long before) were the plants – mosses and mats of algae that were occasionally left high and dry by receding tidal motions. It must have been an extremely harsh environment to find themselves in – direct sunlight, full gravity, rapid desiccation; but they endured and began to spread. Fifty million years later, the first animals came ashore – amphibians and insects, and they must have found some comfortable niches of plant life to settle with.

Just so the profundity of this last statement is not overlooked, it is worth revisiting and rewording: “The first animals came ashore 400 million years ago. They were amphibians.” Every human being alive today, as further expressions along the line of the animal kingdom, has an intimate connection with those early explorers; those first amphibians are direct ancestors of ours. They paved the way for us in the developments of morphology, anatomy, neurology, and adaptability to land surface conditions, etc. At an early stage of human embryology, the young infant-to-be has the likeness of a fish or tadpole. With the advent of *Homo sapiens sapiens* – modern, rational, scientific, civilized ‘man’ – it became fashionable to consider human beings as superior to Nature herself, in all her creative, abundant glory – and much more so superior to individual frogs. Yet how could this be? How could a component of the system be superior to the system itself? – especially when the component arose and owes its existence as a direct consequence of the entire lineage of processes that brought the system to its complex, complete wholeness?

After the first plants and animals became settled in their terrestrial milieu, Life proceeded forward in an accelerated complexification and ramification, an almost frenzied creative outburst. In rapid succession appeared the ferns, fungi, reptiles, conifers, and dinosaurs. (The dinosaurs reigned for 150 million years, roaming in a lush swampy environment that was over time converted into the oil, coal, and gas fields that are exploitatively being consumed in a mere 150 years!) By 200 million years ago, mammals had evolved, then birds, and then flowering plants. Earth was flourishing in a creative bloom of diversity and complexity. It took 2.5 billion years for Earthlife to evolve from the unicellular stage to the first multicellular organism. Within the next 1.2 billion years, the metacellular form had expanded over the entire globe, creating and filling in niches, and forming extended relationships of symbiotic, interdependent communities, or ecosystems, where each member has its role to play in contributing to the health and maintenance of the overall system. And even more dramatically, with every increase in complexity, organization, and mutual interaction, came an expansion of the cognitive capacities of the larger, more inclusive Gaian suprasystem.[3]

By 65 million years ago, out of the crucible of evolution that is Africa, out of the class of mammals, arose that complex bundle of self-organizing eukaryotes called 'primates.' These were small, arboreal, fruit and insect eating creatures who developed some unique capabilities: First, a life of jumping from branch to branch required accurate 3-D depth vision and the need for binocular eyesight. Life among the branches also meant continual grasping and the development of dexterous hands with an opposing thumb. (Hold your arm down loosely by your side and see your hand still shaped to hold that branch.)

The biological order of Gaia called primates continued to diversify and specialize. With cyclical periods of population pressure and resulting food shortages, the early primates would be forced to come down out of the trees, in groups, to scavenge the ground for food. They were very vulnerable out of their protective canopy and would need to raise themselves up periodically to scan over the tall grasses for predators, giving them temporarily erect postures and free hands. Individuals sighting danger

[3] Gaia is the name given to the conceptualizing of the living Earth as a "superorganism" (Lovelock 1987). Gaia certainly shares many of the characteristics of organisms: she is self-organizing, self-maintaining (homeostatic), self-repairing, informationally closed and energetically open, operating far from equilibrium, etc. But organisms are all carbon-based, cellular, and reproduce by exchanging genetic information. For these reasons, I contend, Gaia cannot be considered an organism; but she is certainly a living system, a special class of living system just as 'organism' is a special class. And, of course, all living systems are cognitive systems.

would elicit shrieks and gestures, signals and symbols understood by the group to run for the trees. Eventually, different kinds of vocal messages would come to stand for different kinds and intensities of danger. The primates were developing rudimentary communication – signals and symbols 'representing' conditions in the environment. The signals and symbols were not the reality in their own right; they were merely representations. But a consensus would grow among the group as to what exactly the signals and symbols stood for. This early languaging – that is, the use of vocal symbols to elicit cooperative group behavior – resulted in the continual use and thus growth of the cortex, a region of the brain growing on top of its reptilian substructure.

All of this brain growth took place over millions of years, and was not limited exclusively to the primates. Cetaceans, for example, dolphins and whales, have a larger brain capacity than any human, and the cetacean brain has been that way for over 3 million years. By 4 million years ago, a branch of primate had developed to the point that it can be considered proto-human. These early ancestors, known as the "southern apes," or *Australopithecus*, possessed all the essential 'human' characteristics: they stood upright, they gathered together in cooperative bands, they fashioned tools, they languaged, females would choose males capable of providing resources and protection during the extended infant development stages, they became increasingly purposeful, and most important of all, they began to develop culture, or a verbal transmission of living strategies from generation to generation – and the cortex continued to grow, that collection of neural assemblies providing that especially human capacity to make distinctions and abstract symbolic representations of the environment.

Evolution is largely a creative process of Life experimenting with new forms and possibilities, just because it can, just because there are no restrictions presented. Arguably, evolution is *not* a random mutation of forms, the most reproductively prolific of which are supposed 'proof' of an optimal fit to an objective, separate environment. This is so because all organisms co-evolve with their environments; the environment shapes the organism as much as the organism shapes the environment. The environment is not an objective, external given condition that the organism must somehow optimally adapt to; environment and organism are *mutually* defining, and ultimately have been growing together for billions of years.

Still, there is an element of 'natural selection.' Some novel forms are able to exploit a particular niche, in the short run, and rapidly select for the biological structures that contribute to the exploitation of that niche, until the niche is depleted, at which time the new structure will no longer be 'naturally selected.' In the long run, however, those evolutionary biological structures that are able to create conditions of mutual reinforcement, beneficial opportunities for the whole, and maximum diverse trajectories, will prove to be the most viable and consistently selected. Witness those early prokaryotic bacteria – they satisfy and provide all the above criteria and they are still thriving after 3.5 billion years.

The biological structure that enabled humans to exploit their niche (which has grown to include the whole planet) was the growth of the cortex, and even more distinctively, the emergence of the *neo*-cortex. Over the next several million years, humans underwent various stages of development that can be considered (from the vantage point of an observer) as distinct species: *Homo habilis*, *Homo erectus*, *Homo neanderthalensis*, *Homo sapiens*, and finally *Homo sapiens sapiens*. These were not clear-cut stages, as if one form would exist for a period and then subside while giving way to the next stage. Rather, the evolutionary development was continual, ongoing, radial, and at times co-existing, with different stages of the genus *Homo* living within proximity of time and space, sometimes forced to compete for resources.

At the *Homo neanderthalensis* stage, the growth of the cortex in primates reached its peak; Neanderthal was the stage of largest cephalic index, or brain volume (Brace, 1967, p. 108). The development of this organ provided the ability to visually represent through symbols aspects of the environment, and to communicate these impressions to future generations. This was art, the creation and recording of images; and art initially arose to give expression to emerging feelings of a numinous nature. Significantly, In terms of the 3.5 billion year evolution of the total Gaian life-system, one could say that Gaia had developed a structure *within* herself capable of observing and making images *of* herself.

By just 100,000 years ago, a form of human had developed that could be considered as distinct from *Homo neanderthalensis*. This creature, *Homo sapiens*, has as its distinguishing characteristic a conspicuous growth in the *frontal* lobe of the brain, a region called the neo-cortex. This growth was largely response to a changing environment, for *Homo sapiens* appeared during the onset of the age of glaciation, and has lived its entire existence in between ice advances. The growth of the neo-cortex enabled this new species to take the symbol generating capacity of the cortex, and project those symbols onto the future, an imaginary or anticipated situation that has yet to be. This is an important stage in the growth of planetary life because it creates a whole new domain of possibilities that has the potential to deviate from biological evolution and to take an evolutionary course of its own. Biological evolution is always occurring very much in the here and now.

By projecting symbols onto the future, *Homo sapiens* developed the capacity for abstract thought: for making predictions of the future based on prior information, for analyzing current conditions, for making models of reality that can be used in decision making processes, etc. This capacity for abstract, analytical thought gave *Homo sapiens* a huge advantage in coping with the changing conditions of a glacial period. As the ice sheet advanced and the climate turned harsh and cold, growth in the neo-cortex provided the ability to anticipate coming changes and to modify the environment accordingly. Instead of migrating south and dangerously crowding other groups, *Homo sapiens* would consciously adjust the local environment to ensure adaptability. This of course meant the rapid advancement of technologies: better hunting weapons, more effective fire manipulation with associated cookery, clothing production, construction techniques for shelter, etc., with the development of all the associated tools necessary to manufacture these artifacts. It also meant the rapid advancement and refinement of culture, the vehicle for the transmission of techniques and strategies through the generations, so that each generation could build upon the achievements and understanding of previous ones. This was necessary for *Homo sapiens*, because for their entire existence the environment suddenly could turn into a harsh, foreboding place that needed to be protected against, modified, and subdued.

This was especially true in Europe, where the glaciation was most severe. For a while, *Homo neanderthalensis* and *Homo sapiens* lived in close proximity. During early interglacial periods, when the weather was fair and the flora and fauna plenty, Neanderthal would venture north. As the ice sheet advanced, these Neanderthals had two choices: 1) migrate back down south and encounter fierce resistance from the groups already there, or 2) develop the cognitive abilities, enabled by growth in the neo-cortex, to anticipate coming changes and to begin preparing for them – to develop a sense of the future and a store of goods; or at least those that did created the distinction that is a self-conscious neo-cortex, that defining characteristic of *Homo sapiens*. Those that didn't would find themselves in competition with the newly developing human brain. Although having a larger cranial capacity that must have been capable of generating a wealth of images, Neanderthal was no match for the heavily frontal-lobed, and highly purposive newcomer. *Homo sapiens*, with its expanding technological prowess and increasing ability to control its immediate circumstances, must have hunted the primitive Neanderthals to extinction. *Homo sapiens*, as represented most distinctively by the accomplished Cro-magnon of southern Europe 40,000 years ago, had initiated the evolutionary trajectory that would become the basis of civilization – a completely abstract, human construction, and the product of a neo-cortex seeking to control its environment.

But that's another chapter...

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