21st CENTURY SCIENCE & TECHNOLOGY

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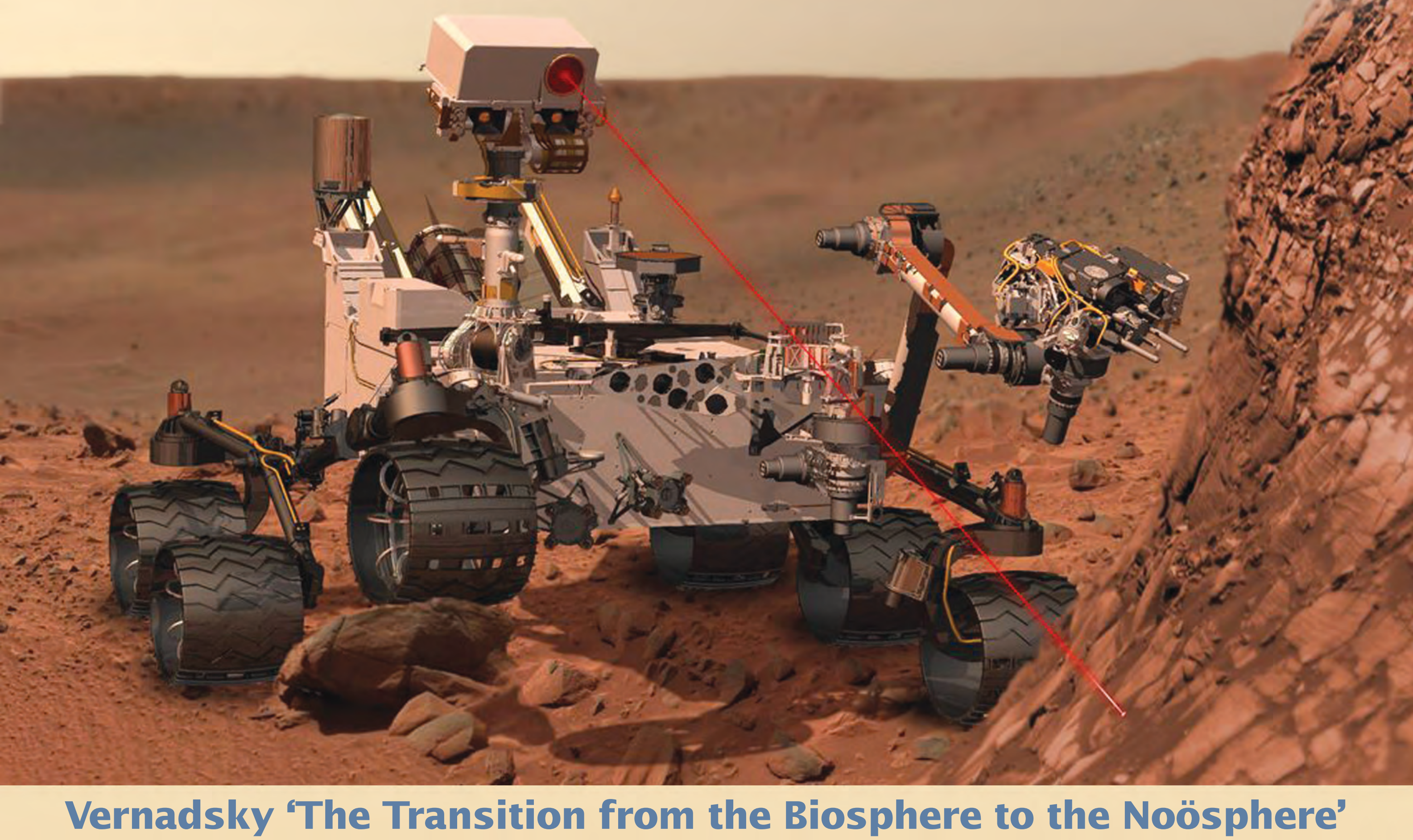
Scientific Thought as A Planetary Phenomenon



Vernadsky 'The Transition from the Biosphere to the Noösphere'
'The Evolution of Species and Living Matter'

21st CENTURY SCIENCE & TECHNOLOGY

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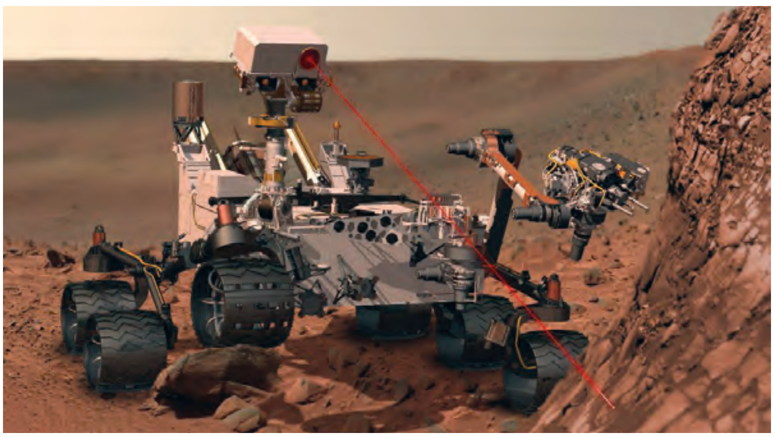
Features



On the Cover: *Curiosity* studying the Martian regolith. Image: NASA. Cover design by Alan Yue

News

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EDITORIAL

The Soul of Science

by Jason Ross

Today, science stands at a crossroads. Technological improvements continue, to a certain degree, but something is missing at the core. Just as we see a complete lack of political direction, of a future towards which we are moving, in the United States, so too is there a certain something missing in science. The question confronting us isn't one typically considered to be scientific, in the sense of regarding the empirical world outside us. There simply is no distinction to be made between the mind and the world beyond that it understands and acts on. That is, it were an error to believe that the world outside obeys deterministic natural laws which themselves have no requirements for existing besides internal consistency, excluding the requirement of purposefulness (or intention) that we apply to human ideas. Mind itself is excluded from science! Such an approach to the physical world leads to the twin problems of a belief in the existence of an empty (or topologically flat) space, and of the self-evidence of particles with self-determined principles of interaction, upon which larger phenomena are understood. We explore:

Examine biological evolution: at each major stage in the development of life, the current biosphere acted very much as a system in itself, open to the incoming radiation from the sun, but a complete system of activity in itself. Yet, when approached not from the timeframe of individual organisms, but rather from evolutionary time, we see not a system approaching a point of equilibrium, but one which continually reaches to higher states of equilibrium. By such measures as energy-density, the rate of biogenic flow of atoms, cephalization, and the increasing independence from the surrounding environment, including the move to land and more extreme climatic conditions, life has been on a march upwards. Towards what end do these different stages strive?

If we compare these evolutionary stages with the platforms of Man's mental and spiritual development, a similar, inescapable observation emerges: our relationship to the rest of nature has not remained fixed, but shows a series of developments which, in a purely biological context, would be understood as developments of new forms of life. We grew from using the power of our muscles, to that of animals drafted into our service, to the use of wind and flowing water to power machinery. Fire, a basic phenomenon of nature, became a tool for our species alone, and continues to be re-invented in higher forms: The fire of wood was outmatched by that of charcoal, then that of coal and coke, as well as petroleum, and the "fire" of the sub-atomic—the power of fission, fusion, and even matter-antimatter reactions. The biosphere itself is increasingly controlled, with plants developed to greater usefulness and caloric-density, irrigation channels built to irrigate land further from rivers, and, more recently, massive dams that shift and control great volumes of water, as well as microbes which are increasingly used as specific tools.

These developments have dramatically re-shaped the life of the human species. But, more importantly, the unique ability that makes these uniquely human endeavors possible—insight into the mind—has itself seen a great development, as an increasingly powerful force of nature in its own right. Unlike the evolution of the biosphere, however, human beings, endowed with free will, are able to decide not to advance. In this brief historical overview, we will watch the activity both of those who advanced human thought, and those who held it back.

The search for a grand unified theory stretches back millennia, but it is a quest which can never be completed. Contrast the sense of completeness of Plato and Aristotle, as evident not only in their explicitly scientific works, but by their means of communication as well. Plato's God does have a single composition of creation, but it need not be one that is completely comprehensible by Man. In his dialogues, Plato's Socrates comes to many more questions than conclusions, and frequently makes the overturning of false conclusions itself the intention of his discussions – as seen in, notably, his *Gorgias* and *Alcibiades*. In contrast, the didactic style of Aristotle created a system in which he was seen as an authority not of thinking, but rather of conclusions. Such a kind of authority means the end of science as a developing system, and indeed, the pace of discoveries under the hegemony of Aristotelianism was rather slow until the Renaissance.

The flourishing of science in the Renaissance developed, in particular, out of the important work of one man: Cardinal Nicolaus of Cusa, whose great works, such as *De Docta Ignorantia*, overthrew Aristotle as an authority in more ways than one. While Cusa challenged Aristotle's conclusions on such scientific concepts as astronomy and physics, he also posed a higher basis for truth in his division of understanding from the sensual, to the rational, to the intelligible, to God. His concept of the coincidence of opposites states that opposites in a lower level of understanding may actually be reconciled by a higher concept, in much the same way that Plato's Socrates demonstrated the approach to truth by being teased into a higher concept through the use of paradox. Cusa's "intelligible" concepts exceeded rational empirical trends in the way that later thinkers would come to consider physics as surpassing mathematics. From the simple point of Cusa's that no motion could be so perfectly circular as not to be susceptible of being yet more circular, he adduces the conclusion that the motion of the stars and planets cannot be circular, with the startling conclusion that *circularity itself cannot be a cause of motion*. If geometry itself cannot measure (or cause) physical motions, what can? Thus begins modern science.

With the new thoughts and discoveries of the Renaissance, as exemplified by such as Leonardo da Vinci, it became impossible to maintain Aristotle as an authority, since his conclusions about the natural world were seen to be so very wrong. The imperial enemies of human thought, seeking to continue to maintain a general control over people, and, naturally, needing a means of controlling their method of thinking, introduced a new concept, that of Sarpian empiricism. Under this outlook, the specific conclusions of Aristotle could be rejected, but a new sort of prison of the mind would be introduced. Under this form of empiricism, any experimental observation was fair game to be incorporated into new theories, but the basis of any such theories would be the modeling of observations: the direct conversion of data into trends, and thus "laws" of nature. The mind and intellect—necessity and cause (purpose) in the human sense—have no place here. Such curve-fitting was in keeping with the method of Claudius Ptolemy, who "saved appearances" with his geocentric planetary model, while not troubling himself with any cause of motion.

The first major, groundbreaking work of what can truly be called modern science was Johannes Kepler's great *Astronomia Nova*, which should have ended the curve-fitting approach of Sarpi once and for all. In this work, of unexaggerably great importance for the development of human thought, Kepler, in the Socratic approach of Cusa, demonstrated, unassailably, that the then-general approach of science, of fitting hypotheses to data inductively, was doomed to fail. This he showed in the motion of Mars, whose orbit defied explanation by the methods of his predecessors: looked at from one standpoint, one set of model parameters matched the orbit, but, from another viewpoint, a different set of parameters best fit. Kepler brought these opposing viewpoints into coincidence, by stepping on the head of mathematics to climb to the realm of physics, of true causes. His development of the elliptical orbits based on a universal physical cause, and his discovery, in his *Harmonice Mundi* of the unified intention behind the various eccentrities and orbital radii of the planets, put the human mind in the center of science; to qualify as a physical cause, a concept needed an inner *necessity*. In Kepler's words, a concept would have to answer the question: "Why is it so, rather than otherwise?" And such a concept would have to be a successful *discovery*—a resolution of an impossibility—a new thought!

We will not enter here into the domain of music, which, along with poetry, is of great importance to the practice of science, by affirming to the mind the existence of creativity *per se*, the development of new concepts.

Science as a Series

Looking back over science as a series of revolutions in thought, we can make conclusions about the practice of science itself. So far as any series of discoveries goes, it may be correct, but is always *incomplete*. That is, there are indeterminables: statements, which cannot be said to be certainly true or certainly false under the theory. In ancient times, such unknown forces may simply have been ascribed to "the gods" or to chance. This domain of the unknown took a new shape in the 20th Century, with the championing of probabilisitc quantum theory as a complete description of nature in the very small. Here, statistical indeterminateness itself is enshrined as a scientific truth, overstepping its bounds. Truly, indeterminateness is an indication that either there is more to know, or the domain of study is unduly restricted, excluding an "outside" factor of causative importance, as we shall see:

As the work of Simon Schnoll has shown, the supposed randomness of quantum phenomena is not actually entirely random. The periodicities he has observed show us that as we peer deeper, we find that there must necessarily exist principles of which we are yet unaware, that govern the behavior of particles on the quantum scale. But, returning to the mind, such higher principles would be necessary, even were it not for the work of such as Schnoll, Ephraim Fishback, and Jere Jenkins.[1] We see why:

Compare the human mind to the brain, by first comparing life to assemblages of physical-chemical components. Without doubt, it is true that living organisms are composed of the same elements as non-living matter, the same matter which spectroscopy shows to make up the stars. Yet, perhaps it is better said that living organisms can be *decomposed into such pieces*.[2] Yet, the ability to break living processes into recognizable abiotic pieces, does not mean that all of the characteristics of life can be understood by combining the characteristics of such abiotic components, *as such components are understood in isolation*. Anomalous characteristics of photosynthesis and the polarizing capabilities of DNA suggest that the *space* of life, the sorts of interactions possible in a living context, differ from abiotic space. Are the nuclear and chemical characteristics observable in non-living contexts the *only* characteristics of energy and matter? And, are those identifiable characteristics identical in the context of life? The answer must necessarily be: no.

The presence of these higher principles is the subject of this issue of *21st Century*.

In This Issue

The unique, higher phase-space of living processes, as demonstrated by the work of Vladimir Vernadsky, necessitates a higher dynamic "dimension," more degrees of freedom, than non-living processes. How do these higher dimensions, these existences between the cracks, express themselves? The translations, by Bill Jones and Meghan Rouillard, of two works by Vernadsky in this issue address the manner in which living processes distinguish themselves from the non-living, as well as the development of the "noösphere" out of the biosphere—the development of Man's reason as itself a physical force in nature.

Dr. Ernest Shapiro's article focuses on nuclear processes, and takes up the question of whether nuclear processes in biology are *unique*. Investigating the work of C. Louis Kervran, his follower Vladimir Vysotski, and others on elemental transmutation in life, Shapiro argues that there are aspects of the nature of the nucleus and nuclear processes that are unique to the biological context. In this case, the apparent body-temperature transmutation of elements in various organisms indicates that there is more to nuclear processes than we currently understand, and, indeed, possibly more than *could* be understood if our experiments are limited to the non-living apparatus typically assigned to such studies in the department of physics.

One may additionally ask: Are there unique aspects to biological processes in the human nervous system? Or, perhaps the seemingly random phenomena of the quantum world find reason in the human brain, in which there is necessarily neither pure randomness nor pure determinism, but rather a freedom, constrained by universal law, but not bound to any past sense of universality. Human creative reason requires a relatively non-determined substrate. Such studies of processes of physics or biology that are unique to the human nervous system, would be a fascinating follow-up to the work treated by Shapiro.

Also in this issue, Shawna Halevy takes us on a journey into the creatively functioning mind. Halevy leads us through Albert Einstein's thinking process, focusing in particular on the necessity of Classical music in his breakthroughs, and on the inability of a closed, deterministic, literal system to express true breakthroughs not in *what* we think, but truly addressing *how* we think. Such discoveries in science mirror the compositional challenges faced by an honest composer, poet, or playwright.

Shifting our attention from different phase spaces, to the topic of scale, we ask ourselves: what differences do we find between the biology of individual organisms, and that of the biosphere as a whole– and what differences do we find in biology considered in the timescale of individual organisms, and that seen in the multi-generational process of evolution? On such time scales are observed both a secular increase in measures such as metabolism rate, independence from environment, and cephalization, as well as a cyclical variation in biodiversity which appears to be tantalizingly correlated to other large-scale terrestrial and even galactic cycles. Jason Ross offers a short examination of both the failures of neo-Darwinism to account for the evolutionary history of life, and several possible means by which extra-terrestrial processes (such as cosmic radiation) can play a role in changing the phenotypic expressions of life here on earth.

Future issues will bring more on both Man's place in the cosmos (specifically, the scientific challenge of detecting and defending against asteroids and comets) and the breakthroughs of Vladimir Vernadsky (whose 150th birthday we celebrate in 2013) respecting the biosphere and the noösphere. It is certainly an exciting time to be alive!

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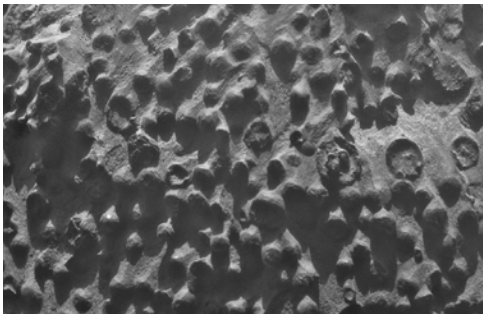
1. See reference in *Planetary Defense*, box 8. larouchepac.com/planetarydefense

2. The identification of the words that make up a poem, or the notes that make up music, does not mean that the poem or the musical piece is composed of these pieces, in the human sense of composition. A new concept requiring expression exists, whose transmission to other people is effected by the aid of a language of communication, including the non-literal use of metaphor.



NASA/JPL-Caltech/Cornell/Arizona State Univ.

Small spherules found on 'Kirkwood Outcrop' at Endeavor Crater

THE OTHER MARTIAN ROVER FINDS CLAY

When the Mars Science Laboratory landed on August 6, the public all but forgot about the other Martian rover: Opportunity. Opportunity has been on Mars for over 3000 Sols, almost 9 Earth years. Late last year, Opportunity had arrived at 23 km wide Endeavour crater, a place suspected of harboring phyllosilicate rock, similar to terrestrial clays. In recent weeks, Opportunity has snapped pictures of strange spherical nodules in Endeavour crater, on an rock outcrop called "Kirkwood." These basaltic knobs are different than the hematite "blueberries" found at the original landing site, and their origin remains a mystery. Opportunity also found what appears to be the phyllosilicate outcroppings, and is currently testing the composition with its arm instruments. If these are, indeed, phyllosilicates, it means Opportunity is in a location that once had water that was the perfect composition for life.

NASA/JPL-Caltech/Cornell/Arizona State Univ.

Strange rock 'fins' at Matijevic Hill, Endeavour Crater

Dishes of the Karoo Array Telescope, or MeerKAT.

SCIENTISTS WILL COME TO AFRICA TO DO NOBEL-PRIZE RESEARCH, SAYS MINISTER

South Africa's Minister for Science & Technology, Naledi Pandor, announced on May 25 that the international SKA Site Advisory Committee has decided to locate two-thirds of the Square Kilometer Array radio astronomy telescopes in Africa, and has granted one-third of the project to the only other contender—Australia and New Zealand. The SKA will be the largest international astronomy project in the world when it is completed in 2024, made up of up to 3,000 radio astronomy dishes. (see *21st Century*, Winter 2011). South Africa will build upon its MeerKAT radio telescope array, (seen here) and along with its partners—Botswana, Ghana, Kenya, Madagascar, Mauritius, Mozambique, Namibia, and Zambia—will expand the array to sites in other Africa nations.

Pandor said that building the SKA radio telescopes would change the character of Africa. "Who comes to Africa to actually do their best research?" she asked at The New Age business breakfast Aug. 31. "People come here to examine us, to find out how poor we are, to look at diseases that we have, they never come here to say, `I want to do Nobel [Prize] science work.' But they are gonna be coming to do that with the SKA."

Petr Pavlicek/IAEA

The ghost town of Pripyat, built in the 1970s to house Chernobyl workers and evacuated in July 2005. It should be resettled!

PRIMARY HEALTH PROBLEMS AT CHERNOBYL ARE PSYCHOSOMATIC

Following a trip in July to the Vladimir Memorial Nuclear Power Station in Ukraine, commonly known as Chernobyl, writer Chris Lewis reported that "in spite of Greenpeace's wild claims, there is no evidence of any significant health problems" among the 600,000 military personnel and civilians who worked to contain, and then recover from, the 1986 nuclear power plant accident. Within three kilometers of the plant, in the city of Prypyat, radiation levels are at background levels.

The primary health problem, Lewis reported, has been illnesses that are psychologically induced, drugs, and alcoholism. This is hardly surprising, considering the more than two decades of psychological warfare that has been waged against, not only the population of Ukraine, but was used as an excuse to shut down most of Eastern Europe's Soviet-era nuclear power plants, even those with Western-style safety up-grades.

Fourth International Specialized Symposium Space and Global Security of Humanity, in Yevpatoria, Crimea, September 3-6. Benjamin Deniston (above left), Jason Ross (right).

SPACE AND GLOBAL SECURITY CONFERENCE CALLS FOR COOPERATION

Two members of the LaRouche Political Action Committee (LaRouchePAC) "Basement" research team participated in the IGMASS-sponsored Fourth International Specialized Symposium Space and Global Security of Humanity, in Yevpatoria, Crimea, September 3-6. The conference brought together a variety of speakers from many countries, to discuss ongoing efforts to use space technologies and space science to serve a safety role for mankind. This included disaster forecasting (such as earthquakes), space threats (such as asteroids, comets, and solar storms), as well the organizational capability, both technical and political, to share such data for the well-being of all nations. The LaRouchePAC representatives, Jason Ross and Benjamin Deniston, brought a political urgency to the conference: they developed the potential for cooperation against space threats as a sound basis for international relations, the unique economic approach of Lyndon LaRouche for understanding the economic value of science, and the necessity to bring mankind to a higher energy-flux density "platform" to deal with space and economic requirements. A fuller report will appear in the next issue.

On Wonder

by Shawna Halevy

February 26, 2012

"It is open to every man to choose the direction of his striving; and also every man may draw comfort from Lessing's fine saying, that the search for truth is more precious than its possession."

– Einstein[1]

We all know children love asking the question "why?" We were once ourselves in a constant state of curiosity. Unfortunately, we know many people who, as adults, no longer question or reflect. The universe depends on mankind's insatiable desire to discover truth, and the current deficit of that is unnatural and detrimental to society. This is not to simply say that the universe is waiting on us to create new states of matter, but that it thrives on creativity *per se*. Wondering about something is what leads to wanting to understand or know that something. With this knowledge, be it scientific, social, or artistic, you now have a greater power to act. The biosphere, for example, depends upon, and can only rapidly increase its power on the planet and beyond by human cultivation. If this wonderment dies down, the acquiring of truth and greater power also ceases.

Let's look at what the state of wonder is, by the way different great minds describe it.

> For the naturalists state that a certain unpleasant sensation in the opening of the stomach precedes the appetite in order that, having been stimulated in this way, the nature (which endeavors to preserve itself) will replenish itself. By comparison, I consider wondering (on whose account there is philosophizing) to precede the desire-for-knowing in order that the intellect (whose understanding is its being) will perfect itself by study of truth.
>
> – Nicholas of Cusa
> *De Docta Ignorantia, Book I*

The wonderment we're speaking of is not the kind that leads to our physical preservation (at least not in the way that hunger literally leads to eating, though we wouldn't have advanced agriculture if not for wonder), but to our spiritual and intellectual survival. Unlike animals, a large part of human existence is for the satisfaction of the soul. This is not too obvious in today's society, where the emphasis is on success in financial terms, where "idle curiosity" in an adult is looked down upon as ivory-tower theorizing or useless daydreaming. Yet, with this need for more ethereal fulfillment, human society still has advanced magnitudes beyond any animal or lower species. Not in spite of this need, but because of it.

How does wonder come about? In speaking of his personal experience of discoveries in astronomy, Johannes Kepler states in his *New Astronomy*:

> When experience is seen to teach something different to those who pay careful attention, namely, that the planets deviate from a simple circular path, it gives rise to a powerful sense of wonder, which at length drives men to look into causes.

This is strikingly similar to Einstein's more general statement from his Autobiographical Notes:

> 'Wonder' appears to occur when an experience comes into conflict with a world of concepts already sufficiently fixed within us.

Our readers may recall that this is what Lyndon LaRouche identifies as a crucial paradox, an irony of the senses, which leads to a creative discovery.

The human mind lives for the type of challenges that help overthrow its assumptions. It seems impractical to gaze at the stars and inquire into their motions, yet the healthy mind craves these ironies to change the way it is thinking, in order to better reflect reality. What a lot of people figure nowadays, is that open-ended questions are for the philosophers. Well, I've got news for you, philosophy wasn't paying too well, so they all got jobs in finance! The leisure of developing your mind (which used to only be available

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1. "The true value of man is not determined by his possession, supposed or real, of Truth, but rather by his sincere exertion to get to the Truth. It is not possession of Truth by which he extends his powers and in which his ever-growing perfectibility is to be found. Possession makes one passive, indolent and proud. If God were to hold all Truth concealed in his right hand, and in his left only the steady and diligent drive for Truth, albeit with the proviso that I would always and forever err in the process, and to offer me the choice, I would with all humility take the left hand, and say: Father, I will take this – the Pure Truth is for You alone. "—Gotthold Ephraim Lessing "Anti-Goeze" Eine Deuplik 1778

to an upper class) is what a Republic relies on so that the population can govern itself. Not only that, the universe relies on this as well. No system built on practical ideas of stagnated people ever flourishes.

So why has the general population stopped asking "why?" Why have they given up on thinking creatively? Is it because they already figured it all out? Have all the answers been discovered? When investigating the ultimate truth of things, every so-called answer leads to new questions! Is this some cruel *Twilight Zone* episode, or torture from the ancient Greek gods? Happily, the universe is not a closed book; so neither are we fixed and finished in our development. Our ability to continually ask "why" reflects the characteristic of the universe as being anti-entropic, alive, growing and progressing at an accelerated rate to higher and higher phases. If someone was perfectly knowledgeable, they would not wonder or have a desire to know. The same is the case for ignorant people; they believe themselves to be in possession of all they need to know (this is the evil of ignorance). Someone who engages in philosophy holds an intermediate state between ignorance and wisdom, in much the same way that the world is in a state of becoming. No state of knowledge is ever perfect, but it can ever be perfected. Now we're better prepared to ask: what happened to the human culture of wonder?

This anti-entropic nature of the universe being the case, why the lack of inquiry and investigation as a common passion in the culture, if it is not from the lack of things to figure out? Maybe there isn't enough time or it takes too much energy and is just more trouble than it is worth? There used to be a rumor that scientific theory was used for the purpose of saving time and effort in thinking. There is truth to the opinion that there can be physical constraints to thinking: lack of food, disease, mind-deadening labor for long hours. But the rumor that thinking is an inconvenience as if we would rather want to use a machine brain for practical efficiency is quite absurd. This is seen in a different way through a funny story. Max Born, "frenemy" of Einstein, writes:

> The ideal of simplicity has found a materialistic expression in Ernst Mach's principle of economy in thought. He maintains that the purpose of theory in science is to economize our mental efforts. This formulation, often repeated by other authors, seems to me very objectionable. If we want to economize thinking, the best way would be to stop thinking at all... the expression 'economy of thinking' may have an appeal to engineers and others interested in practical applications, but hardly to those who enjoy thinking for no other purpose than to clarify a problem.

One of the most well-known equations, $E=mc^2$, opened up resources of energies of ever increasing density to us: fission, fusion, and anti-matter matter reactions. These processes will allow human beings to explore the Solar System and beyond, as Columbus courageously discovered the New World. But a greater thing this hypothesis provided was a magnitude higher ability to understand the processes of our world. Before $E=mc^2$ was discovered, it was quite baffling how our Sun continued to shine, using just the process of breaking chemical bonds from burning material. A new degree of knowledge cannot be measured so much quantitatively because it provides a larger potential to make new hypotheses. Thought leads to higher thought, wonder to more refined wonder. (This is nothing like the questioning of whether, when a tree falls in the forest, does a greenie cry.) The physical possibilities $E=mc^2$ opened up were not the end goal of thinking, but the means to think more!

Our Bohemian friend Einstein has a more staunch stance against materialistic motivations:

> I found the idea intolerable of having to apply the inventive faculty to matters that make everyday life even more elaborate—and all, just for the dreary money-making. Thinking for its own sake, as in music! That is why I also never could take to Mach's principle of economy of thought as the ultimate psychological driving force. Economy, correctly understood, may be one motive upon which intellectual aesthetics depends; however, the mainspring of scientific thought is not some external goal to be striven toward but the pleasure of thinking. When I have no special problem to occupy my mind, I love to reconstruct proofs of mathematical and physical theorems that have long been known to me. There is no goal in this, merely an opportunity to indulge in the pleasant occupation of thinking.

Einstein is no mental masturbator. Pleasure in this sense is the long-term joy one obtains from tapping into what makes us truly human, and what separates us from herds of animals: individual creativity. We are naturally inclined as a species to enjoy the tension of creative thinking and problem solving; this is the reason classical art was invented. It is unnatural to want to find a comfort zone where we cruise through life without a concern in the world. Not only does the mind atrophy, but our physical means of existence also becomes more difficult. Our mind is geared towards progress, not for any greedy intention, but because that's the way the universe is geared. Value should be placed on thinking for achieving quality in life (as opposed to quantity). The value of thinking is not simply for creating more gadgets that further disconnect one from reality, but to create a higher platform of understanding from which to operate in reality.

The truth is, the act of questioning is unpopular not because everything has already been figured out or even because it is too costly or not practical; a lot of people lose their intense desire to know by adulthood because they've been brainwashed to believe that everything has been figured out for them, and so they become practical minded. The line is "go along to get along," conform to group think, don't rock the boat with revolutions in thought from original thinkers.

Think back to the child. Is it not most natural for them to want to know?

Max Planck said: "What, then, does the child think as he makes these discoveries? First of all, he wonders. This feeling of wonderment is the source and inexhaustible fountain-head of his desire for knowledge. It drives the child irresistibly on to solve the mystery, and if in his attempt he encounters a causal relationship, he will not tire of repeating the same experiment ten times, a hundred times, in order to taste the thrill of discovery over and over again."

Only something external and malicious could prevent that normal characteristic from continuing. Cultural warfare, entertainment propaganda, political pessimism, and artificial education methods[2] are the main tools used in our current degenerate culture to maintain a society at the level of peasants, barred from thinking profoundly. What is the solution?

This was the purpose of JFK's manned Moon mission: to inspire a whole generation, to liberate the minds of a generation to think like human beings again. Free play of the mind is the only way we could have even thought of going to the Moon in the first place. Non-linear thinking was encouraged, creating an environment for discoveries of bold ideas, as opposed to coasting along by applying previous discoveries in different ways, or worse, using off-the-shelf technologies. That optimism changed the planet. New challenges were presented in a light that allowed for confidence in overcoming them. That is part of the reason why JFK was assassinated – to kill that optimism. Our mission today is similar to Kennedy's: we need a colonization program for the Moon and Mars, not only for the practical purposes of obtaining more resources and such, but to free the current population from the cynical and pessimistic philosophy imposed on them and to catch back up to lead the development of the universe. With the unleashing of man's mind, no problem is intimidating: disease, the nature of life, hunger, the quantum, war, the operating principles of the universe, etc.. All problems can be conquered. Individuals will be stimulated to take on fundamental questions of 'why' instead of simply 'how?'

Hence Einstein's advice to a young man who was going through an existential phase:

> Then do not stop to think about the reasons for what you are doing, about why you are questioning. The important thing is to not stop questioning. Curiosity has its own reason for existence. One cannot help but be in awe when he contemplates the mysteries of eternity, of life, of the marvelous structure of reality. It is enough if one tries merely to comprehend a little of this mystery each day. Never lose a holy curiosity. Try not to become a man of success but rather try to become a man of value. He is considered successful in our day who gets more out of life than he puts in. But a man of value will give more than he receives … Don't stop marvelling.

Life is not about having the right answers, but about having the right questions.

2. "The only thing that interferes with my learning is my education."

—Albert Einstein.

The Transition From the Biosphere To the Noösphere

by Vladimir Vernadsky

Excerpts from
Scientific Thought as a Planetary Phenomenon
1938

Translated by William Jones

Vladimir Ivanovich Vernadsky
1863-1945

Introduction

by William Jones

The name of Vladimir Ivanovich Vernadsky may be familiar to many people involved in the area of science, particularly in the geological and so-called "earth" sciences, but most of these scientists, without a good working knowledge of Russian, will only have known his work, at best, through the publication of his 1926 monograph, "The Biosphere," which brought him some immediate international attention since it soon appeared (in 1929) in a French edition. This has since been translated into many languages, although first appearing in English only in 1986. Since the 1980s, the work of Vernadsky has been widely circulated and popularized by the movement led by U.S. economist and statesman Lyndon LaRouche, whose work on economics has, over the last few decades, been most significantly influenced by Vernadsky's concept of the noösphere. In their view of man and man's possibilities for development they are kindred souls.

In Russia, Vernadsky's name is as familiar as that of Pasteur or Curie or Einstein. President Vladimir Putin has decreed that the 150th anniversary of Vernasky's birth next year will be the occasion for celebration throughout the country. While much of Vernadsky's early work first appeared in French scientific journals, most of his major works, including his last, unfinished, magnum opus, "The Chemical Structure of the Biosphere and Its Surroundings," exists only in Russian. In fact, since Vernadsky, working for the first part of his life under the Tsarist regime and the last part under the Soviet regime, was in both cases considered something of a "dissident," many of his most path-breaking and creative works were not published until well after his death.

Vernadsky's life covers a long and dramatic span of Russian history. Born in 1863 in the midst of the great reforms initiated by Alexander II and living until the very eve of the end of World War II, dying in January, 1945, Vernadsky was an active participant in some of the greatest upheavals of that era. Born in St. Petersburg, he spent much of his early life and young manhood in Ukraine, the family having its roots in that region.

Studying during one of the most fertile periods in Russian science under the great chemist Dmitry Mendeleyev, and the renowned soil scientist V.I. Dokuchaev, Vernadsky was first drawn to the study of crystallography and mineralogy. Vernadsky went on expeditions with Dokuchaev to study the fertile "black earth" of Ukraine, where his attention was first attracted to the elements of living organisms that contributed to that soil's tremendous productivity. Indeed, it would be later, during his temporary exile in Ukraine after the Bolshevik Revolution that Vernadsky would first develop his own unique concept of the role of the "biosphere."

But Vernadsky, like Leonardo da Vinci, one of his great heroes in the realm of science, was also something of a universal genius. His interests spread over the entire gamut of scientific thought. And like Leonardo, his seminal work in so many areas provided the basis for further research in entirely new fields of research: genetic mineralogy, geochemistry, hydrogeochemistry and hydrogeothermy, oceanography, radiogeology, cryology or the study of permafrost, and cosmochemistry. He virtually created the field of biogeochemistry and his insistence on studying the chemistry of other planets to find the similarities—and dissimilarities—to our own, foreshadowed much of the work that would reach fruition after his death in the manned space program.

Ivan Vasilievich Vernadsky with his family. Vladimir is standing on the far right.

In all these areas Vernadsky left his imprint. And in his extensive work as a teacher and scientist he also left an extensive school of scientific thought that still makes itself felt in Russia today. In fact, one might say with justification, that Russian science is still on the "cutting

Russian Academy of Sciences

Vladimir Vernadsky with other members of the Russian Duma circa 1905.

edge" largely thanks to the "Vernadsky school," which, of course, would include not only his own students, but theirs as well, as well as the numerous individuals who have been attracted to science by the work and example of Vernadsky.

While he worked half his life in Tsarist Russia and the other half under the Soviet regime, he was an adherent of neither. His devotion was to the nation, and he was democratic in spirit, putting him somewhat at odds with both of these political systems. In his younger days, prior to the Bolshevik Revolution, he had been extremely political. His father, Ivan Vasilievich Vernadsky, was a prominent Russian economist who introduced the work of American economist Henry Charles Carey to Russian circles and helped lay the basis for the great reforms of the 1860s. Vladimir was deeply involved in the reform movement of his own time, helping to transform the illegal Union of Liberation (which he helped to establish), into the Constitutional Democratic Party (Kadets) when political parties were finally permitted in Russia after the 1905 Revolution. Vernadsky served on the Central Committee of the Kadets from 1903 until 1917 and for brief periods in the Duma as a Kadet delegate.

When the Bolsheviks took power, Vernadsky, diagnosed with tuberculosis, removed himself to his country home in Ukraine. While in Ukraine in 1919-1920 he set up the Ukrainian Academy of Sciences and established in the capital, Kiev, the National Library of Ukraine which still bears his name. When Kiev fell to the Bolsheviks, Vernadsky withdrew to Crimea, still under the control of the Whites. Here he was elected president of the Tauride University.

When Crimea fell to the Bolsheviks, Vernadsky was considering emigrating to the United States where he hoped he would be able to set up a Biogeochemical Laboratory under the Carnegie Institute. But his election to the presidency of Tauride University and a deep-rooted concern for the fate of Russian science under Bolshevik rule, kept him in Crimea where many Russian intellectuals had sought refuge. With the fall of Crimea to the Bolsheviks, Vernadsky, although known as an active member in the Kadet Party, was brought back to St. Petersburg, not as a prisoner, but in order to again take up his position at the

Russian Academy of Sciences

Teaching geochemistry at the Higher Women's Course in St. Petersburg.

U.S. National Institutes of Health

Florentine physician and scientist Francesco Redi (1627-1697).

Mineralogical Museum which he had left three years before. Lenin's policy of broad electrification of the Soviet Union necessitated a revival of the old scientific cadre from the pre-war period. Vernadsky, who had been a teacher and a mentor for Lenin's brother, Alexander, prior to Alexander's involvement in an attempted assassination of the Tsar in 1881, was also not totally unknown to Lenin.

During the often tumultuous and difficult years following the Russian Revolution and civil war, Vernadsky would steadily work to revive and advance Russian science. Until the mid 1930s, he was permitted to travel abroad almost every year, consolidating contacts with the main figures in international science, with Marie Curie in Paris, with Otto Hahn in Germany, and with Lord Rutherford and Frederick Soddy in England.

Vernadsky almost single-handedly conducted a campaign in Russia to establish a major research center for nuclear energy. Already in 1921 he had succeeded in creating the *Radium Institute in St. Petersburg,* but the Soviet leadership was slow to realize the importance of this research. At the beginning of World War II when Vernadsky began to suspect work on the atom in the U.S. and elsewhere for military reasons, he insisted that the Russian Government move quickly on the matter, and was initially the organizer of the effort. As the program moved closer to weapons development, Vernadsky was effectively cut out of the program, the authorities viewing the ageing scientist as still something of a dissident and therefore not entirely trustworthy.

Indeed, although a patriotic Russian even in Soviet times, Vernadsky never accepted the tenets of dialectical materialism. As the Bolshevik regime in the late 1920s attempted to take over the Academy of Sciences and bring the old "gray beards" under strict supervision by the orthodox Marxists, Vernadsky led the fight to maintain the independence—and the intellectual integrity—of the Academy and the Academicians. Needless to say, he was only partially successful. While the years following 1928 would see an influx of academics from the Party hierarchy into the Academy, Vernadsky attempted to work with those who were intellectually qualified and to limit the damage inflicted on the Academy by those who were not.

V.G.Khlopin Radium Institute

The Radium Institute in St. Petersburg.

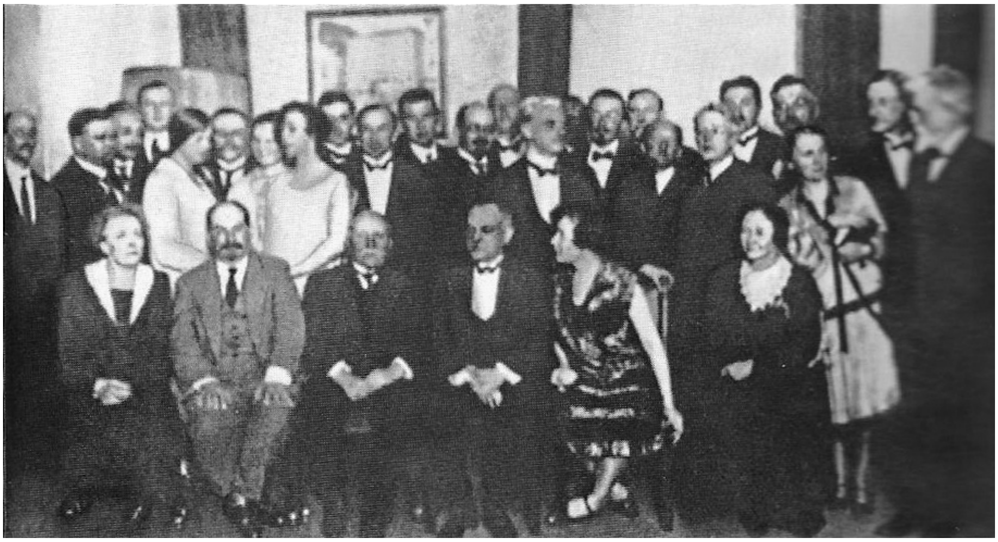
And although Vernadsky was barely tolerated by the Party apparatchiks, accused of being a "vitalist" because of his views on the question of life, he was also "protected," by higher authority from the machinations of the NKVD (the predecessor to the KGB) because of his intellectual preeminence, and continued to exert something of an influence on the scientific elites. He utilized his rather unique position to try to save many of his colleagues from being sent to the Gulag, or, if sent, to get them into a situation in which they could continue doing some form of useful scientific work, and the possibility for such work even in the Gulag became greater after World War II began. A year before he died, Vernadsky was awarded the Hero of Socialist Labor. Half of the money connected with the award, Vernadsky donated to the war effort.

U.S. National Institutes of Health

Louis Pasteur discovered chirality in living cells.

But Vernadsky is most noted for his work on the biosphere and the question of life in the universe. From the beginning he refused to accept the basic premise of abiogenesis, the idea that life proceeded from a combination of inorganic materials, oxygen, carbon, nitrogen which combined in some mysterious way, to become living matter. Vernadsky saw no scientific evidence that such a process ever occurred. He adhered to the principle enunciated by the 16th Century Italian physician, Francesco Redi, *omnium vivum e vivo*, that life only proceeds from life. This was also the conclusion from the 19th Century work of Louis Pasteur, who discovered the notion of chirality or right- or left-handedness in living tissue. This indicated that living tissue had a decidedly different structure than inorganic matter, giving more scientific grounding to the thesis of Redi.

Vernadsky was convinced



Russian Academy of Sciences

A Russian delegation visits with scientific colleagues in Berlin, 1928. Vernadsky on the far right and Albert Einstein, third from the left.

Vernadsky also was the first to recognize the absolutely essential role of the biosphere, i.e. the total aggregate of living matter on Earth, in the development of the Earth's upper crust and atmosphere and stratosphere. With the appearance of Man, however, Vernadsky saw an entirely new dimension in the history of the biosphere in the changes wrought through the productive activity of Man. Just as the biosphere is characterized by a steady increase in its energy throughput as it develops and subsumes the Earth, so also does the activity of Man begin to develop its own characteristic form of "energy" which assumes a predominant role in the biosphere and transforms it.

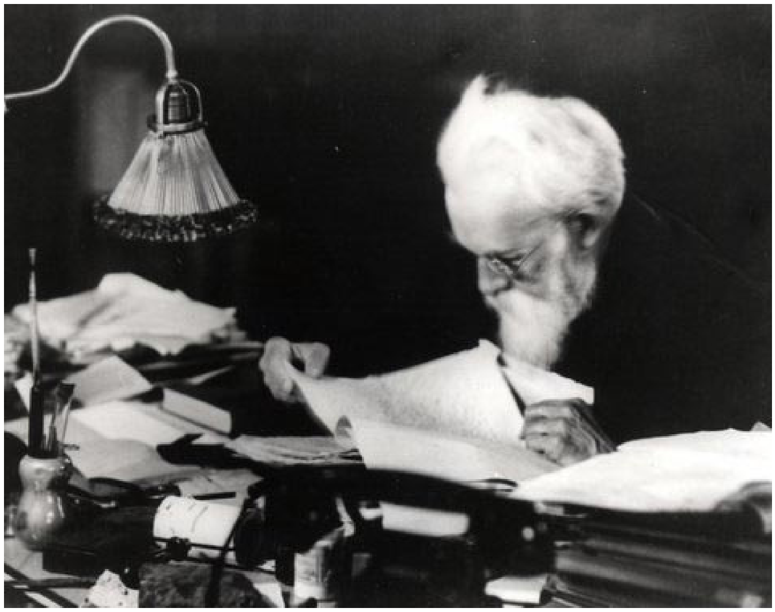
that there was no indication within geological time (which we can examine through a study of the Earth's crust), of life ever proceeding from non-life. He was also convinced that we would not find indications of abiogenesis in cosmic time either, that is, during the earlier period when Earth was forming out of its swirling vortex, although this latter era was more difficult to investigate. Secondly, given the continual exchange of matter between our Earth and the surrounding space, in the form, for instance, of cosmic radiation or cosmic particles, Vernadsky noted, life may well have been brought to us from elsewhere and, finding ideal conditions here, developed and flourished in that environment. Vernadsky urged the examination of material from other planets, such as meteorites, in order to determine their chemical composition, and possibly, if there were also there signs of life. Vernadsky held to his thesis despite the consistent attempts by orthodox Marxist scholars, who deemed Vernadsky's attacks on the theory of abiogenis undermining the "materialistic" foundations of their own "dialectical materialism," to disprove it. The career of science "apparatchik," Alexander Oparin was carefully cultivated by Vernadsky's enemies in order to discredit Vernadsky's hated "vitalism." The "fellow traveler'' networks of Bertrand Russell and J.B.S. Haldane helped to make Oparin's 1936 book *The Origin of Life* the bible of the abiogensists. Oparin was feted by these Western circles as a great scientific thinker in spite of the key and very public role he played in the Soviet Union in promoting the frauds of that notorious fraud, Trofim Lysenko, who led a campaign to eliminate some of the most important scientists in the Soviet Union.

Vernadsky called this new era with the development of man, the noösphere, after the Greek term noos (or mind), to distinguish it from the biosphere per se. The term was coined by Eduard LeRoy, who, together with Jesuit palaeontologist, Teilhard de Chardin, attended Vernadsky's geochemistry lectures in Paris at the Sorbonne in 1924. Vernadsky adopted the term as his own to depict the stage of the biosphere characterized by the preponderant activity of man.

Vernadsky felt that now in the 20th Century, with Einstein's discovery of relativity and with the mastery of atomic energy, man was in the process of taking a tremendous leap forward in the development of the noösphere, putting him on the verge of extending his reach into the surrounding universe. His last great works, the unfinished "The Chemical Structure of the Biosphere and Its Environs" and "Scientific Thought As A Planetary Phenomenon" both written between 1931 and 1944, were to be the final word of his mature thought. Lamentably, the first work, more broad-ranging than the latter, was to have a third section devoted exclusively to the notion of the noösphere, but Vernadsky was not able to conclude the work before his death. Given that critical lacuna, the second work, "Scientific Thought As a Planetary Phenomenon" from which this chapter is taken, undoubtedly represents Vernadsky's most extensive elaboration of the notion of the noösphere.

The chapter appears in the section of the book entitled

New Scientific Knowledge and the Transition from the Biosphere to the Noösphere. In it, Vernadsky traces the development of man from his first appearance as man with his mastery of fire, the first instance that we are aware of, in which man takes direct control of a force of nature. Vernadsky indicates here also the new possibilities for man's role in the universe, the possibility of extending his activity into space and possibly to other planets. It is imbued with a tremendous sense of optimism, optimism which, by the way, never abated, even in the face of the horrors of World War II.



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Vernadsky in his study around the time of the writing of "Scientific Thought As A Planetary Phenomenon."

Quite simply, Vernadsky understood that there existed in the universe a principle of development, which, with the development of man and the new-found role of man's reason, expressed itself in the necessity for continued progress. While a great deal of distortion of the thrust of Vernadsky's thought has been introduced into the public domain over the last several decades by the Green movement's "adoption" of Vernadsky as some form of "ecologist," it is hoped that the ideas expressed clearly by Vernadsky in the present work will lay to rest any doubts about where he stood in that respect, firmly behind the commitment to the scientific and technological development by means of which man becomes ever more the master of his universe.

The Transition From the Biosphere To the Noösphere

by Vladimir Vernadsky

Excerpt from "Scientific Thought As a Planetary Phenomenon"

Chapter VII

100.

The sciences concerned with the biosphere and its objects, that is, all of the humanities without exception, the natural sciences in the proper sense of the term (botany, zoology, geology, mineralogy, etc.), all the technical sciences, — applied sciences broadly understood — appear as areas of knowledge, which are the most accessible to the scientific thought of Man. Here we have concentrated millions upon millions of continuous scientifically established and systematized facts, which are the result of organized scientific labor, and which inexorably increase with each new generation, rapidly and consciously, since the 15th to 17th centuries.

In particular, the scientific disciplines dealing with the structure of the instruments of scientific cognition, indissolubly linked to the biosphere, may be scientifically viewed as a geological factor, a manifestation of the manner in which the biosphere is organized. These are sciences dealing with the "spiritual" creativity of the human individual in his social environment, the sciences of the brain and of the sense organs, of the problems of psychology or logic. These condition the quest for the fundamental laws of Man's scientific cognition, that is, those powers which have transformed the biosphere encompassed by Man into a natural body, new in its geological and biological processes, into a new state, the noösphere,[1] consideration of which I will turn to below.

Its creation, beginning intensively (in the measure of historical time) some tens of thousands of years ago, was an occurrence of extreme importance in our planet's history, connected above all with the growth of the science of the biosphere, and was definitely not by chance.[2]

We may therefore state that the biosphere represents the fundamental sphere of scientific knowledge, although only now are we on the point of distinguishing it from its surrounding reality.

101.

It is clear from the foregoing that the biosphere is equivalent to "nature" in the ordinary sense of the term, as this term is used in the deliberations of the naturalist and in philosophical discussions, where it does not refer to the Cosmos at large but rather to phenomena contained within the bounds of Earth. In particular, it corresponds to the naturalist's nature.

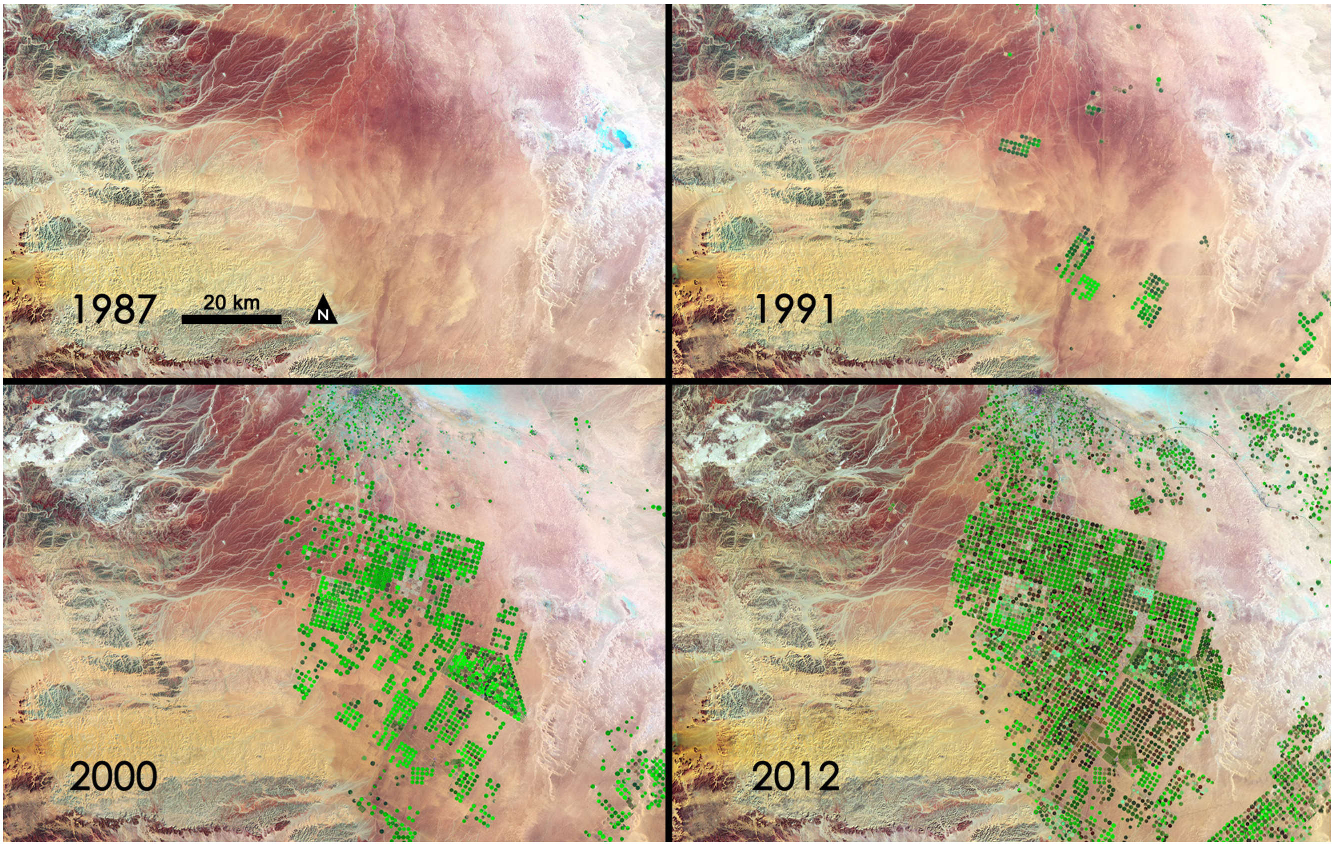
Not only is this "nature" not amorphous and without form, as was thought for centuries, but rather it possesses a determined, well-defined structure,[3] which, as such, must be reflected and taken into consideration in all the conclusions and deductions relating to nature.

In scientific investigations it is especially important not to forget this and to examine it, since unconsciously, sci-

1. *E. Le Roy. Les origines humaines et l'évolution de l'intelligence, III. La noosphère et l'hominisation*. Paris, 1928, pp. 37-57

2. I will return later to that process. Here I will merely indicate the thought of Le Roy: "Deux grands faits, devant lesquels tous les autres semblent presque s'évanoir, dominent donc l'histoire passée de la Terre: la vitalisation de la matière, puis l'hominisation de la vie." — op. cit. p. 47

3. That "structure" is quite distinctive. It is not a mechanism nor is it something stationary. It is dynamic, ever changing, mobile, in each instance changing itself and never returning to a previous form of equilibrium. The closest to it is the living organism, distinguishing itself, however, from it in its physical-geometrical state of its space. The space of the biosphere is heterogeneous in its physical-geometrical dimension. I think, that it is proper to assign to that structure a specific notion of organization.



NASA

The energy of human culture: The greening of the desert near the city of Tubarjal in Saudi Arabia.

entists and scholars, when contrasting the human individual with nature, are overwhelmed by the grandeur of nature against the human individual.

But life in all its manifestations, including the activity of the human individual, radically transforms the biosphere to the degree that not only the aggregate of indivisible life, but even some problems of the solitary individual person in the noösphere, cannot remain without consideration in the biosphere.

102.

Living nature is the fundamental trait of the manifestation of the biosphere, and by this clearly distinguishes itself from the Earth's other envelopes. The structure of the biosphere is characterized first and foremost by life.

We see below that there lies, in a number of aspects, an unbridgeable gulf between the physical-geometric properties with regard to the weight and quantity of the atoms in living organisms—in the biosphere they are manifested in the form of their aggregates-living substance, and such properties, in inert matter, which comprises the overwhelming part of the biosphere. Living matter is the bearer for, and creator of, free energy, not existing to such a degree in any one of Earth's envelopes. This free energy—biogeochemical energy[4]—embraces the entire biosphere and fundamentally determines its entire history. It stimulates and radically transforms the intensity of the migration of the chemical elements which compose the biosphere and determines its geological significance.

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4. The concept of biogeochemical energy came to me in 1925 in a still unpublished paper for the L. Rosenthal Fund (the fund is no longer in existence). This fund gave me the opportunity to quietly devote myself to this work over the course of two years. A series of articles and books from this research are therefore in print:
- Biosfera. Leningrad, 1926, pp.30-48;
- Etudes biogéochimiques, 1. Sur la vitesse de la transmission de la vie dans la biosphère.—*Isvestiia* AH, 6 series, 1926, v. 20, No. 9, pp. 727-744;
- Etudes biogéochimiques. 2 La vitesse maximum de la transmission de la vie dans la biosphère.—*Izvestiia* ANs, series 6, 1927, V. 21, No. 3-4, pp. 241-254;
- O razmnozhenii organizmov i ego znachenii v mekhanizme biosfery. *Izvestiia* AN, series 6, 1926, V. 20, No. 9, pp. 697-726, No. 12, pp.1053-1060;
- Sur la multiplication des organismes et son role dans le mécanisme de la biosphère, pp. 1-2, *Revue générale des sciences pures et appliquées*. Paris, 1926, t. 37, N 23, pp. 661-668; pp. 700-708;
- Bakteriofag I skorost' peredachi zhizni v biosfere, *Priroda*, 1927, No. 6, pp. 433-446.

During the past ten thousand years, a new form of this energy has been created within the realm of living substance, even more intense and complex, and rapidly growing in importance. This new form of energy, associated with the vital activities of human societies, of the genus *Homo* and other closely related genera (hominids), while preserving the expression of ordinary biogeochemical energy, brings about simultaneously new forms of migration of chemical elements, which in their diversity and power leave the ordinary biogeochemical energy of the living matter of the planet far behind.

This new form of biogeochemical energy, which might be called the energy of human culture or cultural biogeochemical energy, is that form of biogeochemical energy, which creates at the present time the noösphere. Later I will return to a more detailed exposition and analysis of our understanding of the noösphere. But at the moment it is only necessary for me to present a brief outline of its manifestation on our planet.

This form of biogeochemical energy is proper not only to *Homo sapiens,* but to all living organisms.[5] However, among these, this energy appears insignificant compared with ordinary biogeochemical energy, and is barely noticeable in the balance of nature, and then only on the scale of geological time. It is associated with the mental activity of organisms, with the development of the brain in higher forms of life, and only with the appearance of reason do its effects produce the form of transition of the biosphere into the noösphere.

Its manifestation in the predecessors of Man was probably developed over the course of hundreds of millions of years, but it was able to express itself as a geological force only in our time, when *Homo sapiens* has embraced the entire biosphere with his life and cultural work.

103.

The biogeochemical energy of living matter is determined primarily by the reproduction of organisms, by their unremitting endeavor (determined by the energetics of the planet) to achieve a minimum of free energy — determined by the fundamental laws of thermodynamics corresponding to the existence and stability of the planet.

It is expressed in the respiration and alimentation of living organisms, by "the laws of nature," which to the present time had not found a mathematical expression, although the task of discovering such was clearly posed already in 1782 by Christian Wolff at the former St. Petersburg Academy of Sciences.

Certainly, this form of biogeochemical energy is also characteristic of *Homo sapiens*. For Man it is, as for all other organisms, a "species characteristic,"[6] and seems to us invariable in the course of historical time. In other organisms, there is another form of "cultural" biogeochemical energy, which is unchangeable or only slightly so. This other form is manifested in the everyday life or technical conditions of life of the organisms—in their movements, in their daily existence and the construction of their habitats, in their displacement of other organisms in their environment, etc. As I have already noted, this energy makes up only an insignificant part of their biogeochemical energy.

With Man, however, the form of biogeochemical energy connected to reason grows and expands with time, rapidly moving to the fore. This increase is possibly related to the growth of reason itself—a process which seems to occur very slowly (if at all) but is chiefly connected to its honing and deepening in using it to consciously transform the social environment, and is especially due to the growth of scientific knowledge.

I shall proceed from the fact that in the course of hundreds of thousands of years, *Homo sapiens* skeletons, including the craniums, do not provide a basis for considering them as belonging to a different species of Man. This is assumed only on the condition that the brain of Paleolithic Man was not in some fundamental way structurally distinct from the brain of contemporary Man. At the same time, there can be no doubt that the mind of man during the Paleolithic period for that particular species of *Homo* cannot bear comparison with the mind of modern man. Hence it follows that reason is a complex social structure, erected similarly for contemporary Man, as well as for Paleolithic Man, on the same neural substrate, but in different social circumstances that formed over time (essentially over space-time).

Its explicit transformation is a fundamental element leading ultimately to the transformation of the biosphere into the noösphere, first and foremost, through the creation and growth of the scientific understanding of our surroundings.

104.

The creation on our planet of cultural biogeochemical energy appears to be a fundamental fact of its geological history. The way was prepared in the course of all geological time. The fundamental determining process here is the maximum expression of the human mind. But in essence this is inextricably linked with the totality of all biogeochemical energy of living matter.

By means of the migration of atoms in living processes, life bundles together into a single whole all the migrations

5. V. I. Vernadskii. *Biosfera*, pp. 30-48; O razmnozhenii organizmov i ego znachenii v mekhanizme biosfera.—op. cit., No. 9, pp. 697-726, pp.1053-1060.

6. Regarding species characteristics, See: V. I. Vernadskii. Considerations générales sur l'étude de la composition chimique de la matière vivante.—*Trudy Biogeokhimicheskoi laboratorii*, T. 1, 1930, pp. 5-32.

of atoms in the non-living matter of the biosphere.

Organisms are alive only until the material and energetic exchange between them and the surrounding biosphere ceases.[7] In the biosphere certain grand chemical circulatory processes of atomic migrations appear, in which living organisms are involved, as a lawful inseparable, and often fundamental, part of the process. These processes remain unchanged in the course of geological time: for instance, the migration of the atoms of magnesium forming into chlorophyll has gone on uninterruptedly for at a least two billion years through countless genetically interconnected generations of green organisms. Living organisms, continuously and inseparably connected to the biosphere through such migrations of atoms alone, constitute a lawful part of its structure.

This must never be forgotten in our scientific study of life and in our scientific judgments regarding life's manifestations in Nature. We must not neglect to take into account that this indissoluble material and energetic link of living organisms with the biosphere—a link of a completely distinct character, which is "geologically eternal," and may be expressed with scientific accuracy—is always present in any of our scientific approaches to living things and must be reflected in all of our logical conclusions and deductions concerning them.

Coming to the study of the geochemistry of the biosphere, we must above all precisely estimate the logical importance of that connection, which must necessarily enter into all of our constructs regarding life. It is independent of our will and cannot be excluded from our experiments and observations; it must always be taken into account as something fundamental that is inherent in living things.

In this way the biosphere without exception must be reflected in all of our scientific judgments. It must be manifest in every scientific experiment and observation—and in all a human individual's deliberations, and in all speculation, from which a human individual—even in his thoughts—cannot refrain.

The mind can therefore be manifest to the maximum degree only under conditions of the maximum development of the fundamental form of human biogeochemical energy, that is, under the condition of man's maximum degree of reproduction.

105.

The potential possibility of the expansion over the surface of the entire planet by the multiplication of a single organism, of a single species, is proper to all species, since, for all of them the law of reproduction is expressed in one and the same form, in the form of a geometrical progression. I have long emphasized the fundamental significance of this phenomenon for biogeochemistry,[8] and I shall return to it in its proper place in this book.

It is evident that the phenomenon of the expansion over the entire surface of the planet by a single species developed widely in the case of aquatic life such as microscopic plankton in lakes and rivers, and some forms of microbes, essentially also aquatic, on the cover of the planet's surface, and disseminated through the troposphere. For larger organisms, we observe this almost in full measure with certain plants.

For Man this begins to be seen in our time. By the 20th Century the entire globe and all the seas have been encompassed by Man. Owing to the progress of communications, mankind is able to be in continual contact with the entire world, nowhere solitary or helplessly lost in the immensity of Earth's nature.

Now the Earth's human population has reached the previously unprecedented figure of nearly two billion people, despite the losses incurred by wars, starvation and disease, which continuously afflict hundreds of millions of people, and which have seriously retarded the course of that process. It will require, however, only an insignificant amount of time in geological terms, barely more than a few hundred years, for such relics of barbarism to cease. This could of course be accomplished even now: the possibility lies already within Man's grasp, and a will informed by reason will inevitably embark on this path, since it corresponds to the natural thrust of the geological process. This is even more the case as the opportunities for doing this are rapidly, almost spontaneously, increasing. The real significance of the popular masses, which have endured these sufferings more than anyone, is irrepressibly growing.

The number of people inhabiting our planet began to increase approximately 15,000 to 20,000 years ago, when Man became less constrained by the shortage of food with the development of agriculture. Presumably at that time, around 10,000-18,000 years ago, the first leap in man's reproduction took place.[9] G.F. Nicolai (in 1918-1919)[10] attempted to quantitatively determine the actual multiplication of Man and the development of agriculture, that is, Man's real colonization of the planet. In his

7. The complete absence of exchanges in dormant forms of life can not yet be considered verified. It is extremely slow—and perhaps in some cases of atomic migrations actually absent—this becomes noticeable only in geological time..

8. Regarding the speed of the transmission of life, see: V. I.. Vernadskii. *Biosfera*, p. 37-38; Also Etudes biogéochimiques. 1. Sur la vitesse de la transmission de la vie dans la biosphere.—op.cit., N 9, pp 727-744; Also *Biogeokhimicheskie ocherki*, (1922-1932) M.-L. 1940, pp. 59-83.

9. V.G. Childe. *Man Makes Himself.* London, 1937, pp. 78-79.

10. G.F. Nikolai. *Die Biologie des Krieges*. 1.—Betrachtungen eines naturforschers den Deutschen zur Besinnung. Band 1. Zurich, 1919. p. 54.

Stefan Kühn

A new form of energy connected to the atomic nucleus. Nuclear reactors in Cattenom , France.

calculations, which encompassed the entire land-mass of the globe, there were 11.4 people per square kilometer, which constituted 2.10% to 4% of the possible colonization. Taking into account the energy received from the Sun, agriculture makes it possible to support 150 people on one square kilometer, that is, on the entire land area of the globe you could support a population of 22.5 billion individuals, that is, 22-24 times the number that now inhabit it.[11] But Man obtains energy for nourishment and subsistence not only from agricultural labor. Taking into consideration that possibility, Nicolai made a rough estimate that, starting from the historic epoch begun in our time, utilizing new energy sources, Earth could support a population of 3 trillion people, that is, more than ten million times greater than the present population. Now after more than 20 years have passed since Nicolai made his calculations, these figures ought to be greatly increased since Man may now use a source of energy to which Nicolai in 1917-1919, gave no thought: namely, the energy connected to the atomic nucleus. We should now more simply say that the source of energy subject to Man's reason, in this energetic epoch of the life of Man on which we have now embarked, is practically unlimited. From this it is also clear that cultural biogeochemical energy possesses the same quality. In the calculations of Nicolai in his day, machines increased the energy of Man more than tenfold. We cannot now give a more precise figure, yet recent estimates by the American Geological Committee indicate that hydroelectric power, utilized now over the entire globe, had reached, by the end of 1936, the level of 60 million horsepower: Within 16 years it had increased by 160 percent, chiefly in North America.[12] As a result, we must increase the calculations of Nicolai by more than one and a half times.

Actually, all of those calculations of the future, expressed in numbers, are not significant, since our knowledge of the energy available to mankind may be said to be rudimentary. Certainly the energy available to Man is not an unlimited quantity, as it is limited by the dimensions of the biosphere. These also define the limits of cultural biogeochemical energy.

We will see that there is even a limit to the fundamental biogeochemical energy of mankind-namely, the speed of the transmission of life, the limit of the reproduction of Man.

The speed of colonization, the quantity V, essentially considered by Nicolai, is based on actual observations of the colonization of the planet by Man under clearly inauspicious conditions of life. In addition, we will furthermore see that there exist some phenomena in the biosphere yet unknown to us, but powerful in a given geological era and under certain conditions of the ecosystem, which lead to a stationary maximum number of individuals per hectare.

106.

It was only at the beginning of the 19th Century that we were able to determine with any accuracy the number of human beings living on the planet. The number was arrived at with a great degree of possible error. In the last 137 years, our knowledge has increased considerably, but it still does not achieve the accuracy required by modern science. For earlier periods, the figures are only provisory. All of this aids us, however, in understanding the underlying process.

Regarding this, the following facts may be of some significance.

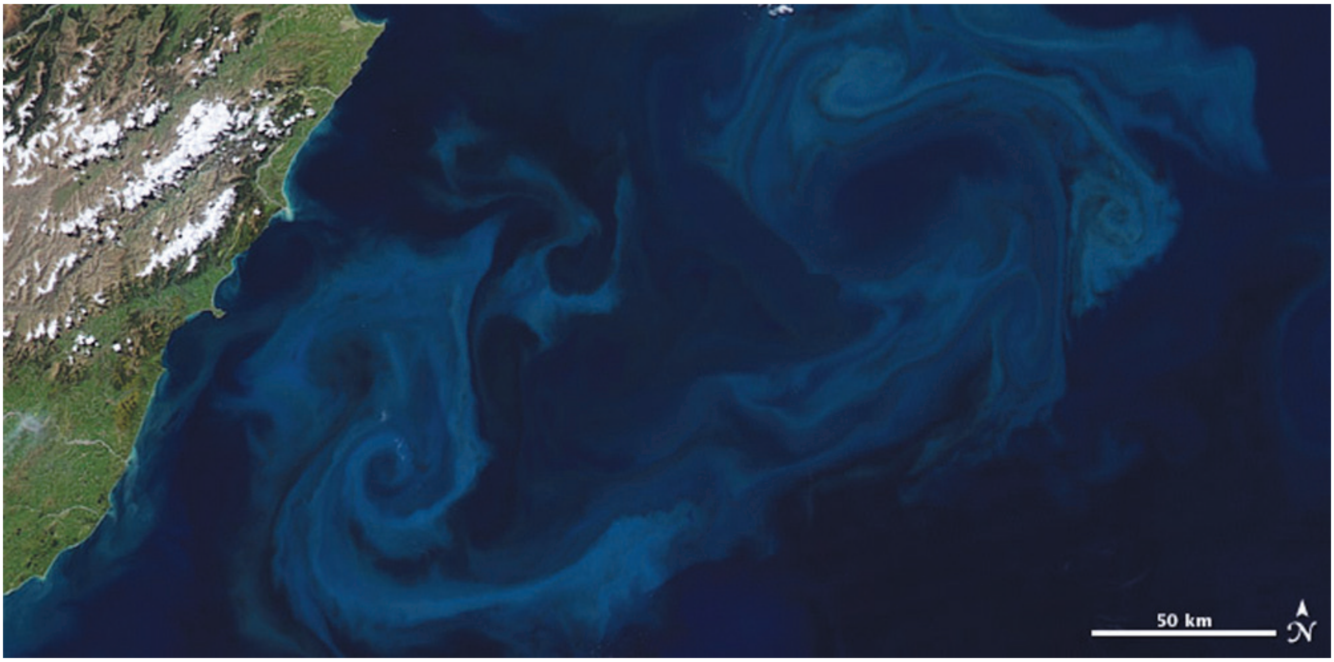
The number of people in the Paleolithic period probably reached a few million. Presumably this developed from one single branch. But the opposite may also be true.[13]

During the Neolithic period, there were probably some tens of millions of people on the entire surface of the

11. G.F. Nikolai. op.cit., p. 60.

12. Water-Power of the World (News and Views).—*Nature*, 1938, v. 141, N 3557, p. 31.

13. See Le Roy. op.cit.



NASA

The formation of phyloplankton off the coast of New Zealand, Oct.2009

Earth. It is possible to assume that even in historical time, the population did not reach 100 million, or perhaps slightly more. [14]

For 1919, G.F. Nicolai surmised that the population of the planet increased annually by 12 million people, that is, a daily increase of approximately 30,000 people. According to the critical report of Kulischer (1932),[15] world population in 1800 reached 850 million people (A. Fisher gives an estimate equal to 775 million). We can estimate the population of the white race in the year 1000 A.D. as being equal to 30 million in all, in 1800, 210 million, and in 1915, 645 million. The entire population in 1900, according to Kulischer, was around 1,700 million, but according to A. Hettner (1929),[16] the number was 1,564 million in 1900 and 1,856 in 1925.

Evidently in our own time this number has reached around 2 billion people, more or less. The population of our own country (around 160 million people) makes up around 8% of the total world population. The total population is rapidly increasing and, apparently, the percentage of our country's population is increasing relatively, as its increase is greater than that of the world average. In general, we should expect by the end of the century a significant increase exceeding 2 billion people.

107.

The multiplication of organisms, that is, the manifestation of biogeochemical energy of the first type without which there is no life, is inseparable from Man. But Man, from the very moment that he distinguishes himself from the aggregate of other life-forms on the planet, already possesses the tools, albeit rather primitive ones, which allow him to increase his muscle-power and is the first expression of contemporary machinery which distinguishes him from other living organisms. The energy which sustained him was, however, produced through the alimentation and respiration of his own organism. It is likely that already for hundreds of thousands of years as Man— the genus *Homo,* and his predecessors—he possessed tools made out of wood, bone and stone. Slowly, in the course of many generations, he developed the ability to fashion and utilize those tools, honing that capability, reason in its initial manifestation.

Those tools had been observed already in the earliest Paleolithic period, 250-500,000 years ago.

In that period, a significant part of the biosphere experienced a critical time. It seems that already at the end of the Pliocene period, abrupt changes occurred—in the water and heat regime of the biosphere, beginning and continually developing during the period of glaciation. We are apparently still living in the period of the last gla-

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14. B.P. Weinberg. *Twenty thousand years from the beginning of the elimination of the oceans. Review of the History of Mankind from a Primitive State to the Year 22,300. (A scientific fantasy).* Sibirskaya priroda. Omsk, 1922, No. 2 p. 21 (assumes a population of 80 million at the beginning of our era).

15. A. and E. Kulisher. *Kriegs-und Wanderzüge. Weltgeschichte als Völkerbewegung.* Berlin—Leipzig, 1932. p. 135

16. A. Hettner. *Der Gang der Kultur Uber die Erde.* 2nd edition, revised and expanded. Aufl. Leipzig-Berlin, 1929. p. 196

ciation's retreat phase, although we don't know whether this is permanent or merely temporary. In that half million years, we see sudden fluctuations in the climate; relatively warm periods—lasting tens and hundreds of thousands of years—gave way in the northern and southern hemisphere to periods, when large masses of ice slowly moved (measured in historical time), reaching the thickness of a kilometer, for instance, in the vicinity of Moscow. These disappeared from the Leningrad region 7000 years ago,[17] but still envelop Greenland and Antarctica. Apparently, *Homo sapiens* or his closest predecessors appeared not long before the onset of that glacial period, or in one of its warmer episodes. Man survived the severe cold of that period, possibly due to the great discovery that had been made in the Paleolithic age— the mastery of fire.

Man's discovery of fire was the first sign of the noosphere

That discovery was made in one, two, or possibly more places, and slowly spread among the peoples of the Earth. It seems that we are dealing here with a general process of great discoveries, in which it is not the mass action of mankind, smoothing and refining the details, but rather the expression of separate human individuals. As we'll later see, we can track this phenomenon more closely in very many cases nearer to our own era.

The discovery of fire presents the first instance in which a living organism takes possession of, and masters, one of the forces of nature.[18]

Undoubtedly this discovery lies, as we now see, at the foundation of mankind's subsequent future increase and of our present powers.

But that increase occurred extraordinarily slowly, and it is difficult for us to imagine the conditions under which it may have occurred. Fire was already known to the ancestors or the predecessors of that species of hominid, which established the noösphere. The recent discovery in China reveals to us the cultural remains of Sinanthropus, which indicate an extensive utilization by him of fire, apparently long before the last glacial period in Europe, hundreds of thousands of years before our time. We have at present no reliable data as to how that discovery was made. Sinanthropus already possessed reason, had crude tools, used speech, and conducted funereal rites. He was already Man, but was distinguished from us by a number of morphological characteristics. We don't exclude the possibility that this was one of the ancestors of the present population of China.[19]

108.

The discovery of fire is all the more remarkable in that the appearance of fire and light in the biosphere before Man was a relatively rare phenomenon and generally occurred when it encompassed a large space, as in forms of "cold light," which are expressed in heavenly luminescence, polar light, silent electric discharges, stars and planets, or luminescent clouds. But only the Sun, that source of life, brightly displays simultaneously both light and heat, illuminating as well as warming the dark planet.

Living organisms for a long time produced a form of "cold light." This was seen in such imposing phenomena as bioluminescent oceans, which encompass areas usually stretching hundreds of thousands of square kilometers, or in the luminescence of the ocean's depths, the significance of which is only now beginning to be understood. Fire, accompanied by high temperatures, was manifest in local phenomena, rarely encompassing a vast expanse as, for example, in volcanic eruptions.

But these phenomena, grand by human standards, obviously owing to their great destructive force, in no way assisted in Man's discovery of fire. Man had to have sought it in natural phenomena closer to him, and in less unusual and dangerous forms than volcanic eruptions, which even now exceed in their magnitude, the powers of contemporary Man. We are only now beginning to achieve its practical utilization in circumstances far beyond the power or the imagination of Paleolithic Man.[20]

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17. Now we know that in the environs of Leningrad, the ice disappeared about 12 thousand years ago. (Ed.)

18. V.G. Childe. *Man Makes Himself*. London, 1937, p. 56. Compare: J.G. Frazer. *Myths of the Origin of Fire*. London, 1930.

19. See: On the technology of Sinanthropus and the use of fire by him, see: B.L. Bogalevskii. The technology of primitive-communistic societies.—*Istoriia tekhniki*, vol. 1, ch. 1, Moscow-Leningrad, 1936, pp. 26-27. Fire was also used by Pithecanthropus which lived earlier in the very beginnings of the Pleistocene, scarcely more than 550 thousand years ago. Compare B. L Bogalevskii, Ukaz. soch., pp. 11, 67. The use of fire for Pithecanthropus is still not proven, but is highly probable.

20. Only in the 20th Century in Larderello on the initiative of Le Conte, did Man obtain, with the help of drilling, superheated vapor (140 degrees C) as a source of energy. Still later in Soffioni (New Mexico) and Sonoma that method was improved. Before his death, Parsons was working on a practical design to achieve, by drilling, an inexhaustible source of energy, at least from the point of view of humanity, from the internal heat of the Earth's crust. An analogous attempt of obtaining energy from the cold depths of the ocean by French academic Claude did not succeed in doing so only because of some acts of criminal hooliganism in 1936. We doubtless have in the hands of Man in these developments a practically inexhaustible force.

He would have had to have sought sources of heat and fire in surrounding everyday phenomena; in the places where he lived—in the forests, on the steppes, in the midst of a living nature with which he lived in close intercourse (now long forgotten). Here he would encounter fire and heat in non-threatening forms in a succession of commonplace phenomena. These were, on the one hand, fires in which living matter, living and dead, was burned. These were precisely those sources of fire used by Paleolithic Man.

He burned trees, plants, bones, the very same that fed the fires around him, independent of his will. Until Man began to use it, fire was caused by two very different sources. On the one hand, lightning discharges caused forest fires or ignited dry grass. Even now Man suffers from such fires. The conditions of nature during the glacial period, particularly during the interglacial period, may have provided even more favorable conditions for such thunderstorm phenomena. Yet there was also another source for the independent occurrence of fire.

These were the life-activities of the lower organisms which led to the fires in the dry steppes,[21] to the burning of layers of coal deposits, to the burning in peat bogs, which endured for several generations and provided convenient opportunities for obtaining fire. We have direct evidence of such coal fires in the Altai region, in the Kuznetz basin, where they occurred in the Pliocene and in the post-Pliocene period, but where they continued into the historical period, and where they must be considered still occurring now. The causes of these fires has to this day not been fully clarified, but everything indicates that we here are hardly dealing with the result of a purely chemical process of spontaneous combustion, that is, one caused by the intensive oxidation of fractured coal by oxygen in the air, or by the spontaneous combustion of the sulphuric compounds of iron produced by the heat developing during oxidation of the coal.[22]

More probable is the existence of biochemical processes connected to the life-activities of thermophilic bacteria. Regarding peat bogs, we even have during the recent period the direct observations of B.L. Isachenko and N. I. Malchevskoy.[23]

These phenomena now require more careful study.

109.

Such warm regions, winter and summer, as well as areas with hot springs, were blessings of nature for Paleolithic Man, who also had to utilize them as they were, or have recently been, utilized by tribes or peoples that we still find living in a Paleolithic state.

With the great powers of observation of Man in that era and with his close proximity to nature, such areas undoubtedly attracted his attention, and would have been utilized by him, particularly in the glacial period.

It is interesting that among the instincts of animals we can observe the use of those same biochemical processes. This is seen in the family of cocks, the so-called brush turkeys, or the big-nosed megapodes of Oceania and Australia, which utilize the heat of fermentation, that is, a bacterial process, for hatching the fledging out of the egg, building large piles of sand or earth and mixing it with strongly rotting organic remains.[24] Those piles can reach 4 meters in height and a temperature of not under 44 degrees Centigrade. These seem to be the only birds possessing such an instinct.

It is possible that ants and termites purposefully raise the temperature of their dwellings.

But these feeble endeavors cannot be compared with that planetary revolution produced by Man.

Man utilizes as a source of energy, fire, the products of life—dried vegetation. Many myths about its discovery have been coined and kept in circulation.[25] But most typical is that Man utilized methods for creating it which would never have been observed by him in the biosphere until his discovery of it. The most ancient technique seems to have been the transfer of muscle-power into heat (powerfully rubbing together dry objects), and creating sparks, and catching them from certain rocks. The complex system of maintaining fire after all came into ex-

21. Some people deny that spontaneous combustion of dry grass in the steppes, pampas, and forests actually occurs. Nowadays fires are nearly always caused by Man, but there are occasions which, it seems, indicate without a doubt the possibility of a process of spontaneous combustion in the steppes as a result of the direct activity of the Sun. The causes of the phenomenon are not clear. Concerning such events, see: E. Poepping. *Reise in Chili, Peru und auf dem Amazonenstrom wahrend der Jahre 1827-1832*, Bd. 1. Leipzig, 1835, p. 398. G.D. Hale Carpenter. *A Naturalist on Lake Victoria.—With an Account of Sleeping Sickness and the Tse-tse Fly*. London, 1920, pp. 76-77.

22. See: M. A. Usov. *Composition and tectonics of the deposits of the Southern region of the Kuznetsk coal basin*. Novonikolaevsk, 1924, p. 58; idem, Subterranean first in the Prokpyevsk region—a geological process, *Vestnik Zapadno-sibirskogo geologo-razvedochnogo trests*, 1933, no. 4, p. 34; and V.A. Obruchev. Subterranean fires in the Kuznetsk basin, Priroda, 1934, no. 3, pp. 83-85. Already I.F. Hermann, who discovered the Kuznetz coal basin, indicated in 1796 these phenomena. See: B.F. J. Hermann. "Notice sur les charbons de terre dans les environs de Kouznetz en Siberie." *Nova acta Academiae scientuarum Imperialie Petropolitanae*. St. Petersburg, 1793, pp. 376-381. Compare: V. Yavorsky and L.K. Radugina. Die Erdbraende im Kuznetzk Becken und die mit ihnen verbundenen Erscheinungen, *Geologische rundschau*. 1933, Hf. 5; V.I. Javorsky and L.K. Radugina.; Coal fires in the Kuznetsk basin and the related phenomena, *Gornyi zhurnal*, 1932, no. 10, pp. 55. [In Russian]

23. See: B.L. Isachenko and N.I. Mal'chevskaya. Biogennoe samorazogrevanie torfianoi kroshki, *Doklady* AN, 1936, T. IV, No. 8, p. 364.

24. See: A. Brehm. *Life of animals*. 4th edition, completely revised and considerably enlarged by Professor Otto Zur-Strassen. An authorized translation translation edited by a professor of the Psycho-neurological Institute for Women and the St. Petersburg M. N. Knipovich Medical Institute for Women. Vol 7. Birds. St. Petersburg, 1912. p. 15.

25. See: I.G. Frazer. op. cit.

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This photo of the Aurora Borealis over Canada was taken by a member of Expedition 30 on the International Space Station

istence hundreds of thousands of years ago or more.

The surface of the planet was radically changed after that discovery. Everywhere sparkled, smoldered, and emerged a hearth of fire, wherever Man lived. On account of this discovery, he survived the cold glacial period.

Man created fire in the midst of living nature, subjecting it to combustion. In this way, by means of fires on the steppes and blazes in the forests, he received the power, relative to the vegetative and animal world surrounding him, which thrust him out of the ranks of other organisms, and presented itself as the prototype of his future existence. Only in our day, in the 19th and 20th Century did Man possess other sources of light and heat—electrical energy. The planet began to glow ever more, and we are presently at the beginning of a time, the significance and future of which for a time remains beyond our ken.

110.

There passed many tens, if not hundreds, of thousands of years until Man possessed other sources of energy, some of which, like steam-power, for instance, appeared to be the direct results of the discovery of fire.

In the course of long millenia, mankind radically transformed his role in the realm of living nature and in a fundamental way transformed living nature on the planet. This began already during the glacial period, when Man began to tame animals, but for many thousands of years this was not so clearly reflected in the biosphere. During the Paleolithic period, only the dog seemed to have a connection to Man.

A fundamental change began in the northern hemisphere beyond the boundaries of the glaciation after the retreat of the last glacier.

It was the discovery of agriculture, creating food independently of the bounty of untilled nature, and the discovery of breeding livestock, which, apart from its significance for Man's sustenance, accelerated the movement of Man.

Today it is difficult to determine precisely the conditions under which agriculture may have arisen. The natural environment surrounding Man at that time, some 20,000 or more years ago, was far different from that we see today in those same locations.[26] It is the result not only of a transformation of Man's cultural activity, as

26. It seems to me that the investigations of N. I. Vavilov regarding the centers where the domestication of animals and plants occurred will compel us to push back considerably further than 20,000 years ago the estimated date for the beginning of agriculture. N. I. Vavilov. *Problema proiskhozhdeniia kulturnykh ractenii*. Moscow-Leningrad, 1926.

was still not long ago believed, but also of a fundamental transformation of the environment of the glacial period in which we are now living. We can clearly see that even in the more recent historical period, the last 5-6,000 years, Man has experienced geological changes in the biosphere. The regions of China, Mesopotamia, Asia Minor, Egypt, possibly even regions of Western Europe beyond the limits of the taiga regions of those times, in terms of its climate, its aquatic regime and its geological morphology, were radically different from today, and it's not possible to explain this simply as a result of the product of the cultural work of Man and its inevitable, albeit unpredictable, consequences. Alongside the cultural labor of Man the spontaneous process of the freezing of the Glacial Maximum proceeded apace, increasing or decreasing in intensity, a process lasting some hundreds of thousands of years—the process of the anthropogenic age.

NASA

Bog land fire, burning since 2012 in Russia.

111.

With the present level of human culture, agriculture is not able to encompass the entire land surface of the Earth. In a recent [1929] estimate, the area of the land devoted to agriculture did not exceed 129.5×10^6 square kilometers, that is, 25.4% of the surface of the planet.[27] If we consider only the land area of the planet, this becomes 86.3%. We probably have to consider that figure exaggerated, but in general it gives an impression of the tremendous cultural biogeochemical energy by which mankind transformed, in the course of 20,000 years or more, the surface of the planet. We have to keep in mind the fact that the Arctic and Antarctic, the deserts and semi-deserts of north and southern Africa, Central Asia, and the Arabian Peninsula, the North American prairie, a significant portion of Australia, and the high plateau and the high mountains of Tibet and North America are either not suitable for farming or can be farmed only with great difficulty. Taken together, these make up not less than one-fifth of the land area of the globe. One must also note that for Man, even after the discovery of fire at the beginning of his cultural labor, the taiga and the tropical forests represented nearly insurmountable barriers to agriculture. He would have to struggle a long time under these circumstances with the resistance mounted by insects and wild mammals, parasites and weeds, which devoured an enormous, and not infrequently, an overwhelming portion of the product of his labor. Even today in our agricultural endeavors, weeds envelop one-fifth to one-fourth of the harvest—in the beginning, that figure would certainly be a minimal one.[28] Nowadays we have, thanks to the socialist construction of our country, somewhat more accurate figures for calculating the intensity and the potentialities of this form of biogeochemical energy of mankind. We are undergoing an extraordinary expansion of cultivated land. As N. I. Vavilov and his colleagues have shown, only in the last two years (1930-31) the land under cultivation has increased by 18 million hectares, which would have required decades by the old standard.[29] With the aid of planned calculations being utilized by eminent specialists, a general map of our own country has been developed. It embraces an area equal to 2.14×10^7 square kilo-

27. H. Rew. Agricultural Statistics. *Encyclopaedia Britannica*, 1. London, 1929, p. 388.

28. A. I. Maltsev. "The most recent achievements in studying the weeds in the USSR." *Achievements and perspectives in the area of genetics and selection*. Leningrad, 1929, p. 381.

29. N. I. Vavilov, N.v Kovalev, N.S. Pereverzev. "Plant breeding in connections with the problems of agriculture in the USSR", *Rastenievodstvo*, vol. 1, ch. 1. Leningrad-Moscow, 1933, p. VI.

meters, or 16.6% of the Earth's land surface. Of this, 5.68×10^6 square kilometers beyond the limits of its northern boundaries are unfit for cultivation. In total, there are around 11.85×10^6 sq.km. unsuitable for agriculture, leaving 9.53×10^6 square kilometers fit for cultivation. Thus the greater part of our country lies beyond the boundaries of modern agriculture or else is deemed unsuitable for it.[30] But this area may be significantly reduced through improvements. The government plan of ameliorating these conditions according to the calculations of L. I. Prasolov[31] will allow an increase of arable land by about 40%. Obviously this is not the end of the possibilities, and there is hardly any doubt that if mankind finds it necessary or desirable, he would be able to develop the energy needed to bring under cultivation the entire land surface, and perhaps even more.[32]

112.

We have still in China an intensive agriculture fully developed for generations, which, in a rather stationary state, existed for more than 4000 years in a country with a huge land area of more than 11 million square miles. Without a doubt, the country's topography changed during that time, but the system of production and agricultural customs were maintained and transformed the mode of life and nature. Only in the most recent period, in this century, does the mass of the population find itself in continual flux with customs that have lasted thousands of years being uprooted. We might speak of Chinese society as a purely agricultural civilization.[33] For countless generations, in the course of more than 4000 years, the population, in general remaining uninterruptedly in the same location, altered the country and in their social existence merged with the surrounding nature. Here probably the greater part of agricultural products are produced, and, yet the population lives under the constant threat of famine.[34] More than three-fourths of the population are farmers. "A large part of China is an ancient nation, settled by farmers with the fields where they worked so close to their limits that large harvests were difficult to keep up. The roots of the Chinese go deep into the earth... The most significant element of the Chinese landscape is thus not the soil or vegetation or the climate, but the people. Everywhere there are human beings. In this old, old land, one can scarcely find a spot unmodified by Man and his activities. While life has been profoundly influenced by the environment, it is equally true that Man has reshaped and modified nature and given it a human stamp. The Chinese landscape is a biophysical unity, knit together as a tree and the soil from which it grows. So deeply is Man rooted in the earth that there is but one all-inclusive unity, not Man and nature as separate phenomena but a single organic whole." [35] And in spite of such unbroken, indefatigable labor of many thousands of years, only a little more than 20 percent of the land area of China is under cultivation,[36] while the remaining area in such a large and naturally rich nation might be improved through government measures, first made possible with our present level of scientific knowledge. A working population existing for thousands of years lives in an area of 3,789,330 square kilometers with an average capacity of 126.3 people on each square kilometer. That is almost the limit of the maximal use of agri-

Vavilov Institute of General Genetics

N. I. Vavilov, plant biologist and geneticist, who was intent upon eliminating famine in Russia. He was targetted for elimination by Trofim Lysenko, and died in Saratov prison in 1943.

30. L.I. Prasolov. "Land reserves for plant breeding in the USSR", Ibid, p. 31.

31. Ibid, p. 37.

32. The possibility of encompassing the oceans in one or another form was expressed a number of times in the scientific utopias even at a time when the physical power of Man was clearly negligible with regard to the powers of the oceans. In the interesting utopia of B. P. Weinberg [*Twenty thousand years from the beginning of the elimination of the oceans*, op. cit.] there is a discussion of that state of Man, which begins, when the reproduction of Man embrace the entire landmass—the state of the neutralization of the oceans. B. P. Weinberg assumes that in the 21st Century that question will be seriously broached. To a certain extent these questions have already become real issues before the mind of Man. The example of Holland in the past on a miniature scale and the idea of Goethe's Faust also on a small scale in the 18th and the beginning of the 19th Century already appear as realistic prototypes of the future. Now it is a matter of establishing a permanent , stationary floating base, existing outside any land area, in the midst of oceans and seas—this also merely the first inkling of what the future may bring.

33. F. Goodnow. *China, an Analysis*. Baltimore, 1926.

34. G.B. Cressey. *China's Geographic Foundations: a Survey of the Land and its People*, New York-London, 1934, p.101.

35. Ibid. p.1.

36. I am using figures provided by G. Cressey as to the total area of tilled land in the provinces and the fields of the small agricultural units and compared it with the total land mass of China. These figures are related to the period between 1928 and 1932. Rhe statistical review by Cressey (p. 395) for agricultural China (including the Hinggan Mountains, the Central Asian steppes and deserts and the areas adjacent to Tibet) gives the number as 379 square kilometers for a population greater than 477 million people—22% of the territory. Thus it is clear that the population is concentrated on a small land area which is utilized to its maximum.

cultural land. It will be, Cressey correctly indicates, from the standpoint of ecological botany, something of a final stage. "Here we have an old stabilized civilization which utilizes the resources of nature to the limit. Until new external forces stimulate change, there is but little internal readjustment." [37]

"The Chinese landscape is vast in time as well as in area, and the present is the product of long ages. More human beings have probably lived on the plains of China than on any similar area on Earth. Literally trillions[38] of men and women have made their contribution to the contour of hill and valley and to the pattern of the fields. The very dust is alive with their heritage." [39] That four thousand-year culture, before it adopted this stabilized form must have experienced a more grim and tragic past, since the former conditions of nature in China were completely different, enveloped by a totally different milieu, with humid forests and marshes; to subdue these and bring them under cultivation—destroying the forests and ridding them of their animal inhabitants—would have taken tens of thousands of years. The latest discoveries reveal that while Europe was experiencing the movements of glacial ice, in China there developed a culture under conditions of a pluvial period.[40] Certainly, the basic system of irrigation, to which agriculture in China owed its existence, had its roots far back in history, 20,000 years ago and more. Until the end of the 20th Century such an ecosystem may have existed in a certain equilibrium. But it could exist only because China was, to a certain degree, isolated, and from time to time the population was decimated by wars, hunger, famine and floods; irrigation work was too weak to cope with such mighty rivers as the Yellow River. Now all of that is rapidly becoming a thing of the past.

In China we see the last example of a unifying civilization lasting millenia. We see at the beginning of the 18th Century when Chinese science stood in high esteem, it experienced a historic shift, and missed the chance of being incorporated at the necessary moment into world science. It was included there only in the second half of the 19th Century.

113.

Agriculture would appear as a geological force, transforming the surrounding nature, only when it occurred together with the raising of livestock, namely, when Man, in addition to the selection and cultivation of plants necessary for his sustenance, also selected and began to breed the animals he needed. Man accomplishes this geological work inadvertently, stimulating a greater reproduction of a certain species of plant and animal organisms, always creating for himself an available supply of food and maintaining a food supply for the animals he needed. In raising livestock he not only obtained a guaranteed food supply, but also increased his muscle-power, allowing him to put more fields under agricultural production at an earlier stage.

In the work of the livestock, he obtained for himself a new form of energy, enabling him to support a larger population, create large settlements, an urban culture, and free himself from the otherwise ever-present threat of famine.

In doing this, he always remained within the bounds of living nature.

During the past centuries, in our age of steam and electricity, the labor-power of livestock and the muscular energy of animals and Man, begin to play a secondary role in the expansion of agriculture. However, even with that, Man does not transcend the bounds of living nature, since the primary source of the electrical and steam energy is that same living nature in the form of living matter or, even more now, past living organisms which have been transformed through geological processes. This energy is obtained from coal and oil. After all, Man has in this manner always made use of solar radiation, which illuminated the Earth for hundreds of millions of years before his appearance, and, which, transmitted through living organisms, were utilized by him either directly, or as preserved in their fossilized form.

In agriculture and livestock are manifest more than anything the cultural biogeochemical energy directed by reason, creating for Man new conditions for his habitat in the biosphere. By these means living nature by and large was radically transformed. For many tens of thousands of years, the inert matter of the biosphere was affected by Man to a degree barely comparable to the present profound transformation in his surrounding living habitat.

As a result of this there has been created a new face of the Earth, that in which we are now living and which began to emerge only in the last millenium. Now change occurs ever more abruptly with each passing decade.

But agriculture alone, even without livestock, radically transforms nature. For in the living nature surrounding it, every vacant area is filled by living organisms, and in or-

37. Cressey, op.cit., pp.1-2

38. Certainly it is not a question of trillions but of a considerably large number of people that have lived on the territory of China, as the presence of the human species and its predecessor, Sinanthropus, in that territory, would have been established in the course of hundreds of thousands of years. The appearance of a new species or race, powerful enough to provide the beginnings of modern Man, may have occurred in one family or at one stage, but could also have occurred over a rather large area. But even in the first case, the number of offspring originating from a single couple must have been much greater than 10 billion over the course of hundreds of thousands of years (even if you introduce) corrections to the general forebears of particular individuals. On this, see: E. Le Roy, Op.cit.

39. Cressey. op.cit., p. 3.

40. As for ancient China see: M.Granet. *La civilisation Chinoise*. Paris, 1926, p. 82 ff.

Chinese agriculture remained static for many centuries. Here, a representation of a farmer tilling his field with the help of his cattle.

der to introduce new life, Man must make a place, clearing the land from other living organisms. Moreover, he must continually maintain that new living substance established by him from the surrounding pressure of other life, from the animals and plants, which were inserting themselves into the vacant areas cleared by him. He has also to preserve the fruits of his labor from animals and plants, lest they be devoured by mammals, birds, insects, fungi, etc. We see that even at the present stage, he has not been able to definitively accomplish this.

Agriculture together with livestock, continually maintained by human thought and labor, in the end fulfills an enormous geological task. Old life is destroyed, and new life is created—new species of animals and plants, created by the thought and labor of Man, emerge from the old, created under different conditions. But even the world of wild animals and plants that have not been directly affected by Man are inexorably transformed in the new conditions of life created by the biogeochemical energy of Man.

114.

The raising of livestock, apart from agriculture, produces a tremendous change in the surrounding living nature. For it consumes food and condemns to a slow or rapid extinction large mammals, among which Man selects a few species. Man appeared at the end of the Tertiary Period, in the epoch in which large mammals reigned in the biosphere, as Osborne correctly points out. [41]

At the present time, it can be said that these mammals have either practically died out or are rapidly disappearing, and are preserved only in reserves and parks, where their number is relatively stable. Observations in these large reserves show that here practically always a stable dynamic equilibrium is achieved, even independently of Man's will, in which reproduction is regulated by the limited quantity of food for the herbiverous animals and by the quantity of carnivorous animals, for which these serve as food.[42] [43] With an insufficiency of food—and a weakening of their organisms, reproduction is primarily determined by diseases caused by microorganisms. But the total preserved numbers of wild herbiverous mammals can certainly not be compared to the number of domesticated animals—horses, sheep, cattle, pigs, goats, etc., and it is conceivable that their number in the Tertiary Period hardly surpassed the number of domesticated mammals. We don't know that number with any exactitude, but we do have some idea about it. At the present time it exceeds by hundreds of times the number of the human population. According to M. Smith (1910), at the beginning of the century, the number equalled 138 billion. According to H. Rew[44] the number in 1929 for horses, bulls, sheep, cows, and pigs reached 15.7 billion. Not taking into account here species of domesticated animals does not change the order of magnitude of the number. Thus one might say that the expression in billions fluctuated between 16 and 138 billion, significantly exceeding the number of people. The number fluctuates sharply as it is under human control. Thus, according to J. Dufrenoy[45], from 1900 to 1930, the number of livestock diminished

41. H. Osborn. *The Age of Mammals in Europe, Asia and North America*. N.Y., 1910.

42. See: James Stevenson-Hamilton. *South African Eden: from Sabi Game Reserve to Kruger National Park*. London, 1937.

43. M. Smith. Agricultural Graphics. United States and World Crops and Live Stock, *Bulletin of United States Department of Agriculture*, Washington, 1910. N 10, p. 67.

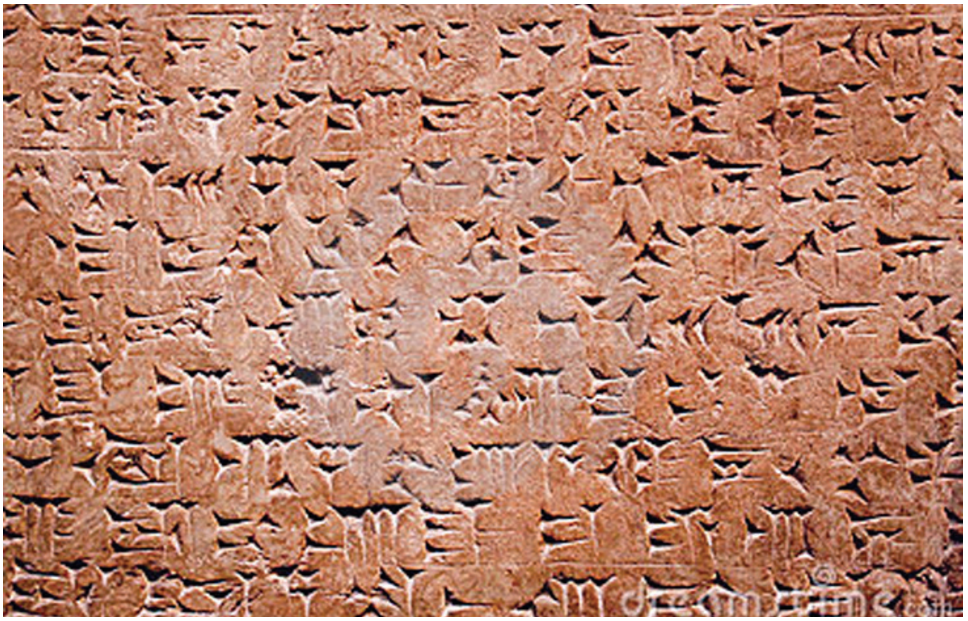
44. H. Rew. *Encyclopedia Britannica*, v. 1, 1929, p. 388.

45. J. Dufrenoy, *Revue générale des sciences pures et appliquées*. Paris, 1935, N 46, p. 72.

by one fourth, displaced by machinery. As Man came to possess new sources of energy, that number quickly dwindled before our eyes, as, for example, the number of horses, donkeys and mules, owing to the increase of tractors and automobiles.

115.

The appearance of livestock and agriculture was established at various times and in various locations within the span of 20,000 to 7,000 years ago, gradually increasing in intensity as we approach our own era. The transition from the nomadic (migratory) hunting and food-gathering phase to our present settled mode of life based primarily on agriculture, occurred at various periods on the boundaries of the uninhabited zones of the temperate latitudes stretching from present-day Morocco to Mongolia. This was possibly the result of climatic changes after the retreat of the last glacial cover and the weakening of the pluvial period[46] of the Pleistocene.



Cuneiform writing of the ancient Sumerians.

Seven or eight thousand years ago appear the first powerful states based on agricultural and the first large cities. This provided Man with the possibility of unimpeded reproduction with only minor interruptions. Here were established the urban civilizations of the Celtic and the Berber states and their predecessors in Egypt, Crete, Asia Minor, Mesopotamia, northern India, and China. We are entering the age, which power and significance is steadily and rapidly growing over the last three centuries (and from which legends have been preserved and have come down to us, and countless material relics provided, unearthed through archeological excavations).

You might say that within the last five to seven thousand years the continuous creation of the noösphere has proceeded apace, ever increasing in tempo, and that the increase of the cultural biogeochemical energy of mankind is advancing steadily without fundamental regression, albeit with interruptions continually diminishing in duration. There is a growing understanding that this increase has no insurmountable limits, that it is an elemental geological process.

46. N. Nelson recently provided a concise review of this on a global scale. See: N. Nelson. Prehistoric Archeology; Past, Present and Future, *Science*, 1937, v. 85, N 2195, p. 87.

116.

It is appropriate to add here a few additional facts. It is possible to date to somewhat earlier than 4,236 B.C.[47] or earlier the origins of the Egyptian calendar (which is based on many years of observations of Sirius), which served as the basis for the chronology of the entire ancient world right up to the present moment, where it is found spread throughout the entire noösphere. Even before that, somewhere between 5-4,000 B.C., there existed an urban culture in India, Mesopotamia, and Asia Minor, with such a level of technology, which we even as recently as a few years ago did not suspect, encompassing a population numbering perhaps in the millions. At the end of that period, around 3,000 B.C., began a shift toward using animals for transportation, and in the course of the next 1,500 years this rapidly expanded, and included oxen, camels and horses. Around 3,300 B.C., in the temples of Mesopotamia, written script was being used. Records were kept by means of a complicated pictographic script, and around 1,600-1,500 B.C., the Semites in the Near East discovered the use of the alphabet. We can assume that around 2,500 B.C., we already had a clear manifestation of scientific thought, and around 2,000 B.C. in Mesopotamia, we had the discovery of the decimal system. At this time old records, written some centuries earlier, were copied and preserved in libraries. Between the 15th and 16th centuries B.C., we note wide-ranging exchanges in

47. It may be that the choice is between these two dates—4236 B.C. and 2776 B.C. From what we now know, taking into consideration the growth of studies in history and archaeology, it appears that the first figure is the correct one. See: Naum Idelson, *The History of the Calendar*, Leningrad, 1925.

Russian Academy of Sciences

Vernadsky with the workers of the Biogeochemical Laboratory which he established in 1928

the cultural world of scholars, philosophers, and physicians of that period. Around 2,000 B.C. or earlier we have the discovery of bronze, probably simultaneously in several places, and around 1400 B.C., the discovery of iron, which in the course of a few centuries came into general use.

With these momentous achievements we have now arrived at the first century B.C., in which scientific, philosophical, artistic and religious creativity achieved an enormous development and laid the first foundations for our civilization.

In the course of the last 500 years, from the 15th to the 20th Century, Man's powerful influence over his surrounding nature and his comprehension of it, ceaselessly advanced, becoming ever stronger. In this period the entire surface of the planet was embraced by a single culture: the discovery of printing, knowledge of all earlier inaccessible areas of the globe, the mastery of new forms of energy—steam, electricity, radioactivity, the mastery of all the chemical elements and their utilization for the needs of Man, the creation of the telegraph and the radio, the penetration into the Earth to the depth of a kilometer by boring, and the ascension of men in aerial machines to a height of more than 20 kilometers from the surface of the Earth, and of mechanical devices, to a height of more than 40 kilometers. Profound social changes, giving support to the broad masses, advanced their interests into the first rank, and the question of eliminating malnutrition and famine, became a realistic option that can no longer be ignored.

The question of a planned unified activity for the mastery of nature and a just distribution of wealth associated with a consciousness of the unity and equality of all peoples, the unity of the noösphere, became the order of the day. It is not possible to reverse this process, but it bears the character of a ruthless struggle, which, however, is grounded on the deep roots of an elemental geological process, which may last two or three generations, or more (although it is hardly probable judging from the tempo of evolution in the last thousand years). In that transitional stage, amidst the intense struggles which we are now undergoing, it would as well seem less likely that there will be any protracted interruptions in the ongoing process of the transition from the biosphere to the noösphere.

The scientific grasp of the biosphere which we now observe is an expression of that transition.

Its non-fortuitous nature and its connection to the structure of the planet—its outer envelope[48]—we must later subject to a possibly deeper thoughtful logical analysis, in considering an understanding of biogeochemistry.

All the above exposition is the result of precise scientific observation, and insofar as this was faithfully done, it ought to be considered a scientific generalization.

It is a scientific description of a natural phenomenon, without the assumption of any hypotheses, theories or extrapolations.

117.

Observing thus the developed scientific disciplines, we see that there exist sciences of different types: in the first category, we have those whose objects, and consequently whose laws, encompass all of reality, such as our planet and its biosphere, as well as the cosmic expanses—that is, sciences whose objects correspond to the fundamental, universal phenomena of reality. The second category is related to phenomena which are characteristic of our Earth.

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48. Actually this is possibly a second envelope of the Earth's crust—the stratosphere, encompassing life (mainly through Man—the noösphere), and it ought to be included in the biosphere. (See:V.I. Vernadsky, "On the limits of the biosphere," *Izvestiia* AN, geological series, 1936, No. 1, p. 3-24). We should think of the upper layers (60-1000 km.) not as part of the Earth's crust, but as analogous to the Earth's crust in the division of the planet, that is, concentric with the planet. The Earth's crust will be the second sphere, and the biosphere is its outer envelope. This, of course, will soon become clear.

In this latter category, we might theoretically admit two classes of scientific objects to be investigated: general planetary phenomena, and individual, purely terrestrial, phenomena.

At present, however, it is not always possible to differentiate reliably and with a sufficient degree of certainty between these two cases. This remains a task for the future.

Here it concerns all the sciences of the biosphere, with the sciences of the humanities, with the Earth sciences—botany, zoology, geology, mineralogy—in all their scope.

Considering such a condition of our knowledge, we can distinguish an expression of the influence on the structure of the noösphere of two areas of human thought: the sciences common to all reality (physics, astronomy, chemistry, mathematics), and sciences related to the Earth (biological, geological, and humanistic sciences).

118.

Logic occupies a special position, in the most intimate manner connected to human thought, embracing equally all of the sciences: both the humanities, on the one hand, and the mathematical sciences, on the other.

Actually it should be included in the realm of planetary phenomena, because only by means of it is Man able to understand and scientifically grasp all reality—the scientifically structured Cosmos.

Scientific thought is both individual and social. It is inseparable from Man. Not even in his deepest levels of abstraction can an individual transcend the realm of his existence. Science has a real existence, and like Man himself, is most closely and inextricably bound to the noösphere. The individual is obliterated—"decomposed"—when he goes beyond the logical grasp of his intellect.

But the mechanism of the understanding, tightly linked to speech and concepts—the logical structure of which is complex, as we shall see (observe the digression on logic at the end of the book)—does not encompass the totality of Man's knowledge of reality.

We see and we know, but we know in an everyday, not in a scientific way, that creative scientific thought transcends the bounds of logic (including logic and dialectics in its various forms). The individual, in his scientific accomplishments, bases himself on phenomena, which are not encompassed by logic (however broadly we understand that term). Intuition, inspiration, the basis of the greatest scientific discoveries, proceeding and operating further in a strictly logical manner—is not brought forth by either scientific or logical thought, nor is it connected to words or concepts in its genesis.

With regard to this fundamental area in the history of scientific thought, we are entering into a realm still not fully grasped by science. But not only can we not take it into consideration, rather we must increase our scientific focus on it. At present this area of philosophical speculation is somewhat clarified, but in general still finds itself in a chaotic state.

This area has been investigated with greater interest and depth in Hindu philosophy, both ancient and modern. Here we have attempts to delve into this realm, barely touched by science.[49] How far it will conduct human thought, and give it a direction—of this we have no definite knowledge.

We only see that a large realm of phenomena, which possess a rigorously lawful, most intrinsic, relationship to the social order, and ultimately, to the biosphere—even more to the noösphere—namely, the world of artistic creation, is not reducible in any meaningful way in any of its parts, for example, in music or architecture, to verbal representation, and yet it exerts a great influence on the scientific analysis of reality. The mastery of this cognitive apparatus, little reflected by logic, is a task for the future.

119.

Biogeochemistry in its greater part, the objects of which are atoms and their chemical properties, ought to be ascribed to the category of the general sciences. However, as a sub-division of geochemistry, that is, the geochemistry of the biosphere, it appears as a science of the second type, that is, associated with the small, more circumscribed, natural bodies of the universe—with the Earth, or, in the more general case, with the planet.

But, in studying the manifestation of atoms and their chemical reactions on our planet, biogeochemistry fundamentally transcends the limits of the planet, and basing itself, like chemistry and geochemistry, on the atom, it is thereby involved with more potent problems than those simply characteristic of planet Earth—namely, with the science of the atom and with atomic physics—with the very foundations of our understanding of reality in its cosmic dimension.

This is less clear with regard to life which is studied by it in its atomic aspect.

Do the problems of biogeochemistry also here transcend the boundaries of the planet? And how far out do they emanate?

49. To avoid any misunderstandings I should explain that I have here in mind not some theosophical quest, which would be far removed from contemporary science, as well as from contemporary philosophy. Both in the new and in the ancient Indian thought there exist philosophical currents, by no means contradicting our contemporary science (actually less so than do the philosophical systems in the West), as, for example, some systems associated with Advaita-Vedanta, or even the religious-philosophical investigations, as far as I know them, of the prominent religious thinker, Aurobindo Ghoshi.

The Evolution of Species And Living Matter

Appendix to the French Translation of *The Biosphere*

by Vladimir I. Vernadsky

Translated from the French by Meghan Rouillard

Mollusk shells represent one of the first cases of biogenic migration of calcium.

TRANSLATOR'S NOTE

The text is from a speech given by Vernadsky to the Society of Naturalists of Leningrad on February 5, 1928. All footnotes were written by the translator.

From the Introduction to the French translation of *The Biosphere* written by Vladimir Vernadsky:

This book appeared in Russian in 1926. The French translation has been reviewed and in several instances, restructured, comparatively with the Russian text. It followed our essay on "Geochemistry," published in the same collection (1924), of which a Russian translation just appeared and of which a German translation will soon appear.

We will not give any bibliographic indications as they can be found in our "Geochemistry."

We have touched upon the same problems in various articles, of which the most important appeared in French in the Revue Générale *des Sciences (1922-1928) and in the* Bulletins de l'Académie des Sciences de Leningrad *(Petersburg) (1926-1927).*

The purpose of this book is to draw the attention of the naturalists, geologists, and above all, that of the biologists, to the importance of the quantitative study of life in its indissoluble relationships with the chemical phenomena of the planet.

We have tried to constantly stay on the empirical terrain without making hypotheses, a terrain which is still somewhat restricted, because of the small number of observations and precise, quantitative experiments which we had at our disposal.

It is essential at the present time to assemble in the shortest amount of time the greatest number of quantitative, empirical facts.

We cannot delay in trying to succeed in doing that, that is, only as soon as the great significance of the biosphere for living phenomena becomes clear.

Maybe this essay, whose purpose is to shed light upon this significance, will not go unnoticed.

I attach, as an appendix to the French translation, my speech, "The Evolution of Species and Living Matter," which seems to me to supplement the ideas established in The Biosphere.

Vladimir I. Vernadsky
December 1928

The Evolution of Species and Living Matter

1) Life constitutes an integral part of the mechanism of the biosphere. It is that which clearly stands out in the study of the geochemical history of the chemical elements: biogeochemical processes, so important, always require the intervention of life.

These biogeochemical manifestations of life constitute an ensemble of living processes, absolutely distinct, upon first view, from those studied by biology.

It still seems that there is an incompatibility between these two aspects of life, between its biological aspect and its geochemical aspect, and only a more profound analysis allows us to recognize the character of this difference.

It forces us to see that it is, in part, a question of identical phenomena which manifest themselves diversely, and in part, of living phenomena which are effectively different and considered differently; that is, either from the point of view of geochemistry, or, on the contrary, from that of biology.

The comparison of these two points of view transforms the scientific conception of the phenomena of life and gives more depth to it.

The difference between these two representations of life manifests itself in a particularly striking manner in the fact that the theory of evolution, which permeates the entire current biological conception of the universe, plays no role in geochemistry. Here, we will strive to shed light on the importance of the phenomena of the evolution of species in the mechanism of the biosphere.

From that standpoint, it is easy to convince oneself that the fundamental conceptions of biology must be submitted to radical modifications.

The species is habitually considered, in biology, from a *geometrical* point of view; the form—the *morphological characteristics*—are primary, in terms of importance. In biogeochemical phenomena, on the contrary, this is reserved to the number, and species is considered from an *arithmetic* point of view. Different species of animals and plants must be, in the manner of chemical and physical phenomena, composed of chemical compounds and physico-chemical systems, which are to be characterized and determined in geochemistry by *numerical constants*.

The morphological indicators which have been taken up by the biologists, and which are necessary for the determination of the species, are replaced by numerical constants.

In biogeochemical processes it is indispensable to take into consideration the following numerical constants: the mean weight of the organism, its mean *elementary chemical composition*, and its *mean geochemical energy*, that is to say the facility with which it produces displacements, otherwise called "the migration" of chemical elements in the living environment.

In biogeochemical processes, it is matter and energy which are primary instead of the inherent form of the species. The species can, from this point of view, be considered as a material analogous to the Earth's crust, as waters, minerals, and rocks, which, for the organisms, are the object of biogeochemical processes.

Seen from this angle, the species of the biologist can be envisaged as *living homogeneous matter*, characterized by mass, elementary chemical composition, and geochemical energy.

Normally, the characteristics of species are expressed by numbers informed by weight, chemical composition, and speeds of transmissions of geochemical energy, but these do not give anything but an abstract and very obscure idea of the reality.

It is possible to replace this idea with another, which relates more clearly to the character of the natural process which creates the organism. In this domain, we may take the point of view of physical chemistry and consider the organisms as autonomous fields where determined atoms in determined amounts are reunited.

This quantity constitutes precisely the characteristic

Drawings by Ernst Haeckel of early photosynthetic material.

property of each organism and each species. It indicates the number of atoms that the organism of a given species can retain due to its force outside of the field of the biosphere, atoms which are drawn, thus, from the ambient environment. The volume of the organism and the number of atoms which compose it, expressed numerically, give the most abstract formula, but, at the same time, the most real measurement of how the species is reflected in the geological processes of the planet. We obtain this formula in measuring the size of the organism, its weight and chemical composition. This *number of atoms* and the volume of the organism thus determined are indubitably characteristics of the species. The presence of life in a sphere of determined volume with the concentration of a certain quantity of atoms constitutes a real phenomenon of nature, as characteristic for an organism as its form or physiological functions.

Fundamentally, this idea probably expresses with the greatest depth the essential traits of its existence.

The numbers obtained are very considerable: For example, concerning the *Lemna minor*,[1] the number of atoms for an organism is greater than 3.7×10^{20}, and reaches the hundreds of quintillions.

These great numbers correspond to reality, and lend themselves to numerical comparisons between the different species.

This determination of the species according to the number of atoms comprised in the volume occupied by the organism, only deals with the more customary biological characteristic of the species, which does not take into account the form and the structure.

The homogeneous living matter of geochemistry and the species of biology are identical, but the modes of expression are different.

2) The study of living phenomena in the mechanism of the biosphere shows differences which are still more essential, among the ordinary biological notions.

The biosphere in its fundamental traits has not changed, in the course of geological epochs, since the Archeozoic, since at least two billion years ago.

This structure reveals itself through a great number of corresponding phenomena, among them the biogeochemical phenomena.

Thus the geochemical cycles of the chemical elements seem to remain immutable in the course of geological time. The Cambrian should have the same character as the Quaternary Epoch or that of our days.

The conditions of climate, volcanic phenomena, and the chemical and physical phenomena of erosion have remained, in the course of all the geological epochs, as we now observe them. In the course of the entire existence of the Earth until the appearance of civilized humanity, not a single new mineral was created. The mineral species on our planet have remained the same, or were modified over time in an identical way. The same compounds as those of today have been formed for all time. In no case would we know how to relate a mineral species to a determined geological epoch. It is in this that the mineral species sharply distinguish themselves from living homogeneous matter, from species of living organisms. These latter modify themselves in a very marked way in the course of geological time; they spring forth and are always new, whereas the mineral species remain identical. Life, considered from the geochemical standpoint, as an element of the biosphere, submitted to simple

1. i.e., duckweed.

oscillations, taken in its entirety, appears as stable and immutable.

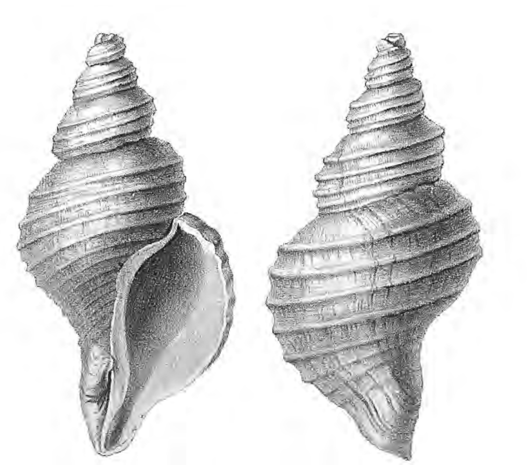
Life constitutes an integral part of the geochemical cycles which unceasingly renew themselves, but remain always identical, and it would not be able to undergo great changes in the course of phenomena studied by geochemistry. The mass of living matter, that is to say, the quantity of atoms captured by the innumerable autonomous fields of living matter, the mean chemical composition of the atoms of living fields, must, in sum, remain invariable across geological periods.[2] Moreover in the course of centuries, the forms of energy connected to life, the solar radiation and probably the atomic energy of radioactive matter, are not modified overall in terms of their amount.

We do not register in all these phenomena anything but oscillations, sometimes in one direction, sometimes in another, around a mean magnitude which appears to us as constant.

3) This immutability which characterizes all cosmic processes in the course of geological time, offers a striking contrast to the profound modifications undergone, at the same time, by the living forms studied in biology.

In particular, it is absolutely certain that all the characteristics of species, established by geochemical phenomena, are, again and again, radically modified throughout the geological epochs. Many a time have numerous animal and vegetable species disappeared, and new species were formed with a different weight, a different chemical composition, and another geochemical energy than those which preceded them. We cannot doubt that the chemical composition of bodies which are morphologically diverse is not altogether different. The extinct species necessarily corresponded to other forms of homogeneous living matter which have now gone extinct. Their numerical constants were different.

If, nevertheless, the general action of life remains identically the same in its details as compared, for example, with the phenomena of erosion, this indicates *the possibility of the formation of new groupings of the chemical elements, but not radical modifications of their composition and their quantity*. These new groupings do not affect



Mollusk shells mainly utilize calcium, whereas later structures like bone incorporate calcium in addition to other elements.

the constancy and immutability of geological processes.

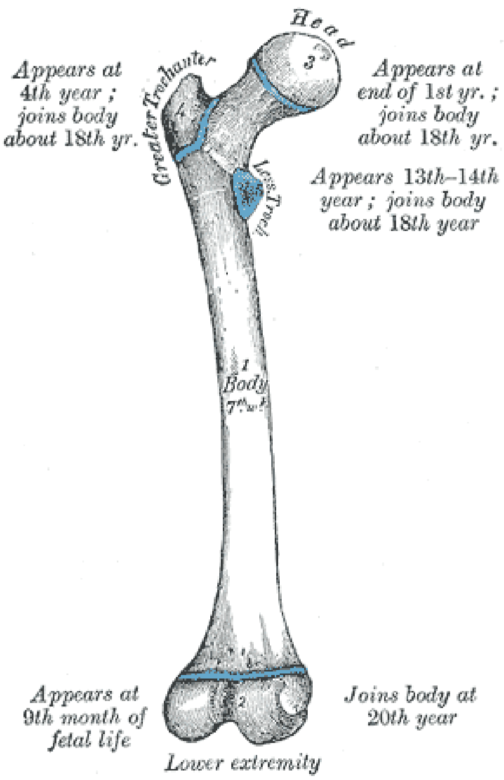
It is a new fact of enormous importance for science, and we are beholden to its introduction into the domain of biology, to the geochemical study of life.

Whereas the morphological, geometrical aspect of life, taken in its entirety, undergoes great changes and continually manifests itself by the great evolution of living forms since the Archeozoic Era, the numerical, quantitative formula of life, always taken in its entirety, remains immutable in its essential proportions and, it seems well to be the case, in its essential functions.

It is true that the attentive study of the phenomena of evolution, in the case of biology, reveal the extreme irregularity of its progress. It cannot be a question of a constant change of all species, of all forms of life. On the contrary, certain species remain immutable for hundreds of millions of years, as, for example, the species of radiolaria from the Precambrian Epoch, which are impossible to distinguish from those of today; the same also goes for the species of the *Lingula*, which, since the Cambrian until our days, have not undergone a single change: they have stayed the same during the course of hundreds of millions of years, across innumerable generations which succeeded. We can cite a great number of analogous examples for periods which may not be as long, during which, if there were changes, they were, in any case, of little consideration. We can also, consequently, observe and study in living forms, not their *variability*, but their extraordinary *stability*. It could even be that this stability of forms of species over the course of millions of years, millions of generations, is the most characteristic trait of living forms, and merits the most profound attention of the biologist.

These purely biological phenomena are probably the manifestation of the immutability of life, considered in its essence in the course of all of geological history, immuta-

2. Ten years after making this speech, Vernadsky had altered his formulation either due to new data available to him or perhaps a more ontological reason: "*The mass of living matter of the biosphere is close to the limit and, evidently, remains a relatively constant value on the scale of historical time. It is determined, above all, by the radiant energy of the Sun, falling on the biosphere, and by the biogeochemical energy of the process of colonization of the planet. Evidently, the mass of living matter increases in the course of geological time, and the process of the occupation of the Earth's crust by living matter has not yet been completed.*" -1938, "On the Fundamental Material-Energetic Distinction Between Living and Nonliving Natural Bodies of the Biosphere."



Bone incorporates other elements besides calcium, such as phosphorus.

bility which, in another form, is revealed through its role in the mechanism of the biosphere.

This stability of species, would merit, it seems, to draw more attention from the biologist than is currently the case.

The thought of the contemporary biologist orients itself in another direction. The evolution of forms in the course of geological time seems to be the most essential trait of the history of life; it embraces, for us, all of living nature.

This phenomenon was noted empirically, and in an absolutely rigorous way, one hundred years ago, by G. Cuvier, a naturalist of great profundity and precision, who demonstrated the existence of another universe, which we have ignored, of an earlier geological epoch.[3] This consideration served as a provocation during the lives of A. Wallace and C. Darwin, and later provoked a radical change of the entire conception of the scientific universe of the naturalist. The evolution of species occupies a central place in this conception, but draws attention to it to the point of forgetting about other biological phenomena which are just as important, if not more.

3. This likely refers to Cuvier's theories on catastrophism. Here, we quote his 1796 paper on living and fossil elephants: "All of these facts, consistent among themselves, and not opposed by any report, seem to me to prove the existence of a world previous to ours, destroyed by some kind of catastrophe."

The notion of the evolution of species occupies a certain space in scientific thought such that a new phenomenon or a new explanation in the domain of biology must, to be admitted, relate itself to this in a more or less explicit way.

It is important to shed light on the manifestations of this evolution in biogeochemical processes, because the latest developments in geochemical studies are now stopped short for lack of facts which only the biologists can supply. The biogeochemical phenomena have to enter into the sphere of the biologists.

But, in addition, the research of the relationship which certainly exists between the evolution of species and biogeochemical phenomena is, on its own, of great interest.

This relationship between the evolution of species and the mechanism of the biosphere, and with the progress of living processes, is not in doubt. The fact that the essential numbers which characterize these processes are properties of species which modify themselves in the course of evolution, would suffice to prove it, and it is precisely the study of this relationship which will permit us to determine those relationships which exist between the immutability of the laws of life, considered in their entirety, in geochemistry, and its evolution, always considered in its entirety, in biology.

It is one of most important scientific problems of our time.

4) We can take on this problem starting from the study of the *biogenic migration of chemical elements of the biosphere*, characterized by the regularity of forms which it takes.

We will call the migration of chemical elements all displacement of chemical elements whatever may be the cause. The migration in the biosphere can be determined by chemical processes. For example, at the time of volcanic eruptions, it occurs by the movement of liquid, solid and gaseous masses. In the case of evaporations and of the formation of deposits, it is present in the movement of rivers, marine currents, winds, sediment transport and displacements of the Earth's crust.

The *biogenic migration* provoked by the intervention of life, thought of in its entirety, counts among the most grandiose, and also, typical processes of the biosphere, and constitutes the essential trait of its mechanism.

Innumerable quantities of atoms are submitted to the action of this uninterrupted biogenic migration.

It is not useful to insist, here, on the effect produced in the biosphere by a biogenic migration at a given scale. We have treated this question more than once.

It is important, nevertheless, to point out several essential traits of the biogenic migration, because it is indispensible to know them to understand what follows:

In the first place, *there exist several absolutely diverse* *forms of biogenic migration. On the one hand, the biogenic migration is linked in the most intimate way, and genetically, to the matter of the living organism, to its existence*. Cuvier gave a correct and precise definition of the living organism during its life, as an incessant current, a whirpool of atoms which come from the exterior and return there. The organism lives as long as the current of atoms subsists. The current encompasses all of the material of the organism. Each organism on its own, or all organisms taken together, continually creates, by respiration, nutrition, internal metabolism, and reproduction, a biogenic current of atoms, which constructs and maintains living matter. In sum, it is the essential form and principle of the biogenic migration, of which the numerical importance is determined by the mass of living matter existing in a given moment on our planet. But this is not yet the entire biogenic migration.

Evidently, the effect of the entire biogenic migration does not depend directly on the mass of living matter. It does not depend any less on the quantity of atoms than on the intensity of their movements in intimate relation with life. The biogenic migration will be all the more intense as the atoms circulate more quickly; this migration can be very diverse, even while the quantity of atoms encompassed by life is identical.

That is *the second form of biogenic migration, in relation to the intensity of the biogenic current of atoms*.

There exists still a third. This third form begins to take on, in our epoch, the psychozoic epoch, an extraordinary importance in the history of our planet. It is the migration of atoms, also sustained by organisms, but which is not genetically or immediately related to the penetration or to the passage of atoms through their body. *This migration is provoked by technological activity*. It is, for example, determined by the work of burrowing animals, of which we notice traces since the most ancient geological epochs, by the consequences of the social life of building animals, termites, ants, and beavers. But this form of biogenic migration of chemical elements has taken on an extraordinary development since the appearance of *civilized humanity*, since tens of thousands of years ago. Entirely new substances have been created in this way, as for example, metals in a free state. The face of the Earth transforms itself and virgin nature disappears.

This migration does not seem to be related directly to the mass of living matter; it is conditioned in its essential traits by the work of the thought of the conscious organism.

It is necessary finally, probably, in the fourth place, to also add the changes in the distribution of atoms provoked by the appearance, in the biosphere, of new compounds of organic origin. It is *probably, as for its effects, the most powerful form of biogenic migration*. It cannot yet be numerically evaluated, and I will not concern myself with it today.

This is the case, for example, for the migration which determines the release of free oxygen by chlorophyllic organisms, or that caused by the transformation of chemical compounds, unknown of until now in the biosphere, and for those transformations created by the genius of Man.

It is true that this type of chemical migration cannot always be easily distinguished from the first two. For example, the powerful chemical migration provoked by the destruction of bodies of dead organisms, is intimately linked to the processes of putrefaction and fermentation, sustained by the existence of special organisms.

Vernadsky points out that the "technological" mode of biogenic migration, as performed by burrowing animals, does not come close to what Man is able to achieve through his activity.

Photosynthesis from trees and forests allowed for a significant increase in the biogenic migration attributed to photosynthetic matter.

But the biogeochemical processes do not explain this entirely.

5) The different forms of chemical migration indicated here constitute a special feature which we should have in view for the rest of our report.

Another characteristic trait is given by the physical laws which govern them.

Biogenic migration is only an element of another, still more powerful process in the biosphere, otherwise called the *general migration of its elements*. This migration is carried out in part under the influence of solar energy, of the force of gravitation, and the action of internal parts of the Earth's crust upon the biosphere.[4]

All these displacements of elements, whatever may be the cause, respond to diverse systems of equilibrium, which are mechanically determined; in particular, in the history of diverse chemical elements, they give birth to new, closed geochemical cycles, to whirlpools of atoms.

They can all be reduced to heterogeneous laws of equilibrium and to the principles formulated by Gibbs.

The cyclical processes in which the biogenic migration participates are maintained by an exterior force, renewed by an uninterrupted influx. The forces of radiant solar energy and atomic energy play a dominant role in the renewal of these elements.

These equilibria, studied outside of this exterior influx of energy, are mechanical systems, which necessarily arrive at a stable state. Their free energy will be zero at the end of the process, because all the work capable of being accomplished in the system will necessarily be expended. In the equilibria of this species, the work always reaches a maximum, whereas the energy in a free state tends towards a minimum.

Biogenic migration is one of the principle forms of work in natural systems of equilibrium and evidently it must tend towards a maximal manifestation.

We can consider this property of biogenic migration as an essential geochemical principle which governs, in an automatic way, biogeochemical phenomena.

The *first biogeochemical principle,* as I call it, can be formulated as follows:

"The biogenic migration of chemical elements in the biosphere tends towards its most complete manifestation."

6) Let us now examine how these two properties of biogenic migration manifest themselves in the biosphere: the first biogeochemical principle and the existence of the two forms of its manifestation—first, that connected to the mass of living matter, and secondly, to the technology of life.

The mass of living matter must, evidently, at the time of the maximum biogenic migration in the biosphere, reach the ultimate limits, that is, if there exist such limits.

The invariability of this mass seems to indicate that the biogenic migration of this form has more or less reached its limits since the earliest geological epochs.

This is not the case for the biogenic migration of elements which is related to the technology of life. Here we notice a sharp jump to our psychozoic geological epoch.

We aid in the development of this form of the biogenic migration and we must, in conformity with the first biogeochemical principle, admit that this form of the migration of elements will inevitably reach, with time, its maximum limit, while supposing that such a limit exists, or that it will constantly strive to reach its maximum development.

7) We can easily evaluate the correctness of the first biogeochemical principle in studying biogenic migration. The tendency which it has to attain its maximum development in the biosphere, can be observed in nature with respect to two phenomena: In the first place, the migration will occupy the greatest space possible, the maximum space accessible to it due to the mass of the living matter and the living technology inherent in this latter. The phenomenon manifests itself by the ubiquity of life in the bio-

4. Perhaps this refers to volcanism, or something similar.

sphere, as we see everywhere.

But biogenic migration, in that which concerns its geochemical action, not only depends on the quantity of atoms caught by it at every moment in the biosphere, but also on the rapidity of their movement, the number of atoms passing through living matter in a unit of time, or on the displacement, in this same unit of time, provoked by an intervention of a technological order by living matter within the ambient environment.

Bird guano increased the biogenic migration of phosphorus.

The first biogeochemical principle manifests itself, then, by the pressure of life, which we effectively observe in the biosphere, and by the growing acceleration of the technological activity of civilized man.

It is especially important to take into account, at the same time, the phenomenon of the ubiquity of life, but also that of its pressure, and of the existence, in the biosphere, of living forms evolved in an environment of a radically different physical character.

We can and we must, fundamentally, admit that life manifests itself in two physically distinct spaces.

On the one hand, it appears in the gravitational field where we live. It is naturally the most customary for us.

But this gravitational field, where all is governed by the law of gravitation, does not embrace the entire domain of life.

The dimensions of the smallest organisms are akin to the dimensions of molecules, [although of another order of magnitude].[5] These organisms, whose diameter does not even attain one hundred thousandth of a centimeter, enter into the field of molecular forces, and their life, and their related phenomena, are not only regulated by universal gravitation, but are also submitted to the action of radiations which everywhere surround us: These radiations can overpower,[6] in that which concerns these organisms, the conditions of existence provided by gravitation.[7]

We know that these infinitely small organisms also enjoy this same ubiquity, fill the maximum space, and that the pressure of their life, the intensity of the current of atoms which they provoke, is extreme.

8) Thus, we can consider the ubiquity of life and its pressure, as an expression of the principle of ambient nature, which regulates the biogenic migration of chemical elements.

It is easy to convince oneself, when studying natural phenomena and the empirical facts which are treated therein, that the same ubiquity, along with the pressure of life, cannot be explained by the immutability of the present life of organisms.

These phenomena modify themselves in the course of geological time and develop, to a large extent, under the action of evolution.

The creation resulting from this evolution of new living forms, adapts itself to new forms of existence, augments the ubiquity of life, and enlarges its domain. Life penetrates, thus, the regions of the biosphere where it had not earlier had access.

We see, at the same time, how, in the course of geological epochs, new forms of life appear. Their occurrence leads, however, to an acceleration of atomic current through living matter, and also provokes, within atoms,

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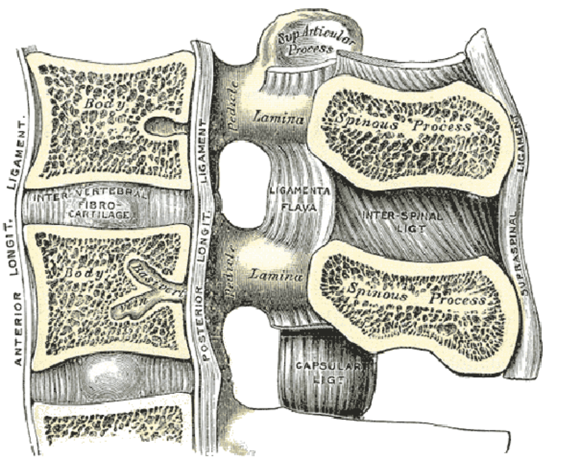
5. "*Bien qu'appartenant a une autre décade.*" The meaning of décade in this context is not clear.

6. The French word is *abolir*. It means to repeal or outlaw, but overpower seems more appropriate.

7. A footnote, to clarify and restate the idea expressed here, from *The Biosphere*: ". . .the field of stability of life is clearly divided into the field of gravity for the more voluminous organisms, and the field of molecular force for the smaller organisms such as the microbes and ultramicrobes (on the order of 104 mm long). The lives and movements of the latter are primarily determined by luminous and other radiations. Although the size of these two fields are not well documented, we know that they must be determined by the tolerances of organisms."



The intervertebral disk incorporates calcium fluoride, and in greater density than is found in other parts of the human skeletal structure.

new manifestations, unknown of until now, along with the appearance of new modes of displacement.

The attention already given by three generations of naturalists to the phenomena of the evolution of species has permitted the analysis of living nature, and convinces us that the ubiquity and the pressure of life observed everywhere, is radically modified and increased in the course of the geological epochs. *It is a result of the evolution and the adaptation of organisms to the environment.*

Two or three examples will suffice to make my thought more clear. The analysis of cave fauna show that it is composed of organisms having lived (at an earlier time) in the light. They adapted themselves to new conditions and thus enlarged the domain of life. This is also true for at least a portion of the benthos of the ocean. They adapted themselves to conditions of high pressure, cold, and darkness, while they originated from organisms having lived in other conditions.

It is a new phenomenon which enlarges the domain of life in the biosphere. The analysis of these phenomena also seems to indicate that the domain of life continues to enlarge itself in our geological epoch, also by the populating of the depths of the ocean.

In that which concerns other phenomena, we can still observe at each step identical processes. The flora and fauna of thermal sources, the flora and fauna of high altitudes or deserts, those of the glacial regions and those with perpetual snow, develop conforming to the laws of evolution. Life, in adapting to this in its environment, slowly annexes new regions, and reinforces the biogenic migration of atoms of the biosphere.

The process of evolution not only enlarged the domain of life, it intensified and accelerated the biogenic migration. The formation of the vertebrate skeleton, without a doubt, modified and augmented the migration of atoms of fluorine, in concentrating them, and the skeleton of aquatic invertebrates did the same for the migration of atoms of calcium.

It is not useful to insist upon the extreme increasing of the pressure of life in the biosphere caused by the appearance of the evolved *Homo sapiens*, who we can, it seems, name by combining the terminology of Linnaeus and that of Bergson in employing the three-fold characteristic of the species, "*Homo sapiens faber*" The thought of *Homo sapiens faber* is a new fact which fundamentally changes the structure of the biosphere after myriad centuries.

9) Thus, the analysis of living, ambient nature establishes in a sharp and decisive way that the ubiquity and the pressure of life in the biosphere are the results of evolution. Said otherwise, *the evolution of living forms in the course of geological time on our planet, augments the biogenic migration of the chemical elements in the biosphere.*

Naturally, the mechanical condition which determines the necessity of this character of atomic migration, is maintained uninterrupted in the course of all geological time and the evolution of forms has always taken this into account.

This mechanical condition which caused this biogenic migration of elements is due to the fact that life constitutes an integral part of the mechanism of the biosphere and, fundamentally, it is the force which determines its existence.

It is also evident that the evolution of species is correlated with the structure of the biosphere. Neither life, nor the evolution of its forms, would have been able to exist independently of the biosphere, nor to be divided from it as separated natural entities.

Starting from this fundamental principle, and the fact of the participation of evolution in the ubiquity and pressure of life in the current biosphere, we are well situated, concerning the evolution of living forms, to pose a new *biogeochemical principle*.

This biogeochemical principle which I will call the second biogeochemical principle can be formulated thus:

"The evolution of species, leading to the creation of new stable, living forms, must move in the direction of an increasing of the biogenic migration of atoms in the biosphere."

10) It is certain that this principle cannot in any way explain the evolution of species and does not enter into the tentative explanations of the different theories of evolution which now preoccupy the great thinkers. This principle regards evolution as an empirical fact, or rather as an empirical generalization, and attaches it to another empirical generalization, that of the *mechanism* of the biosphere.

But it is far from being indifferent, from the point of view of evolutionary theories, and it indicates, in my opinion, with an infallible logic, the existence of a determined direction, in the sense of how the processes of evolution must necessarily take place. This direction coincides perfectly, in its scientifically precise terminology, with the principles of mechanics, with all our knowledge of Earth's physical chemical processes to which biogenic migration strives.

All theories of evolution must take into consideration the existence of this determined direction of the process of evolution, which, with the subsequent developments in science, will be able to be numerically evaluated.

It seems impossible to me, for several reasons, to speak of evolutionary theories without taking into account the fundamental question of *the existence of a determined direction, invariable in the processes of evolution, in the course of all* the *geological epochs*.

Taken together, the annals of paleontology do not show the character of a chaotic upheaval, sometimes in one direction, sometimes in another, but of phenomena, for which the development is carried out in a determined manner, always in the same direction, in that of the increasing of consciousness, of thought, and of the creation of forms augmenting the action of life on the ambient environment.

The existence of a determined direction of the evolution of species can be precisely established by observation.

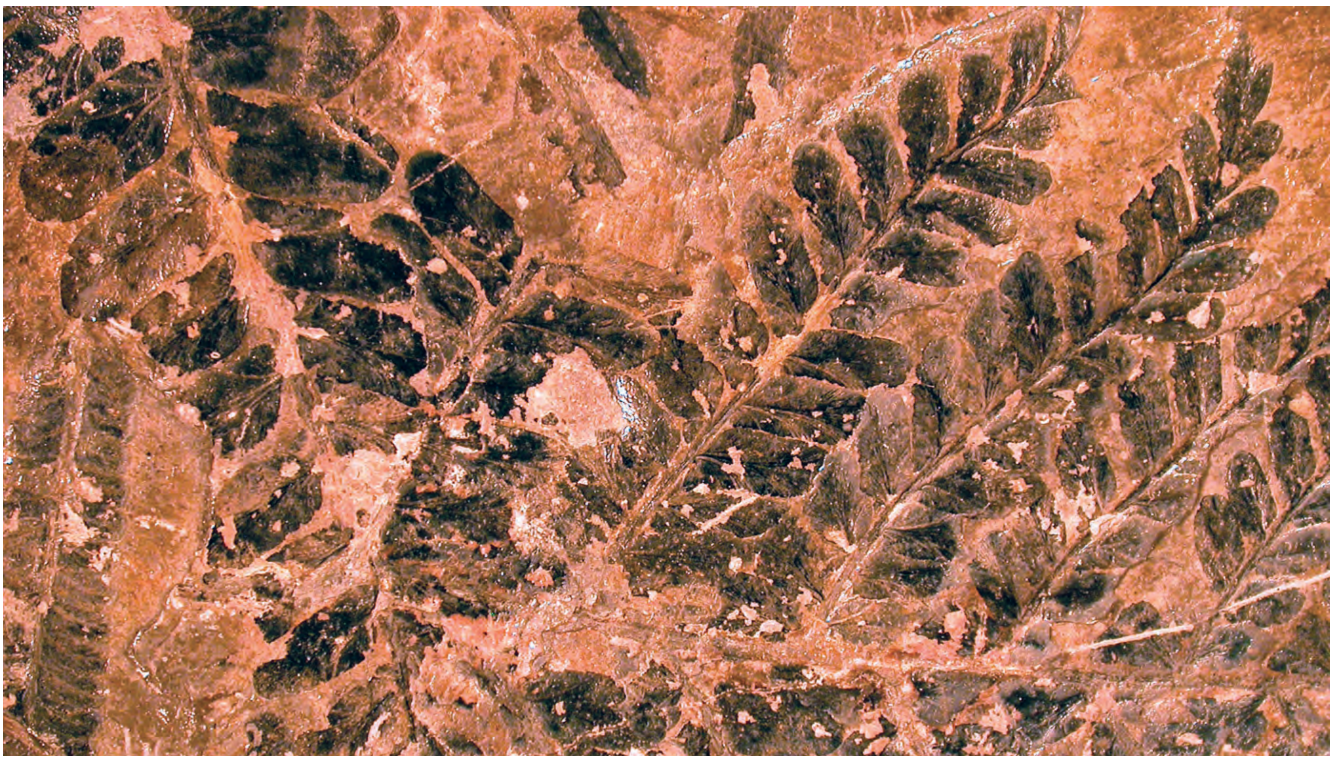
I will limit myself to a small number of general examples relative to the unfolding of processes of evolution, to paleontological indications considered from the point of view of the transformation of the biogenic migration in the course of geological epochs.

11) It was during the Cambrian period, at the limits of the ancient living world studied by us, when the higher invertebrates appeared. The fact in question is not absolutely established, but it is necessary to admit it to easily explain the sharp change which occurred shortly after the beginning of the Cambrian, concerning the conservation of organisms. The complete immutability in the course of the entire Pre-Cambrian period of the processes of erosion, their complete identity, if we consider their essential traits, with the analogous processes now, does not permit us to find the explanation of the absence of fossil remains in the different conditions of the surrounding environment.

There is not, at the same time, any reason to suppose that the metamorphosis of Earth's geological layers, occasioned by a determined duration of their processes, had, following this precise moment, an absence of organic fossils. It would otherwise be necessary to admit that all the oldest layers were completely transformed.

Now, we are quite familiar with the cases where the Pre-Cambrian layers were less metamorphised than those of the Cambrian and those of the more recent times.

It is probably the geologists, who here admit of a sharp



Photosynthesis caused a significant increase of the biogenic migration of carbon, oxygen, hydrogen, and nitrogen.

Feathers incorporate calcium, in addition to phosphosus. The activity of birds greatly increased the biogenic migration of phosphorus.

change of the *biogenic migration of atoms of calcium*, who are right. It is the first phenomenon of this type which we could establish.

It is possible that a similar modification of the biogenic migration of calcium, caused by the formation of new species endowed with skeletons rich in calcium carbonate, corresponds with the invasion of life into new domains of the biosphere. This modification must have had equal repercussions in the history of carbonic acid.

We can get an idea of the importance of this event by remembering the role, played in the biosphere, by the organisms which are very rich in calcium (the organisms containing it in fundamental preference to other metals), in the formation of the calcium deposits. The mechanism of the biogenic migration of calcium experienced great changes during the indicated time and this migration became instantly more intense. In order to judge it by that which we know of the intensity of the migration of calcium, sparked off by the creation of the higher invertebrate skeleton, for example, that of mollusks or of coral, in relationship to those of the microscopic organisms, whose calcium is released, in the end, by water, it is necessary to admit an extreme and sudden augmentation of the intensity of its migration since the creation of these new forms of life.

At the beginning of Paleozoic life, and maybe at the Cambrian period, another very important fact relative to the biogenic migration of atoms calls itself to our attention: It is the radical transformation of the sylvan vegetation of the continents.[8] The process of gradual perfection of these organisms, of which the full blooming seemed to be attained, its point culminating in the Tertiary Epoch, still prolonged itself in the course of further geological epochs. This process corresponds to the conquest by life of a new and immense domain, that of the troposphere. The appearance of forests, exuberant with life, brought about a great change in the migration of atoms of oxygen, of carbon, of hydrogen, and simultaneously in that of all the living atoms of which the cyclical movement, first of all, had to become more intense, because the forests, especially the forests with leafy trees, persisting through new geological epochs, concentrated life, as much vegetable as animal, in proportions unknown of up until then. If we compare from this point of view the spore-bearing forests of primitive times to our tertiary forests of seed-bearing trees, the difference of the intensity of the biogenic migration will seem enormous to us.

During the Mesozoic Epoch, a new fact, the appearance of birds, augmented the intensity of the biogenic migration of atoms, and life again enlarged its domain. It was not until the Mesozoic Epoch and the Tertiary Epoch that flying organisms attained their fullest development, in the form of birds. Two very important biogeochemical functions attach themselves to these two new forms of life. We can hardly conclude that there is a relationship between these forms and the flying invertebrates which emerged very long ago, around the beginning of the Paleozoic, although these flying invertebrates, in particular, had fulfilled these functions and fulfill them still to this day. In any case, only the creation of the birds gave an impetus to the mechanism of the biosphere which it had not had earlier.

In the mechanism of the biosphere, in the biogenic migration of atoms, the birds, as well as the other flying or-

8. i.e., forests.

Man increases the biogenic migration of atoms in a way which is consistent with the increasing biogenic migration throughout evolutionary history, but on a scale not seen before in the biosphere. This would be achieved by building the North American Water and Power Alliance (NAWAPA) pictured here.

ganisms, play an immense role for the exchange of matter between the solid earth and the water, principally between the continent and the ocean![9] The role of the birds differs from that of the rivers, but as far as the quantity of mass transported, it comes close. The migrations of birds renders this role even more important in that which concerns the biogenic circulation of atoms. The appearance of these species of winged vertebrates not only created new forms of biogenic migration that affected the chemical balance of the sea and of the continent, but it also provoked a new wave of biogenic migration in the course of the history of discrete bodies, in particular, for that of phosphorus.[10] The winged invertebrates, the insects, did not play as important a role. It is true that the flying saurians (reptiles) appeared before the birds, but everything indicates that they did not exercise actions comparable to theirs. The appearance of birds appears to be linked to that of new types of forests, or in any case seems to have coincided with them.

The role of civilized humanity, from the point of view of the biogenic migration of atoms, was infinitely more important than that played by the other vertebrates. Here, for the first time in the history of the Earth, the biogenic migration due to the development of the action of technology was able to have a greater significance than the biogenic migration determined by the mass of living matter. At the same time, the biogenic migrations changed for all of the elements. The process was rapidly effected in a relatively insignificant amount of time. The face of the Earth transformed itself in an unrecognizable way, and yet, it is clear that the era of this transformation has only just begun.

These transformations conform to the data of the second biogeochemical principle; the change led to an extreme growth of the intensity of the biogenic migration of atoms in the biosphere.

It is necessary to note here two phenomena: Firstly, Man (and this can not be doubted) is born of an evolution, and secondly, in observing the change which he produces

9. This exclamation point is in the French translation, but not in the Russian.

10. From Mark McMenamin's *Hypersea*: "The first aspect of Vernadsky's law involves actual transport by the motion of living organisms, such as the migration of phosphorus atoms from sea to land when shore birds leave their droppings inland. (To a Vernadskian, a seagull is phosphorus on the wing)."

in the biogenic migration of atoms, we note that it is a change of a new kind, which, with time, accelerates with an extraordinary rapidity.

We can then perfectly admit that the changes in the biogenic migration of atoms were effected in the course of paleontological periods under the influence of the creation of new animal and vegetable species, in a manner which is no less rapid.

The new quantitative form of the biogenic migration, corresponding to civilization, was prepared by the entirety of paleontological history. We would have been able to recover its first fossil remains, if we had known the laws of nature from the first pages of the annals of paleontology.

I stop myself here on several typical phenomena with respect to the evolution of species relative to the biogenic migration of the chemical elements. In all these cases, the agreement of evolution with the second biogeochemical principle is evident, as it always seems to manifest itself, in the analysis of the paleontological annals.

How did this agreement occur? Does it follow from a blind combination of circumstances or, indeed, from a more profound process, determined by the properties of life—incessant processes, always the same in their manifestations in the course of the entirety of the geological history of the planet? The future will decide this.

The regulating influence of the second geochemical principle will manifest itself in these two cases.

Even if the evolution of species happened randomly, accidentally, outside of the influence of the ambient environment, that is to say, the mechanism of the biosphere, a species which was accidentally created would, however, not have been able to survive and to enter into the whirlpool of the planet; at the same time, only the species which were sufficiently stable, and susceptible of augmenting the biogenic migration of the biosphere, would have survived.

It is, however, impossible to now oppose, in an elementary fashion, the organism in its environment, that is to say, the biosphere, as was done of old. We know that the organism is not an accidental inhabitant of the environment: It participates in the complicated mechanism and submits to fixed laws. Evolution itself constitutes a part of this mechanism.

The naturalist must exclude all the philosophical or religious notions, which have penetrated science from the outside, from his conception of the universe. For example, admitting the idea of the independence of the organism from its environment, and of an opposition between these two factors, would be a great error of this type.

From this point of view, there truly exists an intimate connection between the agreement of evolution and the principle which governs it and it is by no means a question of a simple confluence of circumstances.

12) Without preoccupying ourselves with the causes of evolution, while only indicating the necessity for it to have a determined direction, the study of biogeochemical phenomena thus circumscribes the domain of evolutionary theories admissible into science.

It seems that this study opens before us yet another domain of the phenomena of scientific activity, until now exclusively reserved to the speculations of philosophy or religion.

The new form of biogenic migration, at least new to this scale, was provoked, as we see, by the intervention of human reason.

However, it does not distinguish itself in any of the other manifestations of biogenic migration, which are connected to other vital functions.

We can, at the same time, establish in a precise way, that human thought changes in a sharp and radical way the course of natural processes, and modifies that which we call the laws of nature.

Consciousness, and thought, despite the efforts of generations of thinkers and wisemen, cannot be reduced to either energy or matter, however we define these bases of our scientific thought.

How can consciousness act on the work of natural processes which seem to be entirely reducible to energy and matter?

This question was last posed by the American mathematician A. Lotka, precisely on the question of biogeochemical phenomena. It is doubtful that his response was satisfactory. But he indicated the importance of the problem, and the possibility of tackling it.

It is probable that we will not be able to resolve this question until after having radically changed our fundamental physical notions, notions which have undergone and still undergo transformations with a rapidity for which we know of no prior examples in the history of thought.

The physical theories will inevitably have to concern themselves with the fundamental phenomena of life.

It is in this direction that thought now works, and it is impossible not to take into account these new and profound researches, among them the speculations of the mathematician and English thinker A. Whitehead; it is true, more philosophical than scientific, merit analysis. It is very possible that another English thinker, J. Haldane, was right in predicting, in the near future, a radical transformation of physics and its principles due to the introduction of the study of life phenomena into its sphere.

The study of biogeochemical phenomena, pushed to the forefront, allows us to precisely penetrate this domain of the connected manifestations of life and the structure of the physical universe, and, at the same time, future scientific theories.

This makes clear the profound philosophical interest which biogeochemical problems now present.

Are Nuclear Processes In Biology Unique?

by Ernest Schapiro, M.D.

February 2012

Since the published work of Louis Kervran in France in 1960, there has been serious debate as to whether nuclear reactions occur at normal body temperatures in organisms. Kervran reported what he claimed to be many instances. In none of these cases was there any indication of radioactivity or noticeable heat production, and the element formed in the proposed reaction was always stable. In his last book in 1982, he finally described in rigorous detail an experiment in which he sprouted oat seeds under artificial light for several weeks, and obtained a large and reproducible increase in calcium.[1] Hisatoki Komaki, a follower of Kervran in Japan, reported that cultures of fungi could form large amounts of potassium, which he attributed to the combination of sodium with oxygen nuclei.[2]

Louis Kervran
1901—1983

Kervran's handicap was that he had no laboratory of his own. Having been a high-ranking government official, he had been granted opportunities to utilize certain facilities run by the government, but not on any long-term basis and without collaborators. More recently, a professor of physics in Ukraine, Vladimir Vysotski, has made a major advance in this field. He has had the advantage of working with microbiologists, and he is an accomplished expert in nuclear physics and quantum theory. He has been able to demonstrate transmutation of elements in bacteria by an ingenious selection of experiments, which give rise to rare isotopes that can be unequivocally identified by spectroscopic and spectrometric methods, along with the use of appropriate controls.[3]

Vysotski's first such achievement was to demonstrate the formation of Fe-57, a rare but stable isotope of iron which ordinarily makes up only 2.2 percent of the iron found in nature. He utilized a bacterium that can grow in a medium containing D_2O (heavy water) in place of H_2O, to which he added a salt of manganese, atomic weight 55, the only stable isotope of manganese. After a few days of incubation the culture showed a significant gamma ray absorption band for Fe-57 using Mössbauer spectroscopy. As a control, Vysotski added Fe-57 to a culture of the organism and found the same spectroscopic band structure as was exhibited by the transmuting culture. He also confirmed this result using mass spectrometry, which showed that the amounts of Fe-57 yielded by the two methods were comparable.[4]

The Energy Relation in Biology

In another bacterial experiment, he was able to generate considerable amounts of another rare isotope of iron, Fe-54, normally 5.8 percent of natural iron. Vysotski hypothesized that there had been a combination of phosphorus (P-31) with sodium (Na-23). When phosphorus was ex-

1. C. Louis Kervran, *Transmutations Biologiques et Physique Moderne*, Maloine, 1982. There are also two English-language books by and about Kervran:
- Michel Abehsera and C. Louis Kervran, *Biological Transmutations and Their Applications in Chemistry, Physics, Biology, Ecology, Medicine, Nutrition, Agriculture, and Geology*. Swan House Publishing Company, 1972.
- C. Louis Kervran, *Biological Transmutations.* Beekman Publishers, Woodstock, NY, 1980.

2. Hisatoki Komaki, "Observations on the Cold Fusion or the Biological Transmutation of Elements." 1993 *Frontiers of Cold Fusion.* Universal Academic Press, pp.555-558.

3. Vladimir I. Vysotski and Alla A. Kornilova 2010, *Nuclear Transmutation of Stable and Radioactive Isotopes in Biological Systems.* Pentagon Press, New Delhi, 2010.

4. Ref 3, p. 16. See also: Rudolf L. Mossbauer, Zeitschrift fur Physik, Vol 151, 1958, pp.124-143 and T.E. Cranshaw, B.W. Dale, G.O. Longsworth, and C.E. Johnson, *Mössbauer Spectroscopy and Its Applications,* Cambridge University Press, 1985.

cluded from the original culture, no Fe-54 was found.[5] Provided the elements being transmuted were not radioactive to begin with, Vysotski's reactions, like Kervran's, produced only stable elements. On the other hand, Vysotski went on to show for the first time that bacteria can transmute radioactive elements into other radioactive elements.

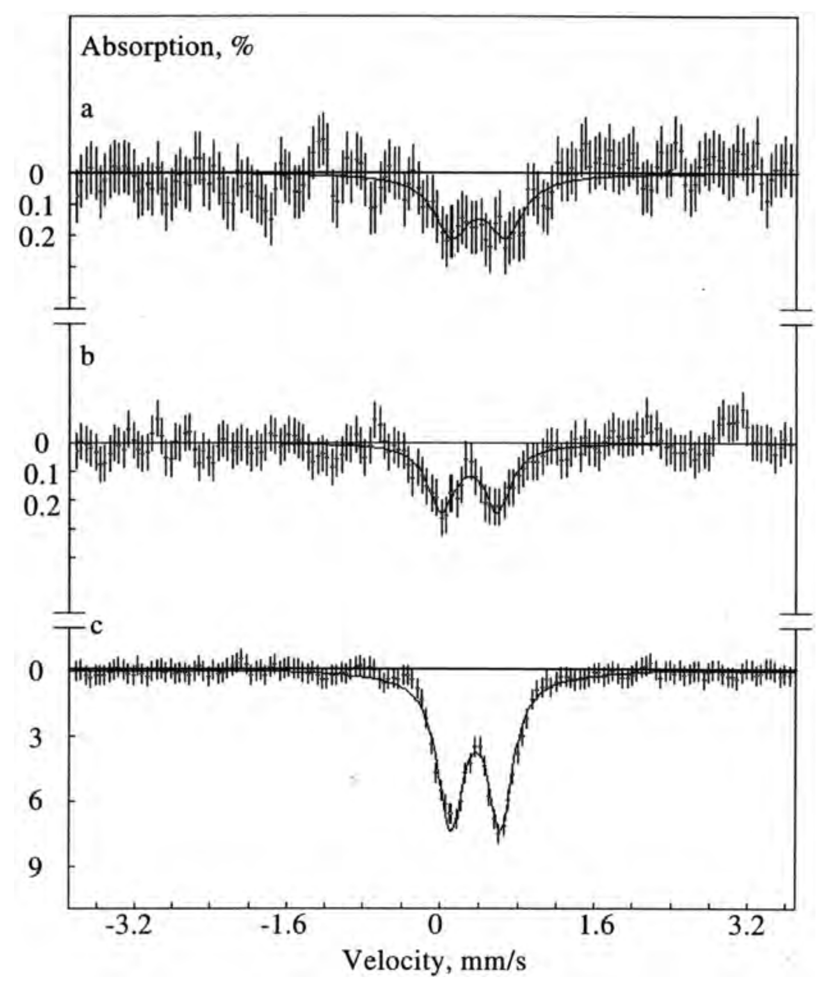
These results raise some fundamental questions. According to the Einstein relationship, $E = mc^2$, nuclear reactions can proceed from an energetic standpoint when there is a loss of mass, i.e. when the product atom weighs less than the two atoms that produced it. The loss of mass is accompanied by the release of energy. This law was recently con-

Mossbauer Spectroscopy

These graphs show the absorption of gamma rays by Fe-57 in Vysotski's bacterial culture. The first two represent the actual experiment, while the third is a control to which Fe-57 was added. The gamma rays were emitted in the course of radioactive decay of Co-57 nuclei present in the source to an excited state of Fe-57. The excited state of Fe-57 in the source in turn then emitted the rays which were absorbed by the nucleus of Fe-57 formed in the bacterial culture, and this is the absorption measured here.

Mossbauer spectroscopy takes advantage of the extremely narrow width of the nuclear absorption of gamma radiation to identify the absorbing isotope, and, by means of the absorption fine structure, to probe the environment of the absorbing nucleus. Mossbauer's discovery was how to overcome the principal problem in such spectroscopy. Because the line was so narrow, one needed a precise match between the emitted frequency and the absorbed frequency. Under certain conditions the emitter would recoil and the ray would lose energy, no longer matching the absorption spectrum of the target nucleus. Mossbauer found that cooling the source and the sample could reduce the recoil interaction with neighboring atoms. Vysotski kept them at 78 degrees Kelvin. Also by giving the source a very small velocity in the direction of the target, one very slightly increased the frequency of the emitted gamma ray to ensure its absorption. In Vysotski's graphs, the x-axis represents the velocity of the source in millimeters per second.

The purpose of the experiment shown in the third graph was to show that the particular shape of the spectrum in the first two was not an artifact. The third graph was produced by adding Fe-57 to a culture lacking Mn-55 and therefore serving as a control. The absorption pattern with its multiple humps was the same as in the growing culture.



**Reprinted from Vysotski, Nuclear Transmutation of Stable and Radioactive Isotopes in Biological Systems, by permission of Pentagon Press.

The Mossbauer specter for the grown culture Deinococcus radiodurans: a) and b) in D_2O with Mn-55; c) in D_2O without Mn-55 and with admixture of small amount of Fe-57 isotope.

firmed by Simon Rainville et al in 2005. They bombarded silicon-28 and sulfur-32 with thermal neutrons (having very low energy), resulting respectively in silicon-29 and sulfur-33. The reactions were exothermic, causing the release of energy in the form of a gamma ray. When the decrease in mass was determined, it was found equivalent to the energy of the gamma ray to within 1 part in 10 million. [6]

But how do we know whether the Einstein relation also holds in biology? Vysotski argued that the relationship does hold. He noted that until we get to the upper end of the periodic table, the combination of two stable atoms, one of which is a light atom, results in a loss of mass. Vysotski believes that in such cases, bacteria have a remarkable facility to carry out the transmutations they need for their growth and metabolism. That is to say, if a necessary element is lacking in their environment and the raw materials are present, the organism can synthesize a substitute by transmutation.

As an example, Vysotski found that in the absence of potassium in the medium, bacteria could transmute Cesium-137 into Barium-138, barium being a substitute for potassium.[7] He argues, citing the work of Syroezhkin, that elements with comparable atomic radius, such as barium and potassium, are significantly interchangeable.[8] Moreover, he believes this capability to transmute elements includes an extraordinary ability to overcome the so-called Coulomb barrier which is supposed to prevent two positively charged nuclei from coming close enough to interact and form a new nucleus.[9]

In what principled way might the biological context change the nature of the process? Vysotski believes that fundamentally we are dealing with a broadened application of quantum mechanics and presents a thorough plausibility argument based on potential wells and overlapping wave functions.[10]

LaRouche on Anti-Entropy

Taking another approach, Lyndon LaRouche, in a 1998 article entitled "The Astrophysics of Gurwitsch Radiation," discussed the way in which the laws of inorganic physics are "bent" or modified due to the higher universal physical principle of life, which is not simply reducible to inorganic physics.[11] Russian biologist Alexander Gurwitsch discovered in the 1920s that living cells release radiation, which he initially believed to be electromagnetic radiation in the ultraviolet. The presence of this radiation could only be demonstrated at that time by its ability to promote cell division, because no instruments to detect it had been invented as yet.[12] Gurwitsch found that successive stages of embryonic growth could be conceptualized as being mapped from a field that changed its form as growth proceeded.[13]

In recent years, Gurwitsch's biophotons have finally been measured by instruments and found to have anomalous properties. Unlike sunlight, the biophoton radiation is coherent. If their spectral distribution is graphed, it is found that the energy intensity is the same across a wide range of frequencies, whereas ordinarily one would expect the lower frequencies to have much higher intensities as the expression of an equilibrium state.[14]

LaRouche defined a principle of powers characterizing the successive domains of the cognitive, the biological, and the non-living. These domains interact in such a way that the higher domain permeates the lower, such that processes that appear to be part of the lower domain may actually be shadows of a higher domain at work.[15] This is a metaphor taken from the Riemannian idea of multiply extended manifolds, whose perceptual spatial characteristics are formed by determining *physical* principles.[16] This same metaphor was used by Russian biogeochemist Vladimir Vernadsky who developed his concepts of the *biosphere*[17] and the *noösphere*.[18] The anomalous behavior of biopho-

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6. Simon Rainville, et al. "A Direct Test of $E = mc^2$" *Nature,* Dec 2005, Vol. 438, pp. 1096-1097. The authors state that this result is 55 times more accurate than the previous best test of $E=mc^2$, which was performed by comparing the electron and positron masses to the energy released in their annihilation as a gamma ray, for which, see Greene, G.L. Phys. Rev. D 44 R 2216-2219, 1991. In Rainville's experiment, the limiting factor in determining the binding energy was the wavelength of the gamma ray, determined by diffraction to only 10 to the minus 7.

7. Ref 3, p. 45

8. Ref 3, pp. 128-139 for a full discussion of substitution of one metal for another missing metal in bacteria.

9. Ref 3, page 113 "Possible scenario of running barrierless nuclear synthesis in growing bacterial systems."

10. Ref 3, chapter 4.

11. Lyndon H. LaRouche, Jr. "The Astrophysics of Gurwitsch Radiation: The Reciprocity of Extremes," *21st Century Science and Technology*, Fall 1998, pp 14-17.

12. Michael Lipkind, "Alexander Gurwitsch and the Concept of the Biological Field" (Parts 1 and 2), *21st Century Science and Technology*, Summer 1998 and Fall 1998.

13. *Ibid.*

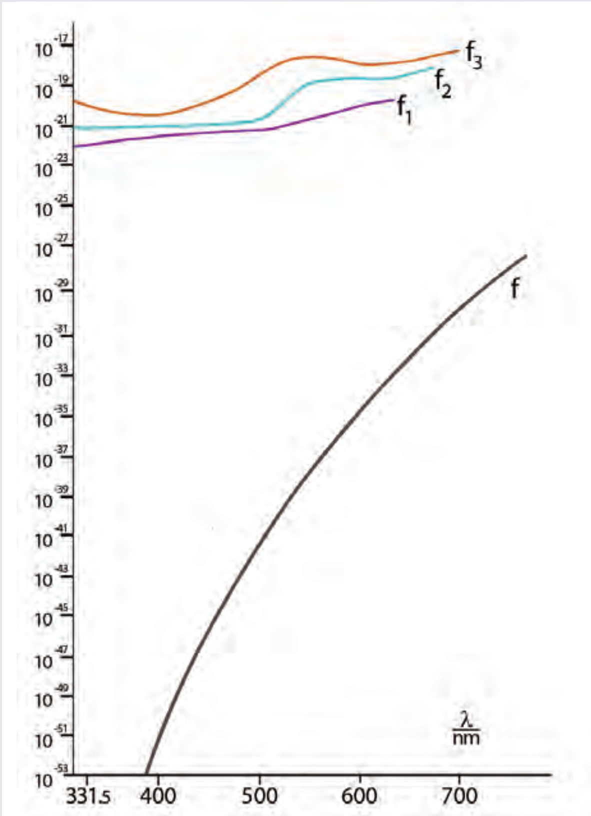
14. Fritz-Albert Popp, "Biophotonen—Neue Horizonte in der Medizin," von der *Grundlagen zur Biophotonik,* Karl F. Haug Verlag, Stuttgart, 2006, p. 69.

15. Lyndon H Larouche, Jr., "Vernadsky and Dirichlet's Principle," *21st Century Science and Technology* Winter 2005-2006 pp 18-38.

16. Bernhard Riemann, "On the Hypotheses Which Underlie Geometry," David Smith, ed., *A Source Book in Mathematics,* Dover Publications, 1959, pp. 411-425.

17. Vladimir Vernadsky, *The Biosphere*, Nevraumont Publishing Co, New York, NY, 1997, translated by David Langmuir.

18. V. Vernadsky, "Some Words about the Noösphere," Dec 1943, translated from Vernadsky's book *Biosfera* (Russian) by Rachel B. Douglas and Jonathan B. Tennenbaum, in *21st Century Science and Technology* Spring 2005 pp. 16-21.



*Adapted from Fritz-Albert Popp, "Biophotonen – Neue Horizonte in der Medizin," in Grundlagen zur Biophotonik, 2006, p. 69

A Crucial Difference Between Living and Non-living Systems

These graphs portray a relationship between the wavelength of the light being emitted in nanometers, as the x-axis, and the relative intensity or energy flux density at the particular wavelength as the y-axis. The lower graph depicts an isolated system in equilibrium with its environment, usually a non-living object. Thus in the isolated system, the longer wavelengths, i.e. the lower energy ones, are where the most energy is emitted. This is the so-called Boltzmann distribution. The three upper curves represent radiation of biophotons by seeds: f_1 are untreated seeds, f_2 are seeds poisoned by Cialith, and f_3 are seeds poisoned by acetone. Poisoning causes an increase in biophoton release relative to the healthy state, because ordered structures break down and their energy is released, according to Gurwitsch's writings. However in all three cases, the pattern is entirely different from the bottom curve, because living processes are far from thermal equilibrium and therefore so-called excited states of higher energy (and therefore shorter wavelength) are much more highly represented than would be seen in thermal equilibrium.

tons expresses the higher power of the principle of life with respect to the inorganic domain.

Supposing however that the life principle doesn't alter the Einstein relation, $E=mc^2$, this might seem to restrict transmutations in living organisms to those involving no more than very small quantities, primarily the cases of microorganisms and transmutation of trace elements in higher organisms. Thus, to take the example proposed by Komaki, Na + O = K in microorganisms. Were 100 mg of sodium to be thus transmuted in the human body as proposed by Kervran, nearly 2,000 kilocalories would result! This is about the daily caloric intake of a human being!

Coupled Reactions and Biogenic Migration

This raises yet another question. Just how might a biological transmutation, such as those demonstrated by Vysotski, get integrated into the living process as a whole? It is a striking fact that biochemical reactions are coupled, so that when a reaction produces energy as adenosine triphosphate (ATP), that ATP is at once utilized in another process.[19] In coupled reactions, there is at least one substrate, or intermediate, common to both. In many other cases, a biochemical reaction can be coupled, not with another reaction but rather with a process that transports compounds or ions across a membrane or does some kind of mechanical work.[20] This prevents entropy formation and dissipation of energy as heat. How could one expect to couple a transmutation producing thousands of electron volts in energy with processes using a fraction of an electron volt, like biochemical processes?

Vysotski's carefully obtained experimental findings are suggestive of this interconnectedness or coupling of biological processes. After doing the monoculture experiments just described, he repeated them using a culture containing thousands of species of bacteria mixed togeth-

19. Donald and Judith Voet, Fundamentals of Biochemistry: Life at the Molecular Level, John Wiley and Sons, Hoboken, NJ 2006, pp. 407-411.

20. Mae-Wan Ho, *The Rainbow and the Worm: The Physics of Organisms*, World Scientific, Singapore, 1993. See chapter 4, "*Energy Flow and Living Cycles*."

See also, James P Isaacs and John Lamb, *Complementarity in Biology: Quantization of Molecular Motion* pp. 37-43, "The Radically Open Nature of Metabolism," Johns Hopkins Press, Baltimore, 1969. In this book it is argued that the extraordinary amount of coupling leads necessarily to quantization of many processes within the cell, and coherent behavior, such as Gurwitsch radiation, which the authors predicted would be coherent. This book was written before biophoton detection devices were invented.

er. The results were dramatically different. Instead of growth stopping in a few days, the mixed culture could go on for weeks and produce a much greater yield of Fe-57. Also, when the mixed culture was placed in a highly radioactive environment, it was able, after a few days, to grow vigorously and break down a number of radioactive elements by transmutation, whereas the monoculture couldn't survive at all in this environment.[21]

The more interconnected system would have more degrees of freedom and a greater flow of energy and molecular constituents, what Vernadsky called the "biogenic migration of atoms." [22] Vernadsky asserted as an empirical generalization that the biosphere evolves in such a way as to increase the biogenic flow of atoms and favors those species that contribute to that purpose. LaRouche draws out in great detail the anti-entropic analogy of Vernadsky's increasing biogenic migration of atoms to the progressively increasing rate of flow of ideas, raw materials, and manufactured products in an economy when it is functioning anti-entropically.[23]

Vysotski observed that sometimes adding elements or compounds not directly involved in the transmutation could greatly speed up or slow down the process, again suggesting that the transmutation was integrated into the cell's total interconnected activity. He found that adding Cesium-133 to the medium increased the yield of Fe-54, although there was no increase in the rate of growth of the culture. He suggested that the presence of Cs-133 reduces the Coulomb barrier in a way that needs to be determined.[24]

He also found that exposing the culture to very low frequency waves dramatically altered the rates of bacterial cell division and of the transmutation reactions.[25] He correlated this with the ability of these waves to alter the physical properties of water. In analogy with biochemical reactions, one can propose that a biological transmutation goes through a transition state of specific geometry whereby the activation energy of the process is reduced. This calls for a geometric model for the atoms involved, especially the nuclei (see below).

Transmutation and Geology

Vysotski conceives the ability to transmute elements as a necessary feature of evolution. Bacteria, and in his view higher organisms, will find a creative way to defend their uniquely characteristic composition.[26] He cites the empirical generalization of Vernadsky that each species has a signature chemical composition, especially as regards the trace elements.[27] If a necessary element is lacking, the bacteria will utilize the raw materials, if available, to produce it. Or, as cited earlier, if those raw materials are lacking, the bacteria will produce a substitute element which can fulfill the functions required.

Kervran, likewise, strongly believed that new biological transmutations emerged at specific epochs in the history of life. For example, he devoted a lengthy chapter to the possible formation of iodine from tin by seaweeds, particularly *Laminaria flexicalis*, which grows attached to granite rocks on the coast of Brittany.[28] Citing the work of Freundler,[29] who found significant amounts of tin in the *Laminaria*, Kervran proposed that the plant absorbed tin through its "crampons" attached to the rock, and that the plant then converted the tin into iodine. Freundler, on the other hand, believed that the plant absorbed iodine from the seawater and that the tin formed from the iodine at a late stage of the plant's life cycle. This case is typical of the numerous bold but unproven hypotheses that Kervran generated, and which deserve careful evaluation. It is easy to underestimate the extraordinary capability of organisms to greatly concentrate elements present in the medium in extremely small concentrations, like the known case of how tunicates extract vast amounts of va-

21. Ref 3, p. 52.

22. Andrey Lapo, *Traces of Bygone Biospheres*. Synergetic Press, London, Mir Publishers, 1987. Starting from page 147, he develops Vernadsky's three biogeochemical principles, and, as subsumed by them, the necessarily increasing biogenic migration of atoms.

23. Ref.15.

24. Ref 3, p. 45.

25. Ref 3, pp. 85-87.

26. Ref 3, p. 117. "The very phenomenon of low-energy transmutation of chemical elements and isotopes in biological systems and creating conditions for sustaining it, is lodged upon the heuristic proposition that if some of the required elements or microelements is not present in the living environment (or nutrient media), then, given that certain prerequisites are met, it will be synthesized as a result of the transmutation. In fact, such an approach unambiguously suggests that the ratio of all necessary elements in each type of living organism is fixed."

27. For Vernadsky's identical view, see "Problems of Biogeochemistry: On the Fundamental Material-Energetic Distinction between Living and Non-living Natural Bodies of the Biosphere" 1938, p. 307, translated by Jonathan Tennenbaum and Rachel B Douglas in Lyndon H. LaRouche, Jr., *The Economics of the Noösphere,* EIR News Service, Washington, 2001.

"There are no stoichiometric properties in the gross chemical composition of living bodies. But their chemical composition is strictly determined, and more constant than the chemical composition of isomorphic mixtures in natural minerals. This composition is typical for a given species, race, etc, constituting a chemical signature of each form of living matter"

28. C. L. Kervran, *Transmutations Naturelles non Radioactives,* Librairie Maloine, 1966. See chapter on iodine and tin, pp. 113-133.

29. P. Freundler, *Introduction a L'Etude des Complexes Biologiques*, Paris, Paul Belin Publishers, 1928.

See chapter 12, "Les Algues Marines," for description of the habitats, life cycles, and biochemistry of different seaweed species that one finds on the coasts of La Manche and Pas de Calais.

Also note page 173. He observes that Laminaria flexicalis grows on granite whereas Laminaria cloustonii more often grows on schist. *"It is only understandable if the elements in the rock serve directly the nutrition of the algae."*

nadium from seawater.[30] Lacking this knowledge, Kervran suggested the tunicates produce vanadium by transmutation.

It was the view of Vernadsky that the entire Earth's crust was ultimately the result of living processes.[31] This theory, for a long time considered impossible, was dramatically elaborated by Minik Rosing, et al. in an article in 2006, "The Rise of Continents—An Essay on the Geologic Consequences of Photosynthesis." His argument is that granite is the result of living processes, and only appeared on Earth concurrent with the appearance of photosynthesis.[32] The process of the Earth's crust is dominated by the energy of photosynthesis, which he estimated to be several times the flow of heat energy from the inside of the Earth! Processes such as weathering and the movement of material from the land to the ocean are a function of life.

In that light one might consider the proposal put forth by French geologists Jean Lombard and Georges Choubert in the 1940s and 1950s, even prior to Kervran's work, asserting that granite must be the product of transmutation of elements.[33] Both geologists were very enthusiastic supporters of Kervran, and helped him to publish in their journal.[34] Based on their observations of huge granite intrusions in Northern Africa and the corresponding coast of Brazil, they asserted that the formation of granite involved anomalies of composition. In particular, the differences in composition between the granite and the surrounding strata suggested that the only explanation must have been the *de novo* formation of silicon, potassium, sodium, and sometimes calcium, and the simultaneous disappearance of iron, aluminum, and magnesium.

The possibility that silicon is being created is especially significant because silicon is the basis for clay, a major structural component of the soil.[35] Choubert and Lombard formulated this hypothesis before the revolution in geology prompted by the discovery of the role of mid-oceanic ridges in the process of subduction of oceanic crust beneath the continents.[36] Choubert's hypothesis was that these transmutations occurred deep underground in the violent tectonic processes which are known to occur during mountain building, in the course of which horizontal strata became folded and bent. Today it is believed that mountains are formed secondary to the subduction of tectonic plates under the continents, carrying oceanic deposits with them. This is why young mountains like the Andes are near the coast.[37]

In his book *Geochemie,*[38] Vernadsky devoted 40 pages to what he called the silicon cycle, much of which he said still remained a mystery. He emphasized that the kaolin mineral nucleus, composed of silicon, aluminum, and oxygen, was formed at great depths in chemical combination with a number of different metal ions utilizing energy from inside the Earth. When these aluminum silicate compounds entered the biosphere in the course of volcanism, granitic intrusions, and weathering, they underwent chemical transformation by living organisms, which are uniquely able to decompose the kaolin nucleus, especially in a watery environment, giving rise to silicon oxides such as quartz and opal, and releasing the energy of formation of the kaolin nucleus, which he presumed to be radioactive in nature. These compounds of silicon form large oceanic deposits due to the activity of plankton such as diatoms, which utilize the eroded, silicon-rich soil washed out to sea.

In the stage of the cycle not yet known to Vernadsky, the silicon deposited on the ocean floor is pushed under the continental coasts during tectonic subduction and returned to the earh's crust or the upper mantle, and the cycle can be completed. The Choubert/Lombard hypothesis of neo-formation of silicon, if it is valid, has to be situated in the context of this larger cycle.

Is There a Nuclear Model Consistent with Known Physical Principles and the Periodic System?

In order to be able to intelligibly represent the processes of low energy transmutation, we are going to need an appropriate model of the dynamics and principle of trans-

30. Edward D Goldberg, William McBlair, and Keith Taylor, "The Uptake of Vanadium by Tunicates," Scripps Institute of Oceanography, La Jolla, *Biological Bulletin* 101: 84-94, August 1951

31. V. Vernadsky, "Some Words about the Noösphere," Dec 1943, translated by Rachel Douglas from *Biosfera* and printed in *21st Century Science and Technology* Sept 2005, pp. 16-21. "The granitic envelope of the Earth is the area of former biospheres."

32. Minik T. Rosing, et al., "The Rise of Continents—An Essay on the Geologic Consequences of Photosynthesis," *Palaeogeography, Palaeoclimatology, Palaeoecology*, Vol. 32, (2006) pp. 99-113

33. Georges Choubert, "Note sur le Mécanisme Probable des Granites: Application à Certains Granites Africains" in *Comptes Rendus du Colloque sur les Granites de L'Ouest Africa*, March 1965, Publication UNESCO tome VIII, des *Recherches sur les Ressources Naturelles* pp. 53-93.

34. C.L. Kervran, "Bilans Metaboliques Anormaux et Transmutations Biologiques," in *Revue Generale des Sciences*, July-August 1960, Vol 67, pp.192-206. Also see preface to reference 28 written by Jean Lombard.

35. M.R. Ashman and G. Puri, *Essential Soil Science*, Blackwell Science, 2002. See Chapter 3, "Soil Surfaces, Acidity, and Nutrients"

36. Edward Tarbuck and Frederick K. Lutgens, *An Introduction to Physical Geology*, Prentice Hall Publishers 2008. See chapter 2, "Plate Tectonics"

36. Edward Tarbuck and Frederick K. Lutgens, *An Introduction to Physical Geology*, Prentice Hall Publishers 2008. See chapter 2, "Plate Tectonics"

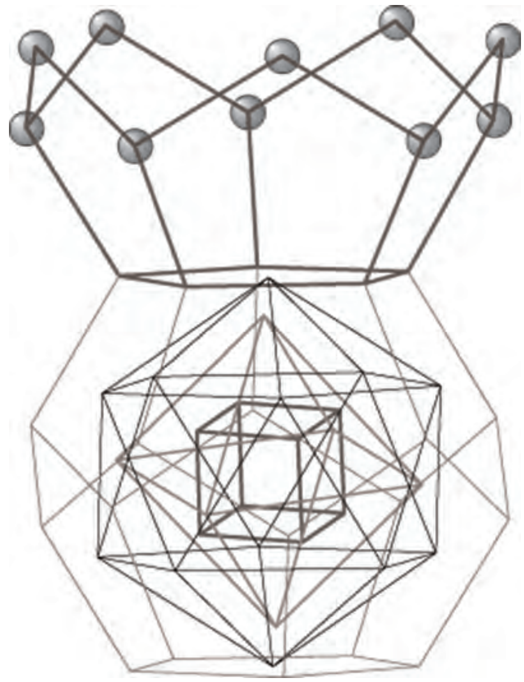
37. Ref 36. See chapter 14, "Convergent Boundaries. Subduction and Mountain Building"

38. V. Vernadsky, *Geochemie,* Leipzig 1930 Akademische Gesellschaft pp. 90-139

formation of the atomic nucleus. The Moon-Hecht model is the first step in that direction.

The Moon-Hecht model grew out of discussions Dr. Robert Moon held with Lyndon LaRouche in 1985, in which LaRouche's emphasis on the importance of Kepler's method for the history of science resonated with Moon's struggle for an intelligible representation of the quantization of space at the atomic level. The Moon-Hecht model of the nucleus, like Kepler's model of the solar system, is based upon successively nested platonic solids. Thus the first four nuclear "shells" are the cube, the octahedron, the icosahedron, and the dodecahedron. Protons are located at the vertices so that starting with the cube 8,the octahedron 6, the icosahedron 12, and the dodecahedron 20, we end up with a spherically symmetrical structure for palladium, atomic number 46. These spherically symmetrical filled shells remarkably coincide with some of the most abundant elements: i.e. oxygen, a completed cube, with Z=8; silicon, a filled octahedron around the cube with Z=14; and iron, with a filled icosahedron, having Z=26.[39] With palladium, the first structure is completed and the next shell starts from the outside with up to 10 protons giving the lower half of a second dodecahedron, like a scalloped dish for barium-56.[40] Next inside this structure go a second cube and octahedron, providing for the 14 member lanthanide series. The second structure is completed with a new palladium unit giving uranium-92, the two palladium units being loosely joined as might befit a fissionable element.

This nuclear model has the further crucial advantage that rather than having to postulate new forces restricted to the nuclear domain—the so-called strong forces—it is based upon a force long known to exist outside the nucleus, the classical Ampère-Weber longitudinal force. Weber showed that at sufficiently short range and high enough relative velocity, like charges will attract instead of repelling, as would be observed with static charges. Hecht proposed that the longitudinal force would stabilize the nucleus. The attracting longitudinal force can be exerted between the protons situated at diagonally opposite vertices of each platonic solid, oscillating back and forth towards and through each other and through the center of the platonic solid at relativistic speeds. In the case of the cube, the angle subtended at the center of the cube between the paths of protons at adjacent corners is 109 degrees 28′, while the two angles formed by these paths with their common cube edge is 35 degrees 16′. Using the original Ampère formula for the force between current elements one gets a zero interaction for this mutual orientation. This implies an unusually stable structure for the cube. The pairwise interaction of diagonally opposite protons could help explain why the most abundant elements throughout the periodic table have an even number of protons.[41]



Building the Moon Nucleus

To reach Ba-56, ten protons are added to the completed dodecahedron of Pd-46, beginning the formation of the second dodecahedron.

This for the first time suggests that a chemical property—the tetrahedral bonding of carbon—might be related to the dynamic geometry of the nucleus. In contrast, the currently hegemonic, chemically based view is that the tetrahedral bonding of carbon is purely a function of its three 2p electron orbitals and their "hybridization" with a 2s orbital.[42] Also, the current chemical model is based on a hermetic separation of the nuclear and electronic do-

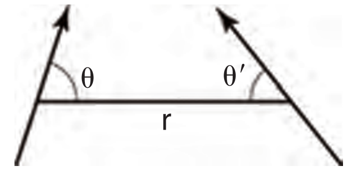
39. Laurence Hecht, "Mysterium Microcosmicum: The Geometric Basis for the Periodicity of the Elements, " *21st Century Science and Technology*, May-June 1988 pp. 18-30.

Robert J. Moon, "Space Must Be Quantized," *21st Century Science and Technology*, May-June 1988 pp. 26-27.

40. L. Hecht, New Explorations with the Moon Model by Laurence Hecht with Charles B. Stevens, *21st Century Science and Technology*, Fall 2004, pp. 59-73. This article first identifies a spin axis for the nucleus. The symmetrical distribution of protons and perhaps also neutrons around or on this axis serves to minimize angular momentum and increase stability. Such a consideration led to the scalloped dish for barium. The axis helps account for which elements like tin and calcium have the most naturally occurring isotopes. The next section discusses at length how the Ampère-Weber longitudinal force can stabilize the nucleus, especially in the case of the cube and the proposed structure for barium.

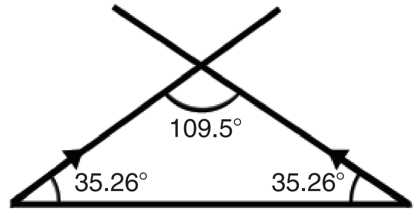
41. Ibid. page 72.

42. Francis Marion Pottenger, III, *Fundamentals of Chemistry,* Scott Forseman and Co 1976, pp. 287, 442.



AMPÈRE'S VIEW OF TWO CURRENT ELEMENTS

The two current elements are represented by arrows; θ and θ′ are the angles which the current elements make with the line connecting their centers; r is their distance apart.



AMPÈRE'S ANGULAR FORCE FORMULA

When the angles θ and θ′ are equal to 1/2 (arc cos 1/3), or 35.26 degrees, for two parallel current elements, the force between the current elements goes to zero, regardless of the current strength. As the two current elements at the base of the cube in the earlier igure (page 50) move toward the center, they trace the sides of an isosceles triangle, which has an apex angle of 109.5 degrees and base angles of 35.26 degrees – and zero force between them.

mains. The distribution of electrons in their orbital shells is based upon an interpretation of the form of the solutions to the Schrödinger wave equation for the hydrogen atom, in which the potential is the electrostatic potential derived from Coulomb's law for interaction of non-moving charges.[43] There are no exact solutions to the Schrödinger equation for more than two bodies.

Furthermore, the Schrödinger equation's only explicit reference to the nucleus is its inclusion of *Z*, the atomic number, in the Coulomb potential Ze^2/r. The current view of atomic structure and chemical bonding is based on quantum mechanics, which gives very little physical picture of what the electrons are actually doing in their "energy levels." Although the electrons are supposed to be in motion, there is no present means of portraying these motions geometrically, or even for describing how such moving electrons are interacting with each other electrodynamically. Any interactions among them are instead attributed to Coulomb's law, which applies to non-moving charges!

Moon hypothesized that so-called empty space consists of a lattice of nested platonic solids similar to his nuclear model, only composed of electrons. The unit structure consisted of three of the palladium structures instead of the two in the uranium nucleus. He proposed that it held 137 electrons or 68.5 pairs. This lattice would be responsible for the transmission of electromagnetic waves in empty space with a known characteristic impedance. This impedance, 376 ohms, is equal to the quantum Hall resistance in ohms divided by 68.5.[44] The implication for Moon was that the Hall resistance involved the action of single pairs of electron charge carriers in the famous Von Klitzing experiment. The experiment measured the Hall resistance in a very thin semiconducting wire at extremely low temperature.[45] Hecht added to Moon's space lattice the concept that the electrons were organized dynamically as Weber pairs, all of which are involved in wave propagation.

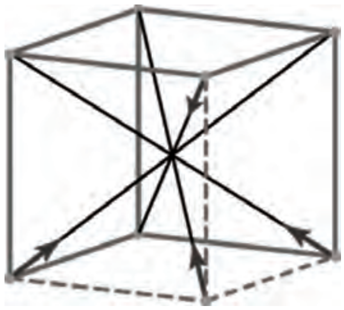
We find that in chemical compounds, the chemical bond consists of one or more pairs of electrons arranged directionally according to the structural chemistry of the molecule. The Weber pair concept might be applicable there as well.

As an example of a similar approach to the chemical bond, G.N. Lewis, one of the founders of 20th century structural chemistry, in 1916 sharply criticized the Bohr atom as violating electromagnetic principles. He went on to define a methodological approach which still makes sense today. "Indeed, it seems hardly likely that much progress can be made in the solution of the difficult problems relating to chemical combination by assuming in advance definite laws of force between positive and negative constituents of an atom and then building up mechanical models of the atom. We must, first of all, do a study of chemical phenomena, learn the structure and the arrangement of the atoms, and if we find it necessary to alter the law of force acting between charged particles at small distances, even to the extent of changing the sign of that force, it will not be the first time in the history of science that an increase in the range of observational material has required a modification of generalizations assumed upon a smaller field of observation. Indeed, in the present case, entirely aside from any chemical reasons, a study of the mathematical theory of the electron leads, I be-

43. Linus Pauling and E. Bright Wilson, *Introduction to Quantum Mechanics*, Dover Publications 1963, p. 113, The Hydrogen Atom.

44. Robert Moon, "Space Must Be Quantized", *21st Science and Technology*, May-June 1988, pp. 26-27.

45. K. Klitzing, G. Dorda, M. Pepper, "New Method for High-Accuracy Determination of the Fine Structure Constant Based on Quantized Hall Resistance, *Phys. Rev. Letters* 45(6): 494-497, 1980.



THE SELF-SUSTAINING CUBE

The current element proceeding from vertex A is attracted by the three nearest current elements. The direction of attraction is along the three edges shown as dashed lines. The vector sum of the attractions is in the direction of the diagonal that the current element is already pursuing. Weber pairs placed along the four axes of a cube thus produce an electrodynamically stable configuration.

lieve, irresistibly to the conclusion that Coulomb's law of inverse squares fails at small distances." Lewis went on to propose a cubical arrangement for the outer group electrons involved in bonding reminiscent of tetrahedral system described earlier.[46]

Kepler's Method

In fact, historically, the only rigorous approach to solving a many-body problem has been Kepler's. Kepler was able to derive remarkably precise values for the relative distances of the six known planets from the Sun, utilizing (1) the relative angular velocities of the planets in their orbits, slightly adjusted to criteria of overall harmony; (2) the inverse square relationship of planetary distance to angular velocity, as seen from the Sun; (3) his Third or periodic law, relating the period of the planet to its mean distance from the Sun.[47]

Kepler recognized discrepancies between the implications of his initial archetype of the five Platonic solids and his second archetype, the requirement for universal musical harmony among the planetary angular motions, and he made adjustments to bring them into coherence.[48] He believed that the metaphor of two musical scales, with modulation to connect them, which he called hard and soft scales, was ultimately decisive in ordering the relative motions and distances of the planets. Furthermore, he used the metaphor of four-voiced polyphony, only recently created in his day, to portray the harmonic interaction among the planets.[49]

What forced Kepler to recognize and remedy these paradoxes in his thinking was his insistence that a physical model based on terrestrially known forces first be hypothesized to account for the findings, rather than resorting to a largely mathematical scheme, such as today's quantum theory, to "describe" the results. Thus, after years of unsuccessfully trying to fit the orbit of Mars to non-uniform motion on a circular orbit, it became clear to him that this would be inconsistent with Tycho Brahe's precise data, nor could Kepler devise a physical mechanism that could cause such a motion.[50]

So now he was forced to account for a two-fold motion by Mars: first, a circular motion around the Sun, and, secondly, a motion towards and away from the Sun. Again, Kepler was not willing to simply offer a mathematical formula to describe this complex motion. Rather he required a physical model, in this case a magnetic interaction, drawing on the recent work of William Gilbert on the earth as a giant magnet.[51] Kepler proposed that Mars, too, had a magnetic axis which interacted with the Sun as a monopole. The magnetic axis, when the planet was at its apsides, i.e. the points nearest and farthest from the Sun, would be at right angles to the line joining the apsides. At the first quadrant, i.e. at 90 degrees from the aphelion, its axis would point directly at the Sun, presenting the pole drawn towards the Sun. At 270 degrees, it would again point directly to the Sun, but present the pole repelled by the Sun. This magnetic power would cause Mars to approach and recede from the sun, with a power depending on the angle between the magnetic axis and the line from the planet to the sun.

When Kepler finally arrived at the ellipse as the shape of the planet's orbit, it was not from testing the ellipse *as a shape*. Rather, Kepler found that the motion created by this dynamic model created (surprisingly) an ellipse, on which areas swept out by the planet measured the time to traverse the corresponding arc. This model gave calcu-

46. G. N. Lewis, "The Atom and the Molecule" *Journal of the American Society*, Vol 38, num 4, April 1916, pp. 761-785. Lewis introduces the cubical atom on page 767.

47. Johannes Kepler, *The Harmony of the World*, translated by E.J. Aiton, A.M. Duncan, and J.V. Reid, American Philosophical Society, 1997. See Proposition 48 pp. 483-488 for his precise prediction of relative distances of planets from the Sun.

48. For Kepler's adjustments to the angular motions as seen from the Sun, see "A Posteriori Arguments," pp. 462-480 in *Harmony of the World*.

49. For four-voiced polyphony, see chapter VIII, p. 449, *Harmony of the World*.

50. For his abandonment of non-uniform motion on a circle, see chapter 44 of his *New Astronomy*.

51. For the magnetic force model, see chapter 57, *The New Astronomy*.

lated positions that agreed precisely with Brahe's observations . . .[52]

Kervran in Russia

Although Kervran's work was largely discounted in European and North American scientific circles,[53] in Russia he was taken seriously by some prominent scientists during his lifetime. This has much to do with the legacy of Vernadsky. Two Soviet geologists, P.A. Ko-

52. For Kepler's proof of how to determine and apply the properties of the elliptical orbit see chapter 59, *The New Astronomy.*

53. O. Heroux and D. Peter, "Failure of Balance Measurements to Predict Actual Retention of Magnesium and Calcium by Rats as Determined by Direct Carcass Analysis," *Journal of Nutrition* 1975, pp. 1157-1167.

Despite meticulous work, the researchers found that on a low-magnesium diet, the rats had more magnesium in their carcass plus cumulative excreta than they had consumed. How to explain it? On page 1166 of this hilarious report the authors note: "The remote possibility of biological transmutation of Na into Mg in the body, which has been proposed by Kervran in 1965, is an intriguing explanation for the negative balances observed under low intake, but it must be regarded as extremely speculative, to say the least." This tells how important was the achievement of Vysotski in establishing by rigorous methods of nuclear physics that biological transmutations are real!

A Short Biography of Louis Kervran

I know of no biographies of this extraordinary man! He was born in 1901 and became a physician. His first published writing in the late 1930s concerned the non-applicability of Ohm's law to the human body and appeared in 1937 in *Revue Générale de l'Electricité*.[1] As the Departmental Director of Work and Manpower in Paris, he wrote the paper "Interpretation of Measurements of Impedance on the Human Skin by the Wien and Nernst Bridges" which appeared in the *Archives de Maladie Professionelles* in 1939 and in *L'Usine* the 11th of April, 1940. He subsequently supervised the chapter on the physical effects of electricity which appeared in Simonin's *Précis de Médicine du Travail* in 1950.[2]

During the war he was in the Résistance, and in 1944 became a Prefect by order of the General Assembly of the Committee for Liberation of the Savoy after having been a prisoner of the Nazi occupation. [3]

After the war he resumed his position in occupational health as a member of the Paris Board of Health (Conseil d'Hygiène de Paris).[4] It was in this capacity that he encountered paradoxical cases of carbon monoxide poisoning in welders in which the levels of carbon monoxide inhaled by the victim were far too low to account for their blood levels. This finally prompted his hypothesis that the nitrogen which passed over the hot metal underwent a change which was completed in the body with the transfer of a proton from one nitrogen to the other to form carbon monoxide.[5]

He became a member of the Jury for oral examinations at the Faculty of Medicine at Paris for specialty certification (presumably in industrial health). He held the title of Director of Conferences at the University of Paris.[6]

He was an official consultant to the French government in the area of radiation protection and had top-level security clearance.[7] In 1959, he was sent to the Sahara by the French government to investigate the anomalous results for thermal, mineral and electrolyte balance in workers living and performing under extreme heat for long periods. These results prompted him to assert that the anomalies were due to transmutations, some of them endothermic.[8]

Kervran's controversial work was endorsed early on by some highly distinguished scientists. Dr. Louis Tanon, who wrote a preface to his first book in 1962,[9] was a professor of industrial health and in 1964 became President of the French Academy of Medicine. The same book also had a preface by Dr. Albert Besson, Inspector General of Health and member of the Commission of the Superior Council of Scientific Research.

In 1975 the Nobel Committee for Physiology or Medicine received from one of their nominators, Professor Hiroshi Maruyama of the Faculty of Medicine of Osaka University, the recommendation of Kervran for the Nobel Prize.[10]

For more high- level endorsements see the section "Transmutations in Geology."

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1. Kervran, C. Louis. *Transmutations Biologiques et Physique Moderne,* 1982, p.14.
2. Ibid.
3. Ibid.
4. Kervran, C. Louis. *Biological Transmutations.* Beekman Publishers, 1971. Front page.
5. Ibid. Several references to the carbon monoxide research in his official capacity.
6. Ref. 4, front page.
7. Ref. 1, p.13.
8. Ref. 4, p.51 on his going to the Sahara.
9. Kervran, C. Louis, *Transmutations Biologiques. Métabolismes Aberrants de l'Azote, le Potassium, et le Magnésium.* Librairie Maloine, 1962.
10. Ref. 1, p.23 shows excerpt of letter by Maruyama.

rolkoff (Ukraine) and V.B. Neiman corresponded with Kervran based on their strongly held view that anomalies found in geology called for transmutations such as Choubert had reported.[54]

Secondly, Alexander Dubrov, author of *The Geomagnetic Field and Life,* had been in correspondence with Kervran from the early 1970s and made Kervran's transmutations the centerpiece in his book.[55] Dubrov's book is a very extensive phenomenology of the interaction of living systems with the geomagnetic field.

Dubrov argued that the geomagnetic field is physically dissymmetric, and can therefore be expected to produce physically dissymmetric effects in accordance with the theory of Pierre Curie. Dubrov noted that the widespread occurrence in biology of left- and right-handed morphologies was strongly influenced by the geometry of the local geomagnetic field, especially at the time of conception. He proposed that:

1. Transmutations such as Kervran's involve a change of atomic "symmetry" when one compares the electronic quantum states of the element transmuted and the element it becomes, such inversion being facilitated by the geomagnetic field.
2. The geomagnetic field can change the chirality of an asymmetric carbon atom, thereby inverting chirality of the molecule of which the carbon was a part and leading to mutation.

Dubrov acknowledged that data in support of his hypothesis are sparse. However, his is a bold hypothesis, relating, as he puts it, the universality to the microcosm. He presents it after a thorough review of how living systems are often exquisitely sensitive to magnetic fields. Experiments to test Dubrov's hypothesis concerning the role of the geomagnetic field in biological transmutations are feasible and ought to be done, now that Vysotski has established a degree of reproducibility.

This article is dedicated to the memory of Jerry Pyenson.
—Ernest Schapiro

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54. *Preuves en Géologie et Physique de Transmutations à Faible Energie*, Maloine Editeur, Paris 1973. See chapter "Recherche en Russie."

55. Aleksandr P. Dubrov, *The Geomagnetic Field and* Life, 1980, Putnam Press. See page 135 for why, contrary to common belief, the geomagnetic field is dissymmetric. See pp. 153-155 for his analysis of Kervran's findings in terms of the effects of the geomagnetic field.

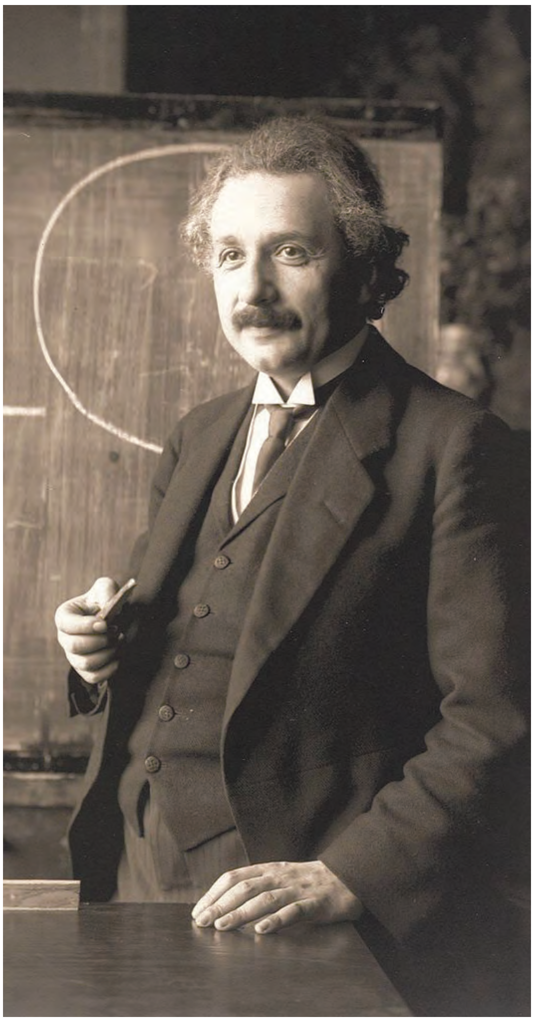
Thinking Without Words

by Shawna Halevy

February 1, 2012

Do you think about how you think? How does it occur? Do you think in sequence of logical steps? If you were to write out a thought, would what you wrote reflect how you came to your idea? Is the end product the same as your thought process? To be clear, we're not talking about just any type of thoughts, such as impressions, a memory, a simple opinion or an urge, but a principled discovery; something you would consider a profound and fundamental idea. If you're a teacher, or have tried to communicate a complex idea, these questions have come up before naturally to you. Did you find with students or another audience, that you really couldn't "just say it" and expect them to understand the idea? That explaining it doesn't get them to think it for themselves either?

The issue of discovering and communicating ideas has been addressed quite explicitly throughout our publications.[1] I would like to add to this discussion the simple question: in what form do your thoughts occur? Do they appear in words? Or other types of sensed objects? Does a data ticker scroll through your brain? Or is it more like scenes from a movie? Before further analyzing ourselves, let's look to another mind. Let's ask Albert Einstein how he thinks:



Picture by F. Schmutzer

Albert Einstein, teaching in 1921.

> "No really productive man thinks in such a paper fashion. The way the two triple sets of axioms are contrasted in the Einstein-Infeld book is not at all the way things happened in the process of actual thinking. This was merely a later formulation of the subject matter, just a question of how the thing could afterwards best be written. These thoughts did not come in any verbal formulation. I very rarely think in words at all. A thought comes, and I may try to express it in words afterward.... During all those years there was a feeling of direction, of going straight toward something concrete. It is, of course, very hard to express that feeling in words; but it was decidedly

1. http://www.larouchepac.com/node/21237, http://www.larouchepac.com/metaphor-intermezzo and http://www.larouchepac.com/node/21206.

the case, and clearly to be distinguished from later considerations about the rational form of the solution."[2]

In another instance Einstein addresses the same question:

"The words or the language, as they are written or spoken, do not seem to play any role in my mechanism of thought. The psychological entities which seem to serve as elements in thought are certain signs and more or less clear images which can be voluntarily reproduced and combined. This combinatory play seems to be the essential feature in productive thought—before there is any connection with logical construction in words or other kinds of signs which can be communicated to others. The above mentioned elements are, in my case, of visual and some of muscular type. Conventional words or other signs have to be sought for laboriously only in a secondary stage, when the mentioned associative play is sufficiently established and can be reproduced at will."[3]

And to sum it up most succinctly:

"I have no doubt that our thinking goes on for the most part without the use of symbols, and, furthermore, largely unconsciously."[4]

If Einstein doesn't think in words, then how does he think? He hinted at it already with bringing up the process of "play" and voluntary synthesis or combination of thoughts. The discovery of a new idea can be related to a surprise, the eureka moment. To accomplish this, the imagination cannot be constrained by fixed answers or characterizations, but has to be able to fly past the shadows of experience (the objects that can be pointed to and named), to the unseen. So, if not words, by what means does Einstein think? He pointedly says: "I often think in music." What does it mean to think in terms of music? Does he have chords constantly playing in his head? Does he see sheet music in his mind?

"… when we communicate through forms whose connections are not accessible to the conscious mind, yet we intuitively recognize them as something meaningful--then we are doing art."[5]

2. Wertheimer, Max, *Productive Thinking*, University of Chicago (1982)

3. Hadamard, Jacques *The Psychology of Invention in the Mathematical Field* Appendix II, A Testimonial from Professor Einstein (1944)

4. Einstein, Albert *Autobiographical Notes* (1946)

5. Einstein, Albert "The Common Element in Artistic and Scientific Experience," from the journal *Menschen* (February 1921)

This would seem to indicate that music is closer to the subconscious thought process then any other system of language and therefore closer to the more ideal parts of thought. This makes sense in relation to what Einstein said earlier, about his thoughts being directed, pulled on as if from outside, to the correct destination. The same thing happens in the unfolding of a well-composed piece of music. As has been noted elsewhere, good classical music is a reflection of the tension and resolution that goes into grappling with paradoxes. Hence Einstein would say: "Every great scientist is an artist."

As put by one of his biographers:

"[Music] was not so much an escape as it was a connection: to the harmony underlying the universe, to the creative genius of the great composers, and to other people who felt comfortable bonding with more than just words."[6]

Others would agree: To get a better idea of what thinking in terms of music, as opposed to words, means, let's turn to a contemporary of Einstein's, V.I. Vernadsky:

"Music seems to me to be the deepest expression of human consciousness, for even in poetry, in science, and in philosophy, where we are operating with logical concepts and words, Man involuntarily and always limits—and often distorts that which he experiences and understands. Within the bounds of Tyutchev's, 'a thought once uttered is untrue.' In music, we maintain unuttered thoughts….It would be quite interesting to follow in a concrete way the obvious influence of music on scientific thought. Does it excite inspiration?"[7]

It is common to associate moods or feelings with certain harmonies or keys, like a minor key as melancholy, but what we're talking about here in classical music are thoughts that could not be expressed otherwise. Thoughts so deep and eternal that they are outside the customary language culture. They both precede and are higher than what can be obtained in a conversation, putting music closer to the innate ideas of the soul.

A more explicit discussion of words versus music to express a true idea is taken up by Felix Mendelssohn in composing 'songs without words;' as a clear polemic against

6. Isaacson, Walter *Einstein: His Life and Universe* Simon & Schuster (2007)—*Emphasis added.*

7. Vernadsky's Thoughts and Sketches: Les musiciens ne font que commencer à connaître la jouissance du sens historique [Musicians are only beginning to understand the pleasure of the sense of history] ~ Landowska, W. Musique ancienne. P., 1909, p.129. Translated by Bill Jones. Vernadsky's question has been addressed in another place by this author.

belittling music to mere tonal painting of pastoral scenes, or to a mimicry of a sensual poem:

"People often complain that music is ambiguous, that their ideas on the subject always seem so vague, whereas everyone understands words; with me it is exactly the reverse; not merely with regard to entire sentences, but also as to individual words; these, too, seem to me so ambiguous, so vague, so unintelligible when compared with genuine music, which fills the soul with a thousand things better than words. What the music I love expresses to me, is not thought too ***indefinite*** to be put into words, but, on the contrary, too ***definite***.... If you ask me what my idea is, I say—just the song as it stands; and if I have in my mind a definite term or terms with regard to one or more of these songs, I will disclose them to no one, because the words of one person assume a totally different meaning in the mind of another person, because the music of the song alone can awaken the same ideas and the same feelings in one mind as in another,—a feeling which is not, however, expressed by the same words.[8] Words have many meanings, and yet music we could both understand correctly. Will you allow this to serve as an answer to your question? At all events, it is the only one I can give—although these too are nothing, after all, but ambiguous words!"[9]

Painting by James Warren Childe, 1829

Felix Mendelssohn Bartholdy at age 30.

Photograph by Pierre Petit

Richard Wagner, the anti-Semite, in 1861.

There exist pure thoughts, musical thoughts, that can't be translated into words. These are the closest to preconscious thoughts and processes. The people that Felix says complain about music are not secure in thinking of principles that are above sense perceptions. They would be grateful to be given a handbook to life to follow, as if they were obeying a parking sign. But would these types of people be developed enough mentally to understand something as universal as gravity, which cannot be sensed directly, nor be described (in terms of what causes its effects), by equations or a basic definition, and doesn't exist itself as an object, but is most real and powerful? Would someone in this state or with this capacity be able to understand something as ethereal as love? They would miss the meaning of both these concepts were they to look them up in a dictionary, though they cannot deny their existence and influence.

The same Richard Wagner who attacks Mendelssohn for being a Jewish musician corrupting German romantic music with intellect, criticizes Beethoven's 9th symphony, by saying that the music does not match the words. Furtwängler, the greatest conductor of the 20th century, defends Beethoven from:

"...the fallacy which results from attempting to record the idea rationally in words—a task which is, of course, impossible without sacrificing the substance of the idea to a very considerable extent....Beethoven more than anyone else had an urge to express everything in a purely musical form. The musician in him

8. Goethe also says, in the fourth part of 'Dichtung und Wahrheit,' "I have already but too plainly seen, that no one person understands another; that no one receives the same impression as another from the very same words."

9. Felix Mendelssohn Bertholdy to Marc-André Souchay, Luebeck [Herr Souchay had asked Mendelssohn the meanings of some of his "Songs without Words."] Berlin, October 15th, 1842. William Empson would agree, though he considered it a tool, rather than a hindrance to express ideas.

felt inhibited, not inspired by a text: he would not allow the textual form of a word to dictate to him what form his music should take. Thus Beethoven becomes completely himself only when he is free to follow exclusively the inherent demands of music."[10]

We should recognize Beethoven's desire to be free from any "textual form of a word" and to live on the musical thought, as similar to Einstein's concept of play and unconscious thought. From this we can gather that music is not limited to an *expression* of imaginative ideas, but is actually man's creation to model the highest, most productive and organic thought process; to become more conscious of it and have more power to wield it.

Johannes Kepler in 1610

Johannes Kepler discovered that the musical harmony man uses to externalize his creative mind, is also found in shadow form in the solar system, the creative expression of God's mind. Maybe the well-tempered system as we know it today is best at communicating genuine ideas, because it's a reflection and bounded by physical principles and laws, unlike simple words. You could say that classical music is the closest the subjective gets to the "objective." Human thought and expression, as noted by Einstein, can be stated as the being and becoming. We start with the living absolute, an ideal, say a discovery, and then try to communicate it by assembling parts which most approach a representation of our idea. In physical science we're given the shadow first (an observation of experience or some other evidence, the parts or the becoming), and have to work backwards to know the idea which generated it.

> "Thus it is no longer surprising that Man, aping his Creator, has at last found a method of singing in harmony which was unknown to the ancients, so that he might play, that is to say, the perpetuity of the whole of cosmic time in some brief fraction of an hour, by the artificial concert of several voices, and taste up to a point the satisfaction of God his Maker in His works by a most delightful sense of pleasure felt in this imitator of God, Music. . ."[11]

To conclude (if this can be done in words): The true scientific imagination is (at least) non-verbal. In order to free our minds from literal thinking, we have to ask ourselves: Does the way language is currently used bound our thinking? Do we let an internal teleprompter tell us what to think? We understand that language is useful and necessary for explaining things to others, but is it sufficient? Is it sufficient for true higher thinking? We see with Einstein that the secret to science is to go beyond language. The secret that humanity has developed for thinking about how we think, is classical music. We use music as a model of pure thought; as a tool for willful creativity, allowing for reflection and improvement of our thinking. This leaves me with the question: Is thinking not only non-verbal, but is it non-visual as well? Is thinking non-sensual entirely?

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10. Furtwängler, Wilhelm *Concerning Music* (1953). This is not to say that Beethoven was not inspired by actual poetry, but is only an emphasis on the fact that Beethoven is superior to someone like Wagner because he was not operating on story-lines, what could be called "program music," or more recently, movie music. A fuller discussion of the difference between an idea in prose being the summation of the words used, versus poetry, being a non-linear effect outside the words and yet using entirely lawful means, and poetry's relation to music, will have to be taken up someplace else; but can be found in part in the works on this site referenced above, and in the works of Shelley, Keats, Shakespeare and Schiller. It should be just as provoking to ask if you think poetically, as it is to ask if you think musically, as oppose to thinking in words merely. Here's an excerpt for anyone interested in trying to make sense of the Wagner quote from his essay Beethoven:

"Neither is it the thought expressed in Schiller's verses, that occupies our minds thereafter, but the familiar sound of the choral chant; in which we ourselves feel bidden to join. . .In fact it is obvious, especially with the chief-melody proper, that Schiller's words have been built in perforce and with no great skill; for this melody had first unrolled its breadth before us as an entity per se, entrusted to the instruments alone. . ."

11. Kepler, Johannes, *Harmonices Mundi* (1618)

Thinking The Unseen

by Shawna Halevy

February 11, 2012

In *Thinking Without Words,* we discussed the question of the nature of certain types of thinking. I would like to follow this up with a bit of a longer exposition along similar lines, but with a different theme. Begin with some basic questions: We can state the ways we express subtle, but meaningful thoughts (poetry, painting, music, etc…) but are we aware of the form these thoughts take in the first place? Can you see yourself thinking? How do your thoughts present themselves to your subconscious, before they've reached the stage of being translated into something communicable? Looking to Einstein for answers, we found out that he didn't think in words, but in terms of music. This left us wondering if crucial scientific (and artistic) thinking is sensual in any way, as commonly accepted. Let's look at the most prized of the senses in terms of thinking, visual thinking.[1] Now, I'm not talking about the visual imagination we use when reading a book. What I would like to look at is, what Einstein is doing when he thinks visually about things that can't be seen. Think back to his thought- experiment which was a seed crystal to his special relativity: "First came such questions as: What if one were to run after a ray of light? If one were to run fast enough, would it no longer move at all?" What does an electro-magnetic wave look like? Has anyone seen light itself? What does light look like when it's standing still?

As summary of what we will discuss to approach this: We will look at how Nicholas of Cusa stretches the imagination beyond what it can visualize or reason, using the example of the circle in the infinite being the same as a line in the infinite. Then we'll look at the case of Gottfried Leibniz' demonstration of the calculus (an infinitely small point which still maintains a proportion.) This will lead into Bernhard Riemann's work, and into the same issue of the non-visualizable in Einstein's four-dimensional, curved space-time.

As we have seen in other places,[2] we can't even take for granted the objects we think we see; so, what's going on when we try to visualize non-objects? Great thinkers do not think in terms of objects,[3] or even in terms of relations between objects. There's the visual imagination for constructing models and navigating and such; but, when we're dealing with concepts like the atom, gravity, justice, etc., all perceptions fall infinitely short. These become important questions when you're trying to imagine the future of mankind—something which can't be seen because it doesn't physically exist yet.

Maximum Sight

Start with Cusa's *De Docta Ignorantia*[4] as an exercise, which begins with the following premise: "The more one

1. For a good counterposition to the argument I'm NOT trying to make, read the final chapter of Oliver Sacks's book, *The Mind's Eye,* and Gerald Holton's paper *The Art of the Scientific Imagination*

2. ΓΝΩΒΘΙ ΣΕΑΥΤΟΝ (Know Thyself), http://larouchepac.com/node/21346

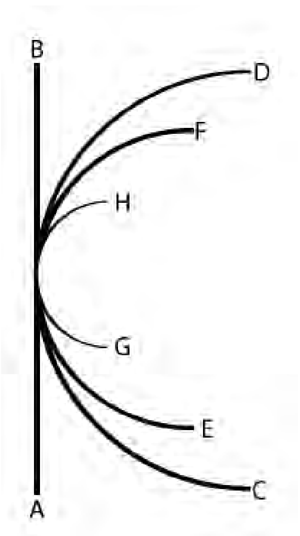
3. But there are thought-objects, what Riemann would call a 'Geistesmasse' or what the psychologist would call a 'Gestalt.' A close relative of Einstein tells us: "He works like an artist. First he sees the outlines, you may say the vision, of a great thought, and then he sets to work to substantiate it, to give it body and soul."

4. A good caution from Cusa: "When we set out to investigate the Maximum symbolically, we must leap beyond simple likeness. For since all mathematicals are finite and otherwise could not even be imagined: if we want to use finite things as a way for ascending to the unqualifiedly Maximum, we must first consider finite mathematical figures together with their characteristics and relations. Next, we must apply these relations, in a transformed way, to corresponding infinite mathematical figures.

knows that one is unknowing, the more learned one will be." Since every inquiry uses comparative relation, the infinite will always be unknowable since it escapes all comparative relation. As a consequence, the intellect never comprehends truth so precisely that it cannot comprehend it infinitely more precisely—we can always learn more. Cusa draws the analogy that the intellect is to truth "as an inscribed polygon is to the inscribing circle"—one always approaching, but never obtaining the other. Then he proceeds to talk about the maximum, because "we want to discuss the maximum learning of ignorance." In Book I, Ch13, he stretches the mind beyond the physical or the visual, by going into the infinite with figures, where you can only use the imagination to think of their possible characteristics.

> "So if the curved line becomes less curved in proportion to the increased circumference of the circle, then the circumference of the maximum circle, which cannot be greater, is minimally curved and therefore maximally straight."

To supplement the reader's understanding, Cusa illustrates the example with the following pedagogy:



> "…we can visually recognize that it is necessary for the maximum line to be maximally straight and minimally curved. Not even a scruple of doubt about this can remain when we see in the figure here at the side that arc CD of the larger circle is less curved than arc EF of the smaller circle, and that arc EF is less curved than arc GH of the still smaller circle. Hence, the straight line AB will be the arc of the maximum circle, which cannot be greater. And thus we see that a maximum, infinite line is, necessarily, the straightest; and to it no curvature is opposed. Indeed, in the maximum line curvature is straightness."

Your senses allow you to see a circle, reason allows you to follow the continuous process of the growing circle, but only a leap of the intellect, a stretching of the imagination, allows you to see the infinite circle as an infinite line.

> "In like manner, you can see that a triangle is a line. For any two sides of a quantitative triangle are, if conjoined, as much longer than the third side as the angle which they form is smaller than two right angles. For example, because the angle BAC is much smaller than two right angles, the lines BA and AC, if conjoined, are much longer than BC. Hence, the larger the angle, e.g. BDC, the less the lines BD and DC exceed the line BC, and the smaller is the surface. Therefore, if, by hypothesis, an angle could be two right angles, the triangle would be resolved into a simple line."
>
> "Hence, by means of this hypothesis, which cannot hold true for quantitative things, you can be helped in ascending to non-quantitative things; that which is impossible for quantitative things, you see to be altogether necessary for non-quantitative things. Hereby it is evident that an infinite line is a maximum triangle. Q.E.D."

When we're dealing with functions of a higher quality than the usual geometric figures, we can use quantitative objects, by pushing them to their boundary of usefulness, to see what lies infinitely beyond their reach as a sort of negative foil.

Minimum Sight

Next, going from the maximum to the minimum, let's take a look at Leibniz's Calculus, his answer to Kepler's challenge[5] to bring physics into the hands of man. By way of introduction into the problem, read from Leibniz' dialog on continuity and motion:

> "Charinus: If I may be allowed to offer an inexpert opinion on such matters, I would declare that the transition from Geometry to Physics is difficult, and that we need a science of motion that would connect matter to forms and speculation to practice—something I learned from experiments of various kinds in my early military training. For I was often unsuccessful in trying out new machines and other delightful tricks of the trade, because the motions and forces involved could not be drawn and subjected to the imagination in the

5. New Astronomy Website on http://science.larouchepac.com/kepler/newastronomy Ch 60. This problem comes up with the elliptical orbits, something far from linear, which are always changing.

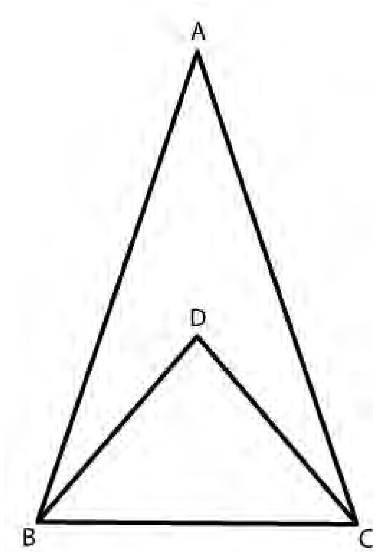
same way as figures and bodies could. For whenever I conceived in my soul the structure of a building or the form of a fortification, to begin with I would reinforce my wavering thought with tiny models made of wood or some other material. Afterwards, when I was more advanced, I was content to represent solids by plane drawings; and finally I gradually evolved such a facility of imagining that I could picture in my mind the whole thing complete with all its numbers, and could form vivid expressions of all its parts, and contemplate them as if they were in front of my eyes. But when it came to motion, all my care and diligence were of no use, and I could never reach the point where one might comprehend the reasons and causes of forces by the imagination, and form an opinion about the success of machines. For I always became stuck at the very beginning of an incipient motion, since I had noticed that what must come about in the whole of the remaining time must somehow already happen at the first moment. But to reason about moments and points, I had to admit, was indeed beyond my grasp. This is why, let down by my reasonings, I was reduced to relying on my own and other people's experience. But this experience often deceived us, as often as we had assumed false causes for the things we had experienced instead of the true ones, and had extended the arguments from them to things which to us seemed similar."

Modeling for engineering something is very useful, not to mention the countless other uses of imagery, yet still there's something above this that cannot be touched by the visual imagination, e.g. anything which involves a process (as in the unseen laws causing motion) or the ability to forecast outcomes of such processes.

It can't be taken up here in full, but Leibniz's development of the calculus (a philosophical discovery in its essence), using invisibles to deal with the tangible world, ruffled a few feathers. Leibniz, in a letter to Varignon, tries to explain the infinitesimal, using the law of continuity:

"... to make sure that there are lines in nature which are infinitely small in a rigorous sense, in contrast to our ordinary lines, [and] in order to avoid subtleties and to make my reasoning clear to everyone, it would suffice here to explain the infinite through the incomparable, that is, to think of quantities incomparably greater or smaller than ours... It is in this sense that a bit of magnetic matter which passes through glass is not comparable to a grain of sand, or this grain of sand to the terrestrial globe, or the globe to the firmament... it follows from our calculus that the error will be less than any possible assignable error, since it is in our power to make this incomparably small magnitude as small as we wish...It follows from this that even if someone refuses to admit infinite and infinitesimal lines in a rigorous metaphysical sense and as real things, he can still use them with confidence as ideal concepts which shorten his reasoning, similar to what we call imaginary roots in the ordinary algebra..."

Mathematicians of the day were uncomfortable with relative measures (as in, they were stuck in the belief in fixed measures) and were therefore afraid of using a quantity which they couldn't compare to their own rulers. The infinitesimal as an idea had to be fought for in very much the same way as the "numbers" such as zero, fractions, negative numbers, "irrationals," and "imaginaries" had, in order to gain their civil rights. Again, Leibniz used a clear analogy to demonstrate his idea, by taking something visibly simple and expanding it past the imaginatively visible. The demonstration goes as follows:

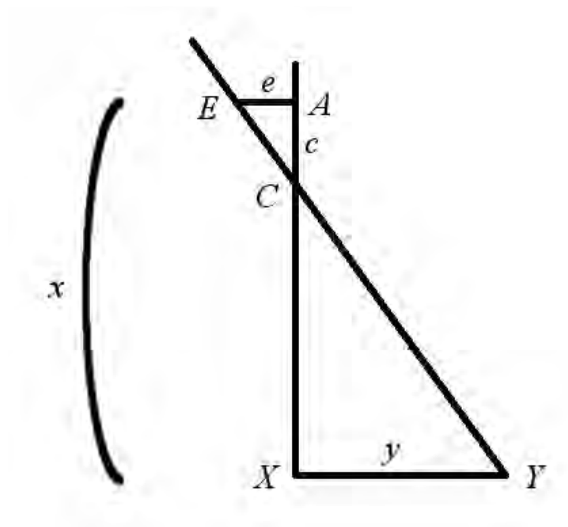


Since triangles *CAE* and *CXY* are similar, it follows that $(x\text{-}c)/y = c/e$. Consequently, if the straight line *EY* more and more approaches the point *A*, always preserving the same angle at the variable point *C*, the straight lines *c* and e will obviously diminish steadily, yet the ratio of *c* to e will remain constant. Here we assume that this ratio is other than 1 and that the given angle is other than 45 degrees.

Now assume the case when the straight line *EY* passes through *A* itself; it is obvious that the points *C* and *E* will fall on *A*, that the straight lines *AC* and *AE*, or *c* and e, will vanish, and that the proportion or equation *(x-*

> $c)/y = c/e$ will become $x/y = c/e$. Then in the present case, $x\text{-}c = x$. Yet c and e will not be absolutely nothing, since they still preserve the ratio of CX to XY. For if c and e were nothing in an absolute sense in this calculation, in the case when the points C, E, and A coincide, c and e would be equal, since one zero equals another, and the equation or proportion $x/y = c/e$ would become $x/y = 0/0 = 1$; that is, $x{=}y$, which is an absurdity, since we assumed that the angle is not 45 degrees. Hence c and e are not taken for zeros in this algebraic calculus, except comparatively in relation to x and y; but c and e still have an algebraic relation to each other. And so they are treated as infinitesimals, exactly as are the elements which our differential calculus recognizes in the ordinates of curves for momentary increments and decrements.

An infinitesimal triangle has infinitesimal sides which have different characteristics to each other in order to hold a ratio. In other words, just because you can't see these lines, doesn't make them simply zero, nor does it make them infinity, i.e. incomprehensible. This invention came at an early period of science when things like microscopic organisms were just coming into knowledge, and was still a ways from a working knowledge of molecules and atoms. It's hard to imagine what the world of science was like before the invention of the calculus. Calculations were more laborious and less precise; the realms which could be investigated were quite limited, given the lack of language to work in. Nothing too fast, nothing too small or large, nothing that changed too



much could be considered. Basically, everything which was beyond simple sense experience was inaccessible. It's amazing to think that all of this was unlocked with something that in no way is logical, intuitive, or practical, according to common sense. The infinitesimal is a nonsensical tool.

Between the Infinitesimal and the Infinite

Bernhard Riemann provides a bridge in science, between Leibniz' early phases in dealing with physics and modern day relativity, by allowing the imagination to be free from the chains of thinking of our world in terms of Euclidean solid bodies, as presented to our senses. During a time when the prominence of electro-magnetism (an invisible and powerful phenomenon) was challenging the dominance of Newtonian physics, Riemann pushed the limits of what people were comfortable thinking about.

Riemann expanded Gauss' work on anti-Euclidean curved surfaces to include an increasing number of dimensions, space being a particular case of a triply-extended magnitude. "It then follows as a necessary consequence that the propositions of geometry cannot be derived from general notions of magnitude, but that the properties which distinguish space from other conceivable triply-extended magnitudes are only to be deduced from experience… These matters of fact are—like all matters of fact—not necessary, but only of empirical certainty; they are hypotheses. We may therefore investigate their probability, which within the limits of observation is of course very great, and inquire about the justice of their extension beyond the limits of observation, on the side both of the infinitely great and of the infinitely small." This generalization freed geometry from the axioms of Euclid and allowed for the possibility of spherical and elliptical space—that is, a finite space whose nature is determined by natural forces. Just like Leibniz's, Riemann's achievements were wholly guided by his philosophical ambitions, as expressed in his philosophical fragments. Let's take a look at how Riemann deals with thinking of the non-visualizable.

From Riemann's Habilitation Dissertation: *III. Application to Space*.[6]

> "§ 3. It is upon the exactness with which we follow phenomena into the infinitely small that our knowledge of their causal relations essentially depends. The progress of recent centuries in the knowledge of mechanics depends almost entirely on the exactness of the construction which has become possible through the invention of the infinitesimal calculus… Now it seems that the empirical notions on which the metrical determinations of space are founded, the notion of a

6. See Riemann's Habilitation Dissertation (http://larouchepac.com/node/12479). Also try exploring some works on Gauss' history and method (http://larouchepac.com/narrowpath).

solid body and of a ray of light, cease to be valid for the infinitely small. The question of the validity of the hypotheses of geometry in the infinitely small is bound up with the question of the ground of the metric relations of space. . . . Therefore, either the reality which underlies space must form a discrete manifold, or we must seek the ground of its metric relations outside it, in binding forces which act upon it. This leads us into the domain of another science, that of physics, into which the object of today's proceedings does not allow us to enter."

Bernhard Riemann

Riemann states that, in order to deal with non-visualizables, infinitesimals and the structure of space, we have to leave the realm of mathematics and enter the domain of physics. The visible realm of symbols and objects in a Euclidean space is abandoned for the more imaginatively challenging world of processes.

Einstein's attempt, with his Relativity Theory, in bringing physics closer to this reality, was the next necessary step of Riemann's work. Of course, the practical scientists of Einstein's day saw his "theory" as just that, an abstract thought that had no importance in the domain of experimental physics, something which was useful only in the subject of philosophy. History has proven this to be silly.

Visualizing 4-Dimensional Space-Time

One of the consequences of the relativity theory is that physical laws determine the shape of space, the geometry in which everything occurs. Physical principles do not bend an already existing flat space, but it creates the effect that we call curved space.

On the basis of the general theory of relativity, space, as opposed to "what fills space," has no separate existence. If we imagine the gravitational field to be removed, there does not remain a space, but absolutely nothing, and also no "topological space." This is the idea of space, not as an empty box, but as a field, and is exactly what Riemann called for in searching for the metric relations of space "in the binding forces which act upon it." The nature of Gravity is your geometry of space.

If we are to gain more power and knowledge over our space-time (e.g., in long-distance space travel), we, at the very least, need to be able to conceive of it, as Einstein anticipated in a speech given to the Prussian Academy of Science.

> "No man can visualize even three dimensions. I think in four dimensions, but only abstractly. The human mind can picture these dimensions no more than it can envisage electricity. Nevertheless they are no less real than electromagnetism."

Einstein uses a simple analogy to show how someone could begin to think of these things abstractly:

> "Imagine a scene in two-dimensional space, for instance, the painting of a man reclining on a bench. A tree stands besides the bench. Then imagine that the man walks from the bench to a rock on the other side of the tree. He cannot reach the rock except by walking either *in front of* or *behind* the tree. This is impossible in two dimensional space. He can reach the rock only by an excursion into the third dimension.
>
> "Now imagine another man sitting on the bench. How did the other man get there? Since two bodies cannot occupy the same place at the same time, he can have gotten there only before or after the first man moved. In other words, he must have moved in time. Time is the fourth dimension."

That's pretty simple to follow, but add to that the fact that these dimensions aren't merely linear or flat, but that the four dimensions curve in on themselves, and then you're dealing with something that would boggle the average person's mind.

"Can we picture to ourselves a three-dimensional universe which is finite, yet unbounded?"

(Hint: It's not a warped sphere or plane. That's not 3-D. Maybe you're thinking of the space inside the sphere? But what does it mean for that to be curved?)

"The usual answer to this question is 'No,' but that is not the right answer. The answer should be 'Yes.' I want to show that, without any extraordinary difficulty, we can illustrate the theory of a finite universe by means of a mental image, to which, with some practice, we shall soon grow accustomed. A geometrical-physical theory as such is incapable of being directly pictured, being merely a system of concepts. But these concepts serve the purpose of bringing a multiplicity of real or imaginary sensory experiences into connection in the mind. To 'visualize' a theory, or bring it home to one's mind, therefore means to give a representation to that abundance of experiences for which the theory supplies the schematic arrangement. My only aim has been to show that the human faculty of visualization is by no means bound to capitulate to non-Euclidean geometry."

Nicolaus of Cusa

In Einstein's speech,[7] he carefully walks people through how they could map the processes of our universe, to determine whether or not it is an actually curved space-time which is not infinite in extent, but also not constrained by borders—like the same conditions we have in two-dimensional space on a sphere. Again, we are impressed by the fact that Einstein boldly approaches thoughts which have no direct sense expression, either in chasing a beam of light or working with the curvature (beyond two dimensions) of the entire universe.

This conceptualizing of a multi-dimensional, curved space-time, which is finite, yet unbounded, is exactly what's occurring in the composition and performance of a classical piece of music.[8] When music is used to conjure up visual objects, as in Gustav Holst's "The Planets" Suite or in "The Carnival of the Animals,"[9] it's not music classically composed at the level of a Mozart or a Beethoven (which is the closest expression of preconscious thought).

The positivist would pull his or her hair out over what we're attempting to do. "If it's not directly observable," they would cry, "then it has no meaning!" "And how dare you compare science to something as subjective as music." They separate the creative imagination of man from science, turning science into the job of robots that gather data received from our animal senses. Yet the empiricists were completely defeated by a non-Euclidean space-time, not to mention the discovery of electrons and the whole advent of atomic science.[10] As we've seen,

7. Geometry and Experience (http://www.relativitycalculator.com/pdfs/einstein_geometry_and_experience_1921.pdf)

8. See LaRouche, Lyndon *That Which Underlies Motivic Thorough-Composition* (http://american_almanac.tripod.com/motivic.htm) *EIR,* Sept. 1, 1995

9. *Camille Saint-Saëns, I'm sure, would agree.*

10. Take this actual response from the positivist manifesto, *Wissenschaftliche Weltauffassung: Der Wiener Kreis* (*The Scientific Conception of the World: The Vienna Circle*):

"Neatness and clarity are striven for, and dark distances and unfathomable depths rejected. In science there are no 'depths'; there is surface everywhere. Here is an affinity with the Sophists, not with the Platonists; with the Epicureans, not with the Pythagoreans; with all those who stand for earthly being and the here and now. The scientific world-conception knows no *unsolvable riddle.* Clarification of the traditional philosophical problems leads us partly to unmask them as pseudo-problems, and partly to transform them into empirical problems and thereby subject them to the judgment of experimental science. The method of this clarification is that of *logical analysis*. . .The metaphysician and the theologian believe, thereby misunderstanding themselves, that their statements say something, or that they denote a state of affairs. Analysis, however, shows that these statements say nothing but merely express a certain mood and spirit. To express such feelings for life can be a significant task. But the proper medium for doing so is art, for instance lyric poetry or music."

– i.e., not in science. Funny enough, as an appendix to the manifesto, the Vienna Circle listed Albert Einstein as a *leading representative of the scientific world-conception*, along with Bertrand Russell and Ludwig Wittgenstein. Here's what Einstein has to say to that:

"I am not a positivist. Positivism states that what cannot be observed does not exist. This conception is scientifically indefensible, for it is impossible to make valid affirmations of what people 'can' or 'cannot' observe. One would have to say 'only what we observe exists,' which is obviously false."

—Interview with Alfred Stern in *The Contemporary Jewish Record,* June 1945.

Albert Einstein

superior power of our ideas over the sensuous. This type of practice in thinking frees us from the oppression of the physical and from narrow thinking.

In the same way, we shouldn't allow geometry (a useful science in its own realm) to dominate physics. Visual thinking, even as simple analogy, cannot be a crutch for, or boundary on, creative thinking. As with all sensual tools, it should be seen, when dealing with fundamental principle, as a negative with regard to that which we're actually looking at, a shadow and a limited case of a universal, and as only truly useful when left behind by a seemingly infinite leap.

The fact that we cannot rely upon sensual thinking for direct reality, shouldn't be seen as a disadvantage, or something crippling, but instead as a greater power that only mankind has. From these few cases of extraordinary men and ideas from throughout history, it's clear that the human thinking which is far from resembling the perceived reality of the senses, actually gets us closer to the reality of what matters the most: the principles acting upon what we see. Why would going further into the recesses of our imagination, further away from what outside "reality" looks like, get us closer to the inner secrets of the universe? For one thing, the essence of the universe is not material objects. But also, the rigorous, distilled process of the creative mind is a principle in that universe. It is a mirror of the unseen, creative process of the "objective world." We still have to be in dialogue with the universe through means of the senses, by conducting physical experiments and reading data—we can't simply talk to ourselves and expect to find all the answers—but the non-verbal, non-visual imagination has to be explicitly nourished and tapped into, to keep that dialogue progressing. The first step is recognizing it, the creative principle of the human identity, as such. So let us continue to practice thinking in forms above the sights and sounds of everyday experience!

some of the most ground-breaking thoughts in science lie outside the reach of what can be directly visualized. Think back to Einstein's thought-experiment of chasing a beam of light, which led to his Theory of Special Relativity; or think about his ability to conceptualize the cosmology of our world. Whose advice would you take? Einstein's, or someone who likes to stare at things?

The Infinitesimal, Yet Infinite Mind

Cusa's work, and that of others, demonstrates that the human imagination, when contemplating the truly profound things of our world, is inspired by the Maximum (the infinite, or that which is undetectable to the senses), and is able, through learned ignorance, to embrace the infinite as a whole in the intellect, rather than being enslaved to it. Instead of being intimidated by the objects that overwhelm our senses (the incredible heights of mountains, the endless distance of the horizon of the ocean or even the beautiful expanse of the night time sky), instead of being reminded of the limits of our imagination, we go to these things on purpose to willfully summon up the image of the sensuous infinite, to exercise the

Cambrian Cannibals

Agnostid Trilobites and The Earliest Known Case of Arthropod Cannibalism

by Mark A. S. McMenamin

A slab from the Middle Cambrian Wheeler Formation, from Millard County, Utah

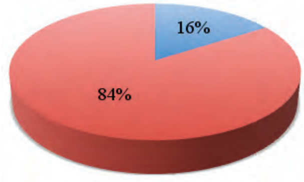
Association between two Agnostid trilobites, Peronopsis interstricta, showing a larger Agnostid overiding a smaller one.

Agnostid trilobites are tiny compared to their better known and larger relatives from the Paleozoic seas. Agnostids survived for almost exactly one hundred million years, living from the Early Cambrian (beginning 542 million years ago) to the late Ordovician Period (which ended 443 million years ago). Largely due to their diminutive size, agnostid trilobites have defied attempts to properly interpret their affinities, environmental preferences, behavior, and feeding strategies (McMenamin 2010).

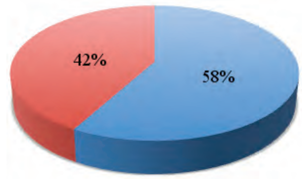
Results from a suite of 44 separate slabs bearing specimens of *Peronopsis in-*

Trilobite associations

Total sample number:	44
Total number of large (>4 mm) intact trilobites:	44
Total number of small (<4 mm) intact trilobites:	3
Number of samples with possible cannibalism events:	7
Total number of possible cannibalism events:	8
Number of slabs with just one trilobite:	32
Number of slabs with multiple trilobites:	12
Percent of total number of samples suggesting cannibalism:	7/44 = 16%
Percent of samples with multiple trilobites suggesting cannibalism:	7/12 = 58%

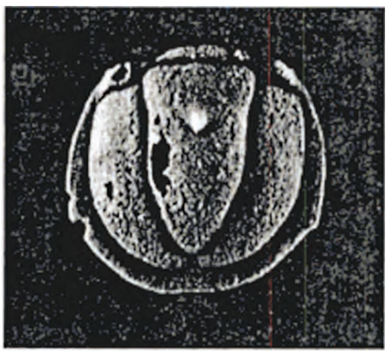


Proportion of samples showing large and small agnostids juxtaposed: N=44; red=no juxtaposition; blue=juxtaposition



Proportion of multi-agnostid samples showing evidence of cannibalism: red=no evidence; blue=evidence of cannibalism

terstricta have provided new data concerning agnostid behavior. Most of the specimens (43) were donated to Mount Holyoke College by an alumna, so their precise fossil locality is not known. Nevertheless, the samples are undoubtedly derived from the Middle Cambrian Wheeler Formation, Millard County, Utah. A final slab, also derived from the Wheeler Formation, Millard County, Utah, was purchased for comparison purposes in an online auction. The matrix of the auction sample shows iron staining that does not occur in the donated samples, thus the suite of samples probably represents at least two separate stratigraphic horizons within the Wheeler Formation. Seven samples out of the entire suite (16%) contain juxtapositions of large (>4 mm in length) and small (<4 mm) specimens. The small individuals of the pairs frequently appear to be damaged or partly ingested.



Bite marks to the pygidial margin. Taken from L. E. Babcock, 2003, in Kelley et al., ed., Predator-Prey Interactions in the Fossil Record.

In some cases a small individual is overridden by the cephalon of a larger animal, in what does not appear to be a merely chance association. These associations are interpreted here as evidence of attack by the larger member of the conspecific pair. As shown above, of the samples preserving multiple trilobites, 58% show evidence for cannibalism.

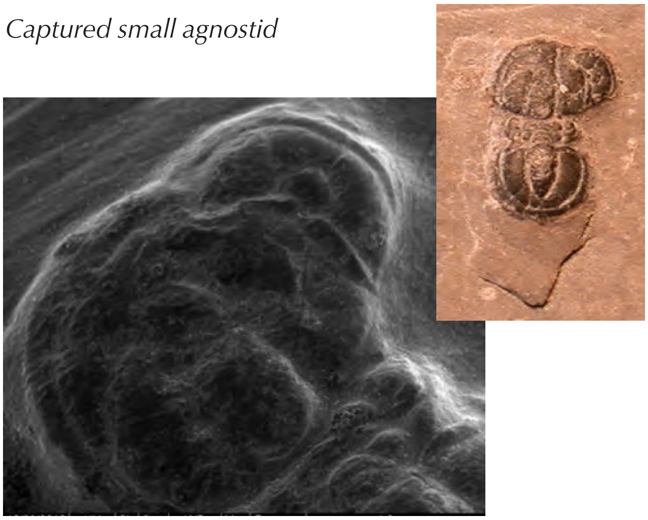
These results suggest that the agnositid trilobite *Peronopsis interstricta* was a predator. The predator interpretation is supported by putative tiny bite scars on the pygidium of a specimen of *Peronopsis interstricta*, damage that may be the result of intraspecific attack (Babcock 2003). This damage looks like someone nicked the posterior edge of an agnostid trilobite with a manual hole puncher.

An alternative to the predatory attack interpretation holds that the attacks represent an expression of intraspecific territoriality or mating competition. Scavenging and accidental juxtaposition interpretations must also be considered. The cannibalism explanation, however, seems best supported by available data. As such, these encounters represent the earliest known examples of arthropod cannibalism, and thus add to the accumulating evidence indicating that the Cambrian biosphere experienced an unprecedented increase in marine predation pressure (McMenamin and McMenamin 1990).

As the agnostid *Peronopsis interstricta* was evidently

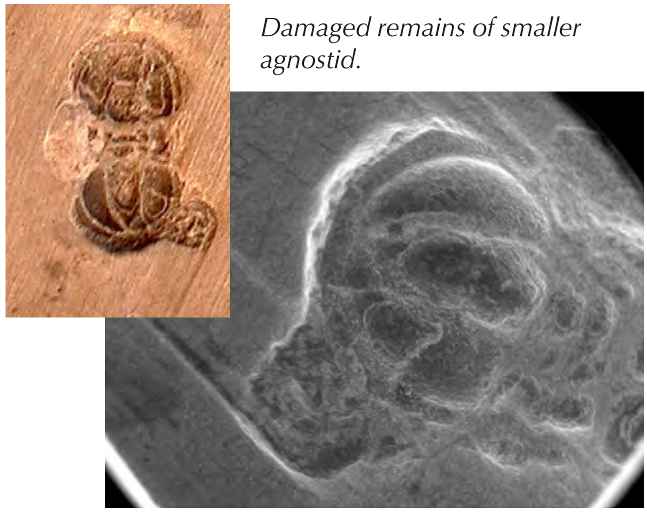
Agnostid damage: shredded thorax. Note, both agnostids are in the same bedding plane.

Captured small agnostid



Marian Rice

Damaged remains of smaller agnostid.

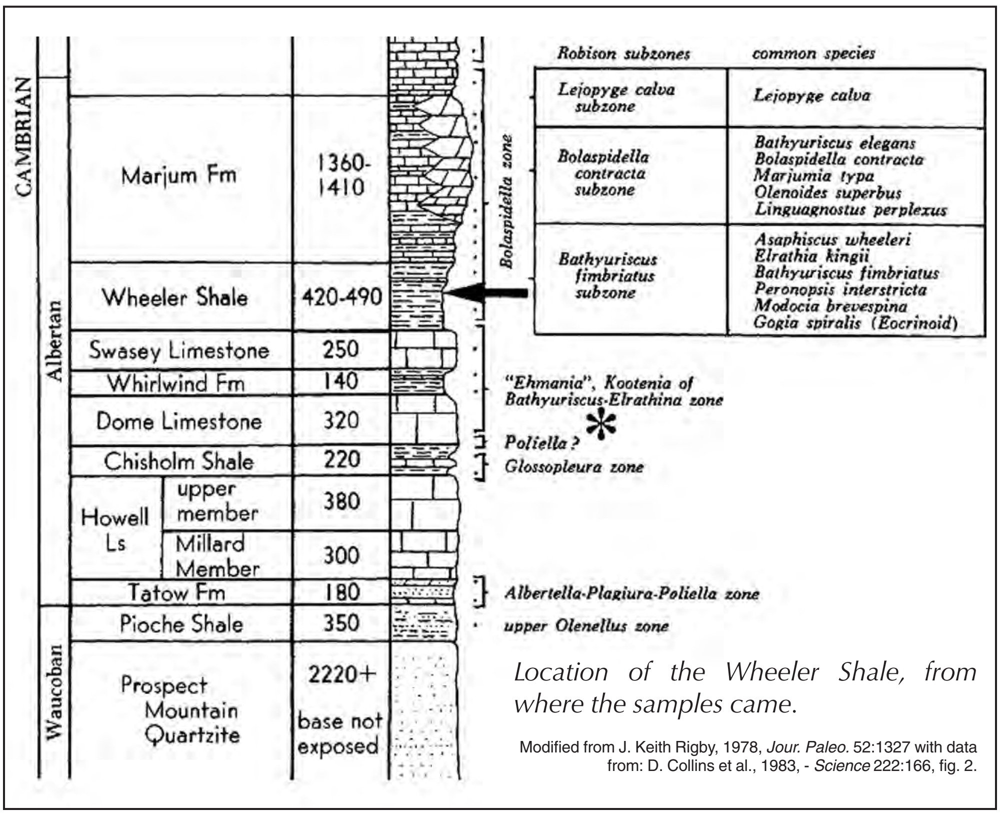


Marian Rice

blind, these predatory trilobites must have relied on senses other than sight to locate and capture their prey. Alternate sensory modalities, such as chemotaxis, electrotaxis or phonotaxis, may have been put into play in the search for prey. The slabs may be arranged in such a way as to suggest that the attacking trilobite approached its smaller prey in a coiling trajectory, spiraling inward to eventually seize the hapless victim. Other interpretations of the seek-and-destroy pattern are also possible. We might be able to obtain an unambiguous solution to the approach pattern problem if a specimen were to be located that showed agnostid trace fossils (crawling tracks) associated with the body fossils.

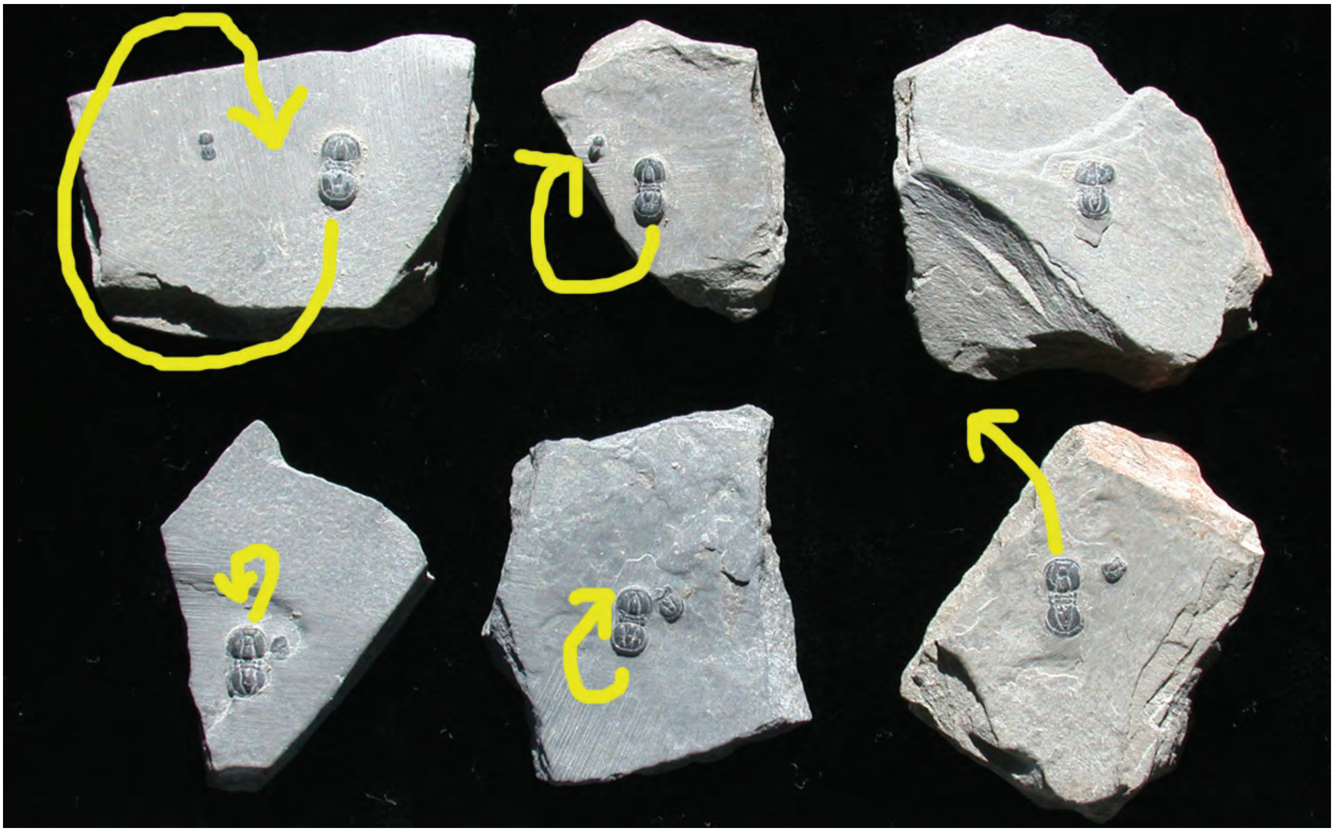
The earliest known case of cannibalism, just slightly older than the case for agnostid cannibalism presented here, occurs in fossils of the Burgess Shale priapulid worm *Ottoia* (Nudds and Seldon 2008). A number of specimens are known in which a large *Ottoia* has swallowed a small *Ottoia* of the same species. Cannibalism is common in modern priapulid worms as well. No cases of cannibalism have yet been reported from the Early Cambrian; however, the trace fossil *Treptichnus pedum* may be the track of an early priapulid worm. If so, this Early Cambrian trackmaker may have been cannibalistic as well.

Interestingly, the priapulid worm *Ottoia* and the agnostid trilobite *Peronopsis* were both apparently blind. This implies that cases of early cannibalism are not necessarily associated with vision-directed predation. Vision-directed predation has been blamed as the primary cause for the development of skeletons at the base of the Cambrian in an event known as the Cambrian Explosion (McMenamin and Schulte McMenamin 1990; Parker 2003).



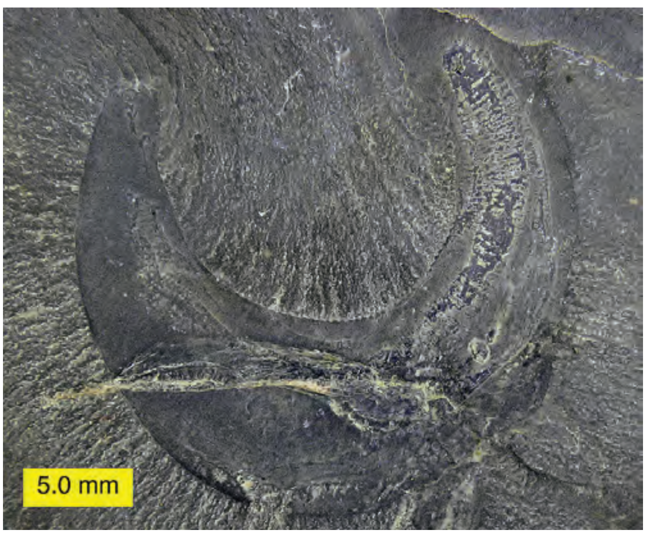
Location of the Wheeler Shale, from where the samples came.

Modified from J. Keith Rigby, 1978, *Jour. Paleo.* 52:1327 with data from: D. Collins et al., 1983, - *Science* 222:166, fig. 2.



A possible chemotaxis, spiralling approach pattern.

Ecological reconstructions of the Cambrian sea floor must now portray agnostid trilobites as predators. The agnostid trilobite species *Agnostus pisciformis* had antennae with regularly spaced spikes that may have served a predatory function (see the C.O.R.E. Cambrian fossil research group web site). Cannibalism should also be considered as a potential contributing factor to the appearance of widespread Cambrian predators (McMenamin 2003). The behavioral tools associated with macropredation may have been refined within a single species before being unleashed on the rest of the biosphere. This suggests that cannibalism in animals first appeared shortly before, or right at, the beginning of the Cambrian Period.



Mark A. Wilson

Burgess Shale stem-group Priapulid Ottoia prolifica.

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Evolution and Organismic Communication

by Jason Ross

According to the neo-Darwinists, the tree of evolution splits and develops in a single manner: Genetic changes conferring a competitive advantage are preferentially passed on to the next generation, leading to different kinds of specialization and a development towards more competitive forms of life (**Figure 1**). I intend to show that this idea is so completely absurd, that it may no longer even be considered as a basis from which to posit "alternative" theories.

This will occur on several counts: the failure of an evolutionary "tree" to correspond to the organismic differences and development actually observed, the great variety of hereditary mechanisms beyond genomic transformations, and, most importantly, the fraud of attempting a mechanical explanation, where each state comes to exist because of previous states.

Additionally, mechanisms of embryological and cellular development and communication will be considered from the standpoint of dynamics and cosmic radiation.

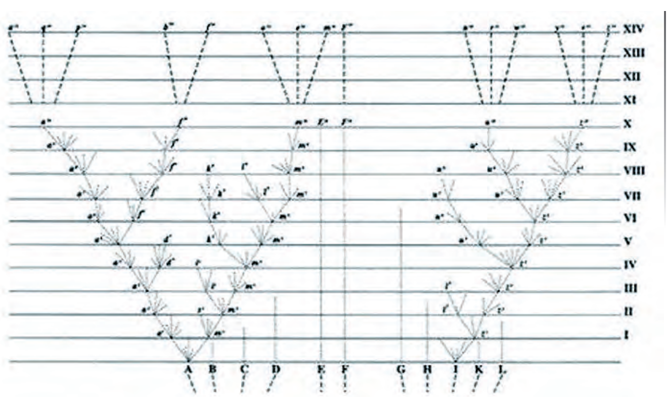

Figure 1
DARWIN'S 'TREE OF LIFE'

The "Tree of Life" included in Charles Darwin's Origin of Species *(1859) represents all evolutionary development as vertical differentiation, excluding any horizontal connections. This caricature of Darwin appeared on the cover of a Parisian satirical magazine of the 1880s.*

The Trouble with Trees

There are many ways of conceptualizing and organizing groups of phenomena. The characteristic of a tree as the scheme is that each element or branch has one unique immediate ancestor. On a structural (or physical) tree, each leaf has one twig that it springs from, which has only one limb it grows out of, coming from one branch, which, like all branches, comes from a trunk. Under this organizational scheme, there is no possibility of branches having joint children, of limbs combining into a new trunk, or of leaves connecting with each other. When a tree structure is imposed on the evolutionary development of life, it is pre-supposed that there is no horizontal development or connection, but only vertical changes, i.e., changes from organisms to their direct descendants.[1]

An evolutionary tree is particularly ill-suited for understanding the development of single-celled life (e.g., bacteria). An ancestral, generational approach to development is familiar to us in the sexual reproduction of animals and plants, but unicellular organisms do not engage in sexual reproduction in this familiar form. Instead (following the typical, but inappropriate, language), "mother" cells split asexually into identical "daughter" cells, without the need for a "father." Unicellular organisms do, however, engage in behavior that seems to resemble the sexual reproduction of higher species. This takes two forms: one of which appears to be characteristic of the organisms themselves (plasmid transfer), while the other takes place in a larger context (viruses).

In the case of plasmid transfer, one bacterium transfers a piece of its genome to another, by excising a segment and copying it, then physically passing it off to another bacterium which incorporates it into its genome. In this world of what is known as horizontal gene transfer, the application of a tree is questionable. It would only be through the development of different species,[2] incapable of engaging in such plasmid transfer, that the distinct branches of a tree could be formed. However, the not-infrequent transfer of plasmids among what are classified as different bacterial species, forces the characterization of links between species as a net: It is said to be reticulate.[3]

While most viruses only add their own genetic material to their hosts, it is also possible for viruses to pick up parts of their hosts' genomes, and transfer them to others. This introduces a factor beyond direct plasmid transfer between bacteria: viruses are a new vector. The numerous cases of viruses that infect across species lines, indicate again that it is impossible to have branches on a tree that are unable to interact.

Tantalizingly, because their functional cycle lies outside any particular species as such, viruses must be considered as potentially a major factor in the evolution of life as a whole.

Your Father's Eyes; Your Mother's Sweet Tooth

While the genome indisputably plays an essential role in known forms of life, allowing for the easy production of proteins, including those not currently existing in a cell, there is much more to heredity than an organism's DNA sequence. Four examples will be discussed here: introns, gene expression, genomic tagging and conformation, and other biological non-genetic inheritance.

An organism's genome codes for the production of proteins, which perform many functions in a cell (e.g., as enzymes). It is now known that codons, triplets of the base pairs making up DNA, code for specific amino acids, and that strings of DNA are decoded (transcribed) into amino acids, which are then strung together into proteins. While the process by which this occurs is by no means completely understood, enough is known to be able to point out some anomalies. Introns are one example.

In all higher forms of life (plants and animals), a large portion of DNA is not used: In the transcription process, segments of the DNA seem to be thrown away while the remaining pieces are stitched together, and then form the appropriate protein. These non-expressed segments are called introns, while the segments that are then transcribed into their products are called exons. There is as yet no clear understanding of how the transcription process "knows" whether a certain segment of DNA is an intron or an exon. Furthermore, under certain conditions, a portion of DNA may change its role from intron to exon. What would be the immediate competitive advantage in developing a repertoire of potentially expressible introns that are not yet being used?

While the genome can be thought of as a gigantic recipe-book, it cannot itself explain which dishes an organism decides to cook at a given moment. For example, there is no difference between the DNA in the cells that produce your hair and the cells that produce your toenails, but it certainly is a good thing that each cell remembers its proper role! The field of embryology takes up the question of progressive cell differentiation in single organisms, typically with the same DNA in all cells. As the embryo develops and tissues form, the genome is selectively expressed to correspond to the cell's role in the entire organism.

Several other factors are at play in determining expression. DNA can itself be "marked" by replacing a hydrogen on a base pair (cytosine) with a methyl (CH_3) group, in a process known as methylation. Methylated DNA is less likely to be transcribed. The histones around which the DNA wraps itself play a role in determining its conformation (shape), which can also be a factor in determining which genes are to be expressed.

Additionally, it is possible to inherit behaviors in a non-chemical-biological way. Behaviors can, by the internal biological environmental differences they engender,[4] alter gene expression. This different behavior, and the resulting change in expressed phenotype, is

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1. As an example, there are many efforts to represent the Indo-European languages with an image of a tree, which, while it has many merits, makes it difficult to graphically represent such linguistic phenomena as the Norman Conquest of England, and the introduction of French words. An example tree: http://bit.ly/bzgDwP

2. I use this word with concern. A species is defined for higher, sexually reproducing life, as a group of organisms that are able to mate and produce fertile offspring. This definition does not apply to bacteria; there is no universally accepted definition of species for bacteria.

3. As with so many English nouns, scientists are fond of using the longer, Latin-based adjectival form, *reticulate*, instead of the perfectly good English *net* or *net-like*.

4. Dietary preferences, for example. Experiments with human mothers fed carrot juice, and pregnant rabbits fed juniper berries, have shown that their young develop preferences for these foods.

heritable, without being a change in the genome itself.

Changes in gene expression are also determined by environmental factors outside the organism. In fact, there are plenty of heritable changes that are not genetic in character at all.[5] Changes in cell membranes are passed directly to daughter cells, as are mitochondria.

It is thus possible for evolutionary changes to take place very rapidly, by changes in the set of genes that are expressed, and not simply changes in the composition of the genes themselves. A recent article has demonstrated that higher apes contain a number of genes in common with humans, but the apes do not express them, while human beings do.[6] What role may cosmic phenomena play in triggering such changes in gene expression? What potential exists, waiting to be tapped into?

Returning to viruses, it is remarkable that, in human beings, not only is the majority of our DNA composed of introns, but most of it is viral DNA. The basis for that statement is the lysogenic behavior of viruses. While viruses can "commandeer" a host cell, and use its machinery to reproduce themselves, eventually causing the cell to pop open (lyse) and release copies of itself, they can also hop into the host cell's genome. This process, called lysogeny, allows a virus to remain incorporated into a host's genome, and offer new genetic material. Although it is integrated into the host genome, viral DNA maintains characteristic code sequences revealing its origin.

In a remarkable example of the role of viruses in evolution, the human placenta's syncytium (the region across which nutrients from the mother and waste products from the child transfuse) requires a protein for a singular behavior. The cells of the syncytium lose their cell membranes and merge into a gigantic, multi-nucleated cell. The protein allowing for this transformation is coded for in viral DNA![7] Viruses could be serving as vectors to set up the dynamic for the expression of revolutionarily new phenotypic characteristics, just waiting for the appropriate cue to come into play.

The response of viruses to very specific electromagnetic radiation, particularly in the ultraviolet range, and the many unanswered questions of the determination of which parts of the genome are to be expressed, give the opportunity for extraterrestrial factors to play a role in the evolution of life on Earth.

Evolutionary Leaps and Direction

Here, we reach the epistemological kernel of the error of neo-Darwinism: mechanism. Under a mechanical view, each state of a system can be understood as resulting from the previous state. This rules out teleological considerations and the opportunity for functional dynamic wholes and directions. Several topics will be briefly considered here: the correlation between cosmic radiation and biodiversity, the phenomenon of punctuated equilibrium, and dynamics.

Compelling evidence exists that there is a strong correlation, statistically impossible to ignore, between cosmic radiation incident upon the Earth and cycles of biodiversity, measured as the number of genera alive at a given time period.[8] Such a correlation demands that evolution not be considered as a terrestrial phenomenon, and implicitly forces the entire universe to be the context for any scientific study. The means by which the intention, given expression through cosmic radiation, acts on life, have yet to be studied to the degree they warrant. One obvious initial possibility, is the role of viruses. Since some viruses can be triggered to go from lysogenic (dormant) to lytic (active) states by ultraviolet radiation, the possibility confronts us that the role of viruses as evolutionary mediators is orchestrated on a galactic level (**Figure 2**).[9] More will be said on the potential for radiation to direct the development of life in the next section.

Those studying evolutionary history face the emergence of punctuated equilibria of whole-Earth evolutionary stages. Single-celled organisms existed on the planet for more than a billion years before multicellular life finally began to form. In another example, the process known as the Cambrian Explosion (about 570 million years ago), a tremendously yeasty period of evolutionary development, took only 5-9 million years. In general, while different species exist in the fossil record, "halfway-species" are hardly to be found, and many evolutionary technological upshifts (e.g., flying birds) seem hard to imagine as having been driven by intermediate competitive advantages.[10]

Some neo-Darwinists hold that stressful environments lead to more mutations, an hypothesis for which there is

5. Jablonka and Lamb cite M.M. Clark et al.'s work on Mongolian gerbils. Female gerbils, in a male-dominated uterine environment, develop different behavioral characteristics, including territorial aggressiveness, and male-biased litters. Their female children will then be more likely to have male-biased litters, etc. See Jablonka and Lamb, p. 146, and M.M. Clark et al., 1993, "Hormonally mediated inheritance of acquired characteristics in Mongolian gerbils," *Nature*, vol. 364, no. 6439; Aug. 19, 1993, p. 712.

6. For a similar article: http://tiny.cc/gq12v

7. I owe this example to Frank Ryan's *Virolution* (see References). The required protein is coded by the envelope gene of a human endogenous retrovirus, known as HERV-W. The characteristic "long terminal repeat" bookends of viral genomes allow their identification in host genomes. See *Virolution*, and Sha Mi, Xinhua Lee, Xiangping, et al., "Syncytin is a captive retroviral envelope protein involved in human placental morphogenesis," *Nature*, vol. 403, no. 6771; Feb. 17, 2000, pp. 785-89.

8. Sky Shields, "Kesha Rogers' Victory Launches the Rebirth of a Mars Colonization Policy": http://larouchepac.com/node/13802

9. Not only does cosmic radiation originate from distant locations, the entire galactic electromagnetic field can play a role in which radiations are directed towards the Solar System at any given time.

10. What use is the development of a wing that is completely nonfunctional for flight? How would a useless appendage repeatedly be selected for, until it is able to serve a purpose?

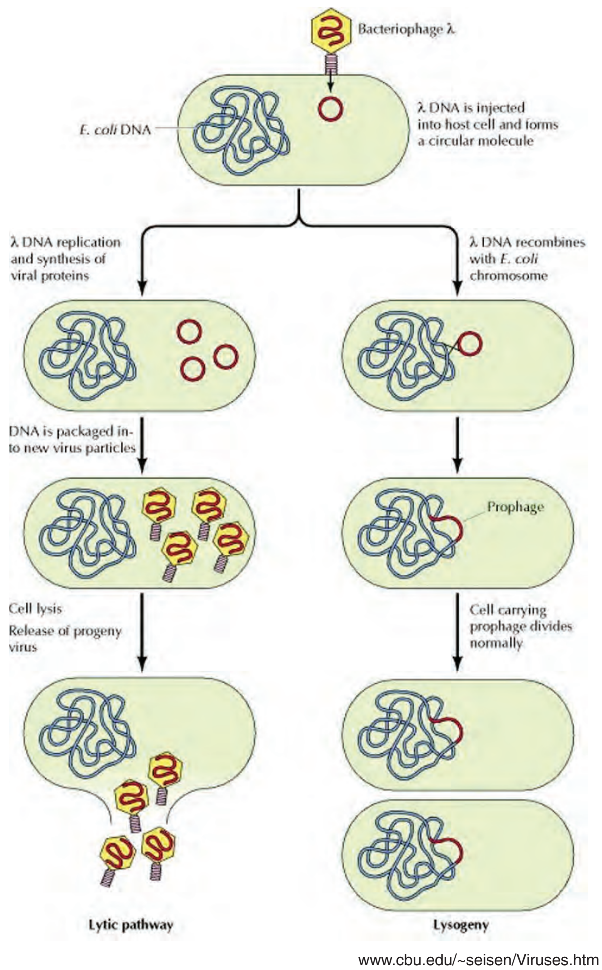


Figure 2
LYTIC AND LYSOGENIC PATHWAYS OF BACTERIOPHAGE

A virus behaving in a lysogenic state integrates itself into its host DNA, whereas one in the lytic state reproduces rapidly without integrating, eventually popping (lysing) the cell. Ultraviolet light can trigger some viruses to switch their role.

some evidence, but even seemingly "close" genes require a large number of changes, which would seem difficult, if they proceeded randomly.[11] Again, if the potential for new phenotypic expressions is being developed, without being expressed along the way, we need not worry about competitive advantages of life along the path of development—life may simply leap.

To truly consider these phenomena with fresh eyes, the mechanistic approach inherited from Descartes, Newton, Darwin, Bertrand Russell, and their ilk, must be rejected.

While great success has been made in physics and engineering by the consideration of efficient causes, this cannot be projected upon life processes. (Indeed, point-by-point mechanism is not even true on the abiotic level—see "The Matter of Mind."[12])

Unlike the so-called laws of physics, which describe abiotic goings-on with formulations that are independent of the direction of time, almost all empirical generalizations about living processes have a clear direction to them. But, this direction is not a vector! On the scale of evolutionary time, these processes are not directed as an arrow, from one possible state to another, but are, instead, the development of greater domains of possibility. A new potential may appear to come from the past, temporally, but it is not generated from it, causally. Time is drawn forward, not pushed.

We will continue this theme as we consider organization across cells.

Cellular Communication and Poetry

Embryology is a fascinating discipline. Nineteenth-Century experiments revealed that the differentiation of cells as the embryo develops was not determined by the physical composition of the cells. If it were, it would be impossible to switch cells around in a 16-celled embryo, and have the organism, as a whole, develop properly, compensating for the change. Since experiments such as this had been successfully performed by German biologists Hans Driesch (1867-1941) and Hans Spemann (1869-1941), it has been necessary to consider the developing embryo as a whole, and not as a growing collection of cells. Russian biologist Alexander Gurwitsch (1874-1954) hypothesized a biological field to guide the development, and performed studies on one possible means of organization of the field: what he called mitogenic radiation.

In a famous experiment, Gurwitsch oriented two onions, such that the root tip of one pointed perpendicularly at a location on the axis of the other. He discovered that the region pointed to by the first tip had a greater rate of mitotic division than neighboring regions. Experiments with different shielding materials led him to conclude that this mitogenic radiation, as he called it, expressed itself in the ultraviolet range.[13]

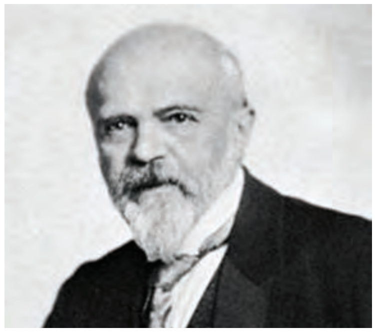
Continued work on this subject, with the great advantage of sensitive photomultipliers, has indicated that seemingly all biological processes emit various sorts of electromagnetic radiation. Examples, such as the coordinated development of groups of fish eggs, sympathetic symptoms of disease expressed by cells in optical communication with infected ones, and variations in organized cell behavior, that is induced by the spectra permitted to pass be-

11. See Brig Klyce's discussion of the supposed random mutation creating antifreeze protein genes at panspermia.org/neodarw.htm

12. http://tiny.cc/lmbb7

13. Lipkind, *Op. cit.*

Since the late-19th-Century experiments of the German biologists Hans Driesch (below) and Hans Spemann (left) revealed that the differentiation of cells as the embryo develops was not determined by the physical composition of the cells, it has been necessary to consider the developing embryo as a whole, and not as a growing collection of cells.



tween cell groupings, indicate a great responsiveness of life to such radiation.[14]

In evolutionary terms, it stands to reason that the cosmic radiation environment can play a major role in regulating cellular activity, both directly, as triggering radiation, and potentially, through inducing Cerenkov radiations of appropriate frequencies in organisms. The previous discussion of viruses, and the turning genetic expression on or off by environmental factors, offer no shortage of fields of study to explore the means by which the environment of the galaxy as a whole shapes the development of life here on our current home planet.

It must be emphasized that while factors such as cellular emissions, virus operation, and genome transcription may serve as mechanisms for such development, they are not the cause. As an example of a disposition to move towards a different state, I offer the simple example of a mixture of hydrogen and oxygen gas. Such a mixture in a vessel is not at a thermodynamic optimum: The combination of the gases to form water would be preferred. Yet, such a transformation cannot occur without a catalyst, such as a spark in the chamber.

Although higher apes may have human genes which they are not expressing, and the Cambrian Explosion may have been the letting loose of a great evolutionary potential, such triggered releases are not the same as the process that set up the disposition for such changes.[15] Here we must join with Percy Bysshe Shelley, who lauded the role of the poet in crafting a dynamic, along which thoughts could then run.

No matter what the British biologist Richard Dawkins might claim, there is no proximally advantageous mechanistic cause for the development of such genomic potentials. Indeed, the cause of evolutionary development is just that: a cause. Not being able to find it in the realm of mechanism does not mean it does not exist, but rather, that we are seeking in the wrong place.

We find a process rigorously analogous to this development of the universe as a whole, in the creative advancement of human society. At this point in human and planetary history, it is essential to organize culture around the goal of manned colonization of the Moon and Mars. Without a personal commitment to such a shift—without such a political-cultural goal—it were impossible to make the "scientific" breakthroughs required to piece this matter together. A faulty view of the fertile potential of human nature will, necessarily, analogously, lay barriers to what may seem to be discoveries of "scientific" matters.

To truly be a scientist, one must also be a legislator of mankind.

14. See Jonathan Tennenbaum, ``The Biophoton Revolution," *21st Century Science & Technology,* Winter 1998-99.

Russian biologist Alexander Gurwitsch hypothesized a biological field to guide the development of cells, and performed studies on one possible means of organization of the field: what he called mitogenic radiation.

15. The development of the genome, creating new evolutionary potentials, does not require competitive advantage along the way. The problem of the utility of middle stages of development would not be an issue, to the extent that changes in expressed characteristics actually occur with surprising rapidity.

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NAWAPA XXI Update

by Michael Kirsch

NAWAPA XXI coordinator

In 1964, a grand development proposal was put forward: the North American Water and Power Alliance (NAWAPA). This imaginative plan would transfer a portion of the run-off water from Alaska and parts of Canada, through a series of dams, canals (both natural and manmade), and pumping stations, into the drier regions of the continent, creating a great surplus of electricity and doubling potential irrigated agricultural acreage in some states. That original proposal has been updated and recast for today's economy as NAWAPA XXI. In the last year, the development of this national recovery and continental water management plan has taken great strides forward.[1]

Last November, the full legislative and diplomatic history of the proposal was captured in a video documentary *NAWAPA 1964*, through the use of previously unseen footage, correspondence, and news articles of John F. Kennedy's speeches on water development and Senator Frank Moss's letters with U.S. and Canadian government officials.

In March 2012, a LaRouchePAC Special Report presented the full concretized proposal, with an executive summary of the plan, based on all the available data in the archives around the country, and new calculations on the estimated tonnage and cubic yards of concrete, steel, aluminum, and earth moved for the projects tunnels, canals, power stations, dams, and reservoirs. Every single engineering, construction craft, machining, and scientific job was outlined with respect to a four-phase critical path outline for the implementation of the project. The full impact in the basin states of the U.S. Southwest and Northern Mexico was presented regarding the relation of the water brought by NAWAPA XXI to the surface and ground water currently available. The relation of building the plan, which will create a new generation of productive power in the U.S. and secure the future productivity of the land, to the implementation of a new credit-based financing system, was developed in great detail, including a review of various credit financing periods in U.S. history.

The 100-page Special Report was distributed in hard copy to select skilled labor, farmers, industries, and government officials around the country. This special report was followed by draft legislation, based on the review of the original 40-page legislation of the TVA, and is written in legislative language for city councils, state legislatures, and national congressmen presenting the treaty agreements, and all of the powers requisite for the design, pre-construction manufacturing, construction, financing, and operation of the NAWAPA XXI Authority that would be established.

Various animated overviews of the updated version of the project, and historical financing were made, including a succinct but rigorous 15-minute overview, and a longer in-depth tour for policy makers. The latter stands as the most compelling and precise demonstration of the project so far, making comprehensible every major river and water amount involved in the entire project in just 30 minutes.[2]

Meetings have taken place presenting slide versions of the project, in state and national government offices, and various venues around the country including water district meetings, farm bureau and union meetings, union halls, labor associations, scientific groups, and more. The ferment around the proposal is exciting, as it represents the possibility of Canada, the US, and Mexico engaging in the most large-scale development program ever undertaken, one which will push the earth and related sciences more fully into the status of experimental sciences.

21st Century Science and Technology will provide ongoing coverage of developments in the engineering and political progress of NAWAPA XXI. In this issue, we bring you an interview with hydrological engineer Bryan Karney.

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1. These developments are available at the project's webpage: www.larouchepac.com/nawapaxxi.

2. larouchepac.com/nawapaxxi/feature

INTERVIEW WITH DR. BRYAN KARNEY

NAWAPA: A Bold, Fascinating Program That Deserves Consideration!

Bryan Karney is the Chair of the Division of Environmental Engineering and Energy Systems, Associate Dean of Cross-Disciplinary Programs, and a professor in the Environmental Section of the Department of Civil Engineering at the University of Toronto. His research has focused on the design, analysis and optimization of various water resource and energy systems, with interests in infrastructure renewal, transient and water hammer analysis, system optimization and the effects of climate change on system design. In addition to winning several awards for excellence in both teaching and research, and providing his expertise as a consultant, he has served in an editorial capacity for technical publications such as the Journal of Hydraulic Engineering *and the Special issue of Transients in Distribution Systems for the* Urban Water Journal.

He was interviewed by 21st Century correspondent Robert Hux on Dec. 7, 2011.

21st Century: Could you describe for our readers your own background, and the kind of projects you have been involved in?

Karney: I did my undergraduate degree in bio-resource engineering at the University of British Columbia. I was particularly interested in biological systems and in transfer systems, in particular irrigation. And then I had a sort of twist, at the graduate level.

I ended up making a decision to get involved in hydroelectric development, in a specialized area of hydraulic transients, which is a fairly technical area of civil engineering. And much to my surprise, doing a Ph.D. in that area as well.

When I graduated, there were almost no jobs in western Canada at that point, and when I was offered a faculty position, it was pretty hard to turn down that with a family to feed. So I decided I would become a faculty member, and I've been in that position for 27 years now.

Bryan Karney. Professor in the Department of Civil Engineering, Environmental Section, University of Toronto.

Early on, we created a consulting company called HydraTek and Associates, Inc. and we've done hundreds of consulting projects, mostly related

The North American Water and Power Alliance (NAWAPA) would transfer a portion of the run-off water from Alaska and parts of Canada into the drier regions of the continent. Shown, Canada's Yukon Territory.

to water supply systems, with a variety of different systems involved in that as well. But it has always had the connection to water resources. Some of those involved large-scale projects, and many small-scale projects as well.

21st Century: You mentioned that you had been involved in a consulting project on the Grand Canal.

Yes, a few years ago a few of us decided to really dig our teeth into that Grand Canal project, looking at the possibility of collecting up fresh water, water that is tributary to James Bay, and transferring that into Lake Superior. It was a very bold, a very interesting scheme, and it was invigorating for me, I think in the same way that NAWAPA is invigorating.

It's a project that thinks in terms of intergenerational problems. It's not thinking in terms of what the current needs are, but it's projecting. It's saying, "what are the challenges that are coming down the road?" I think that those projects need to be carefully elucidated. They need to be considered and weighed. The pros and the cons need to be looked at seriously.

So that was the first foray of looking at a major project. I was really looking at the technical aspects, but our team looked at various biological and ecological considerations as well. It was not something that was disseminated widely, or published. In fact, the person that was the force behind it ended up having some health issues, and so the project sort of sat. But I think that at some point it needs to be dusted off.

21st Century: What is your overall impression of the NAWAPA project?

I guess the descriptive is: It's bold. The project both fascinates me, in the sense of the vision of it, and, I'll be honest and say that the number of problems that have to be solved in the project is gigantic, as well. Just one aspect of it: land claims are going to be such a huge issue with respect to things that have to be sorted out. But certainly, civilization has existed because people were willing to think boldly.

I think that the fact that it's bold doesn't mean that you reject it out of hand for that reason. It means you roll up your sleeves, and you have to do some analysis, really do proper assessment of the pros and cons. So, I think this kind of project is going to need some careful consideration.

21st Century: In the past few days I have been at a conference here in Toronto on the refurbishment of the Canadian nuclear reactors. One of the things that I was circulating there is an article written by a retired nuclear engineer, Dewitt Moss, which is an assessment of the nuclear power requirements of NAWAPA—not only in terms of pumping requirements, for pumping water uphill at certain points, but also the nuclear energy requirements associated with the industrial recovery that would be required to build this . . . I was also posing the question to the Canadian nuclear industry, what are the capabilities in Canada, to be able to gear up to build something like this? If we look more specifically at the various components of NAWAPA, are there any particular elements of the NAWAPA design that you thought might pose a problem?

I guess, my gut reaction is, that the technical problems are probably the least of the concerns of the project. I think that if humans put their minds to something, we have a tremendous capacity for moving things and rewiring things.

We were reflecting with a variety of people on the possibility of fast neutron reactors, as an example. They are able to reuse spent nuclear fuel, and just that could more than fund this project. There are challenges. Every nuclear reactor that has ever been built has a lot of environmental, political, and economic considerations with respect to it.

My guess would be that issues of land claims alone are potentially able to jeopardize the project. I mean that one link that can't be resolved, to a certain extent has implications for the whole project. It is not like there are a lot of ways around certain of the bottlenecks that are going to arise. I think that the ecological concerns with respect to fisheries, and moving parasites or invasive species across watersheds, inter-basin transfers, are very sensitive issues. And those are going to have to be handled well.

The other aspects of this are certainly going to be the economic issues. I think to a certain extent that we have lost the vision of government-supported infrastructure as a way of facilitating and creating large-scale and long-term possibilities. That is one of the aspects that we have got to work to rethink. We think that any government money is always a tax-dollar, and not something that facilitates economic development.

That's a hurdle, and I think that's one that we have to overcome in a variety of ways. We tend to think of water supply systems, and transportation systems, and energy systems as some kind of dirty necessity rather than something that opens possibilities.

So, I think that's something that is very important for us as a species to come to grips with again. You know: What are the implications that infrastructure creates for economic development? And that is one of the areas that I do have some resonance with the kind of agenda that you folks represent.

21st Century: Clearly, it's the kind of project that is impossible to do in the existing collapsing international financial system. It's the kind of thing that would require a shift like that which occurred in the 1930s with Franklin Roosevelt, with protection of commercial banking ... a directed credit policy that, initiated from the United States, will become the basis for these kinds of policies globally.

Shasta Dam under construction, June 1942.

Certainly it's going to need visionary planning. I guess the question in my mind is: do we have the will or the courage to have visionary finances? It's going to take the coordination of a reversal overall, where at the moment we're afraid of making mistakes.

21st Century: Are there any elements of the NAWAPA project that you have any insights into how you would approach? For example, the idea of a transcontinental navigable waterway across Canada?

Again, I think the attractive thing is really the scale of the vision. Very few people think in terms of water and energy problems on a continent-wide basis, and an inter-generational basis. There is a visionary scope to this, which I think is extremely attractive. As I said, the range of problems that are going to be encountered are enormous!

But, you visit a place like Rome, and you look at the kinds of things that were created by a society that didn't have our technical advantages. I don't think this is a non-commensurate scale. The Roman aqueducts that were hundreds of kilometers long were built when only the barest essentials of hydraulics and surveying were understood.

I don't know if it's more visionary than that; I don't actually think it is! But certainly, it's more visionary than we have become accustomed to think about for a long time. And therefore, again, I genuinely think that I sit on the fence now. I haven't made a decision in my mind that says absolutely we must do this, or we must declare that we don't want to stage certain segments, but I am totally convinced, that it's worth really putting on the table and having this whole open debate about it again, which, I think, is one of the agendas.

So, let's bring this forward and let's truly discuss it.

21st Century: Obviously, from the standpoint of Americans looking at NAWAPA, there is a very clear need for getting water into the Western, very arid part of North America. We have done interviews with engineers, geologists, all kinds of people who are very interested in this. What do you think the impact of this will be on Canada, in terms of water for irrigation and other benefits?

Again, if I can give an honest comment. I think that some of the current literature, the movie that was produced,[1] was very much targetted to the U.S. audience, and not to the Canadian audience. I think there's going to have to be some significant nuancing of that messaging, because, there are some aspects to which an average Canadian is going to react negatively, although an average American might react positively. To my mind, it's a matter of careful, and very strategic, and creative positioning in the way we do that.

We have deep-seated reactions as Canadians. We view our identity very strongly in terms of our water. That has to be viewed as a way of positioning this carefully, not to create negative reactions. But it could also create positive ones.

We are also very positive about our health-care system. But our health-care system is having funding problems. If we can position this in such a way that allows some of the net Canadian transfers of water to the United States to be directed toward funding our health care, I think, the view of that could be very different.

Certainly, in terms of economic stimulus, there's a potential here; certainly in terms of agricultural aspects. But, Canadians don't think of themselves as farmers as much as they used to. I'm not sure that's a healthy thing, but farming is very low on the political agenda at the moment.

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1 NAWAPA 1964: http://larouchepac.com/nawapa1964

So, I'm not sure the average Canadian is going to respond more to the agricultural side. I think the health-care issue is more the way to position this to a Canadian.

21st Century: You are aware that a group of graduate students from the University of British Columbia did a study on NAWAPA in 1966. Basically, they limit their study to NAWAPA's impact on British Columbia. However, it just struck me that it was a much more straightforward assessment than you would think possible from a Canadian province to such a great project. Maybe that has to do with the fact that it was 1966, compared to today.

I read a lot of literature that comes from the 1960s and 1970s. I think there was, on average, a much higher degree of collective vision than we have today. We understood what we could do collectively, more effectively than we do now. We tend to think even of voting as a kind of consumer action. We don't think collectively. We think only as individuals.

My feeling is that the world has changed. You take something like natural gas, which we all have delivered to our house. I wonder if the world has changed so much that, if we didn't already have the delivery of natural gas, whether you'd actually be able to sell that idea now?

In this case, you've got this inflammable, explosive material that you are bringing into a home! Could one actually do that? To a certain extent it's improbable. So the question is now: is there enough political will? And I don't think anyone has pushed hard enough to know yet. But it's an interesting question.

Along these lines: in your video, the one that's on the website, one of the things that I think you would want to edit out, particularly for a Canadian audience, is the talk of doing the tunneling process with atomic weapons, or atomic bombs, if it were cheaper. I don't think that as a selling point will help. In the 1960s, there was still a sense of, "wow, this is powerful! This makes things cheaper." Now there is a great deal of reluctance and skepticism about using these things.

There are many facets. Many people are involved. I am sure there won't be a consensus position on a great many things for a while. But, then again, I think that for me this is a perfect opportunity to maybe seek a serious academic study of the project again. Like the 1966 study, but with more participants and broader dialogue. And to really, vigorously develop the public debate over what the pros and cons of the project are.

You know, academics don't always have a lot of credibility. And sometimes we deservedly don't! But, what other group could do that and be accepted? I think it's bold enough that it deserves to be considered seriously.

21st Century: You said one of the areas you are looking at is energy systems, and also water management?

We, like many others, are thinking a lot about the energy side of things. And certainly, one of the things I think needs to be done is the whole role of—what I am calling and doing a lot of work in—"water-energy systems," where water and energy come together. This is of tremendous importance to cooling systems, to hydroelectric systems, and even to water supply systems.

Almost all of our major power systems, whether thermal or nuclear, have cooling requirements. The possibility of climate change in what may be happening to the planet long term, have really important implications. Certainly, I would say that the issues of the 21st century are water and energy, and probably food and health, and how those things go together. I think that the future of civilization is going to depend very much on how we answer those questions, but first we have to face them.

21st Century: The assessment of the hydroelectric potential of Canada is more than 100 gigawatts. But, not many large hydroelectric dams have been built anywhere in Canada in the last 20 to 30 years. Is Canada putting itself in the position of not being able to meet its energy requirements, by not developing large hydroelectric projects, by not going aggressively ahead with nuclear energy?

That's a big question. It raises all sorts of issues. But certainly, I think humans are very bad at solving problems that we think we have already solved!

One of the things that has happened is that we were very aggressive about building power capacity, particularly in the electrical system, through the 1970s, and '80s, even petering out into the '90s. And in many jurisdictions, we have had the issue of: "We've got enough!"

We don't recognize that energy is not a problem that you can solve once and for all. Any more than human health is a problem that you can say: "Okay, I was once fit! That's all that matters."

No, I think these systems require continuous assessment. I don't think we have lost the ability to solve it, but we certainly will if we continue to be complacent. I think there are many things that characterize modern society, and one of them is that we want the good things, but we often don't want the associated cost!—This is true in a great many areas.

We want a healthy food system, but we don't really want food processors or feed lots anywhere near us.

We want power consumption, but we don't really want power production near us, whether it's wind power or it's hydroelectric, or whether it's nuclear. All of these things so easily become, "not in my backyard."

If we don't get a little bit more realistic in this, then we are going to have drastic problems!

But, certainly there are a lot of energy options that we have, and a lot of things we can do. The question is really what we are prepared to do as a priority, what we are prepared to afford. As the price of oil goes up, more and more options come onto the table as economically viable.

Certainly, Europe has been looking seriously at the Sahara as a source of solar thermal.

Within Canada, there is hydro development, and also with a variety of other countries, We have the capacity. We have the technology. We have the ability to do it.

The question is do we have the will? And are we prepared to pay?

21st Century: You mentioned that you are interested in presenting NAWAPA to your graduate students in civil engineering to study. How would a feasibility study of a project like NAWAPA proceed?

I think it's a matter of trying to start to create some basic models of what the transfers would look like, what they would involve. I know some of that work has been done, but again, I think the current generation of students has not really been challenged to think about larger issues, and issues where you really need a multi-component team to get them.

I love that aspect of it, to get the students involved in all the aspects. You know, prairie irrigation, the hydro transfer issues, bulk water transfer. Can we recover the electricity used in pumping?

Again, looking at this in the context of China. China is rewiring its whole national hydrology. It's doing it quite aggressively. I think we should be watching that! And to a certain extent, taking an interest, learning the lessons they are paying for.

What kind of problems arise? They are doing systems where they are pumping a lot of water and they are recovering a lot of the energy on the other side. So there is net transfer in the individual components. Those are intriguing approaches.

21st Century: Do you have any other comments on NAWAPA?

It's certainly going to be something that I'm going to play around with and think about. I would like to try to maintain a degree of academic interest and a degree of neutrality with respect to where this thing goes, because I think it's going to be very important to have interested people who are asking both the really exciting questions, and the tough questions. Certainly, I think that's something that we can do.

The Grand Canal project was intriguing. It had so many interesting questions, and it was similar in terms of scale. That was about a 13-gigawatt project, just for the James Bay transfer component of that. But, downstream you can recover that energy again. You enhance the hydroelectric capacity of the Great Lakes.

I'm involved in another project that's looking at the various possibilities of rethinking what we have been doing with the Great Lakes power. And I think those considerations are important. I think that the 21st century is going to progressively be not a business-as-usual scenario. We are going to have to roll up our sleeves and think really seriously think about what's worth doing and what's worth avoiding.

21st Century: When NAWAPA was proposed originally, there was a U.S. Senator, Frank Moss, who had said that the International Joint Commission should be commissioned by the United States and Canadian governments to do a feasibility study on this. One of the problems which the International Joint Commission is concerned about is the lowering of the levels of the Great Lakes: this is something which NAWAPA could resolve… How do you see the process that would have to be undertaken in Canada to get the go-ahead to do such a project?

I am not sure if I'm politically astute enough to make the best call. I have certain models in mind, but they are strongly academic. I think the idea of International Centers of Excellence, that would look at large-scale water transfer issues, would be the kind of model I would have. The International Joint Commission has a variety of people who weigh in on that, but it's become very significantly driven by political urgency.

I think you need a group that is a little bit more removed from, sort of, tomorrow's policies in this. That's why I think that a Centers of Excellence model might be something worth considering, where you consider projects of this kind. To me it would be almost more of a kind of a Rand Institute applied to water, where you've got a bunch of good people.

For doing anything that's feasible, that's technical, it's worth considering. I think you need something that's got a wider scope on the agenda than the way the International Joint Commission has tended to evolve more recently.

Three Gorges Dam Proves Its Worth

by William Jones

The famous Three Gorges Dam in central China, the world's largest, faced its greatest test last month, and passed with flying colors. With unusually heavy rains pounding the region, on July 24, at 8 p.m., the water flow into the dam's reservoir reached its highest peak ever, at 71,200 cubic meters per second, and on July 25, the dam released water at the rate of 43,000 cubic meters per second.

Heavy rains on the upper reaches of the Yangtze have caused high waters in all of the tributaries flowing into the river, along with heavy flooding in the towns and cities along the flood reservoir, including the waterfront sections of the city of Chongqing, with a metropolitan population of 32 million. More than 600 ships are at anchor in the reservoir, delayed by the flooding. These vessels will proceed downstream through the system's locks, as soon as the floodwaters recede.

The stunningly beautiful Three Gorges Dam on the Yangtze River creates a new infrastructure platform in China that will lift the conditions of life for hundreds of millions of people. For exactly that reason, the radical Green movement opposed it, and is campaigning to prevent any further such development in China.

Thanks to the recent completion of the Three Gorges Dam, even though a Level II emergency was declared in the region, it did not entail the massive military evacuation mobilization which would have been mandatory in years gone by. The trouble spots nowadays are no longer in the Yangtze River valley, but in other parts of the country which have been hit by massive flooding, without the protection that the dam provides.

The Yangtze River, the longest in China and the third-longest in the world, has experienced extreme flooding at fairly regular intervals. The 1954 flood inundated 48 million hectares of farmland, affecting 18 million people, and claimed 30,000 lives. In 1998, another huge flood affected 21.8 million hectares of farmland and destroyed 5 million houses; 4,150 people were killed. Flood control and rescue operations involved the deployment of 300,000 Army troops to the regions.

This year saw an unprecedented amount of rainfall, and not only in the Yangtze River region, but in the entire country. In the generally arid northern regions on the Yellow River, which in some sections is often dry as a bone, there was extensive flooding, not seen since 1988 or earlier. Similarly, in the South, in Guangzhou. Even in Beijing, there was so much water that the city's drainage system could not cope with it. In addition to a general tie-up of traffic for days, dozens of people were killed.

Sun Yat-sen's Great Project

The location of the present Three Gorges Dam, just up-river from the town of Yichang, had already been identified in 1919 as a prime location for a hydroelectric power facility by Dr. Sun Yat-sen (1886-1925), in an article entitled "Industrial Plan." He further elaborated on the idea in a lecture on his "Third Principle of the People: Peoples' Livelihood"; it also figured prominently in his 1922 programmatic work, "The Industrial Development of China."

During World War II, the site was investigated by engineers from the U.S. Bureau of Reclamation, taking the successful development by the Tennessee Valley Authority as a paradigm for what could be accomplished if a dam were built. The Bureau's John Savage had even outlined a program for how many engineers, physicists, electricians, mechanics, and skilled workers would be required for its construction. The ensuing civil war in China, however, put a stop to this development.

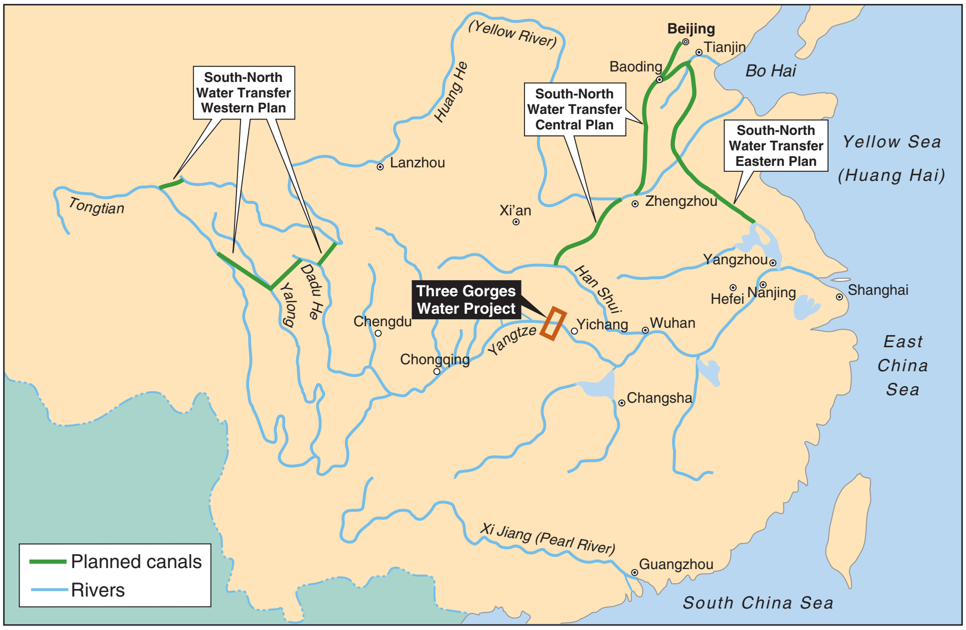


Figure 1
CHINA'S GREAT WATER MANAGEMENT PROJECTS

But in 1969, when China was just coming out of the disastrous Cultural Revolution, a call was again raised by officials in Hubei Province, where the Three Gorges is located, for construction of a dam. A decision was made to build a dam further downstream from the Yichang site. Here, the Gezhoubo Dam began producing electricity in 1981, giving Chinese engineers practical experience which would be put to good use in tackling the bigger project farther up the river at the Three Gorges.

In 1992, the Seventh National People's Congress made the final decision to construct a dam in the middle section of the first of the gorges, just above Yichang. Construction on the dam was finished in 2009. Officials with the Three Gorges Corporation say that the dam has actually prevented at least 10 major floods since it was completed.

The last of the 32 turbines for producing electricity—hydroelectric power being another major function of the dam—was just installed in June, bringing the dam to its full production of electricity. Electrical production at the Three Gorges represents 11% of the total hydroelectric power generation in the country, and has so far generated 564.8 billion kilowatt hours.

Like any major water-management project of this size, construction of the Three Gorges Dam required tremendous amounts of labor and sacrifice by the people who built it, and by those who were forced to move to allow its construction. Hundreds of thousands of people had to be relocated from the areas which had to be flooded to create the dam reservoir.

Enter, the Greenies

The dam was heavily criticized internationally by the so-called environmentalist movement when it was first proposed; the Greens claimed that it violated the major tenet of their insane ideology: It was a great project, which would prevent the forces of nature from sweeping man away—just the type of project the Green movement was created to prevent! It became an ideal target around which to organize the burgeoning environmentalist movement in China, which launched an effort to prevent its construction. The dam also became a banner issue for the international Green movement, which saw it as a

Figure 2
LOCATION OF THE THREE GORGES DAM ON THE YANGTZE RIVER

"dangerous model," which might well be followed by other countries lacking sufficient energy and flood control.

The success of the Three Gorges Dam during the recent terrible floods has no doubt infuriated the Greenies, who have embarked on an global offensive to stop all dam-building, particularly in the developing nations of Asia and Africa, where it is needed the most. Malaysia plans to build 12 hydroelectric dams in the Sarawak province of Borneo. Malaysian and Swiss (yes, Swiss!) protestors presented a petition to the UN office in Geneva, with 6,000 signatures protesting the dam project.

Impoverished Laos hopes to build 60 dams to become what it calls an electric "battery" for Southeast Asia. This too has been met by protests by the international Green movement. Brazilian dams on the Amazon River have also met with protests. Unable to stop the Three Gorges in China, the Greens have targeted China's dam-building in Africa, where China is constructing or financing numerous water projects in Sudan, Zaire, Ethiopia, Nigeria, Zambia, and Ghana.

Assistance from the United States for construction of the Three Gorges Dam had been forthcoming in the beginning, when closer relations with China were established under the Reagan Administration in the 1980s. When construction began in the 1990s, the Clinton Adminstration also considered assisting China's great project. But the Greenie movement, with Vice President Al Gore as its chief spokesman—he had been handed the environmental portfolio by President Clinton—succeeded in sabotaging that cooperation, and prevented the U.S. Ex-Im Bank from providing any funding whatsoever for the dam's construction.

Even now, following its completion, the Greenies have continued their campaign against the dam. As recently as last year—a year of significant drought in China as a whole—Greenie critics claimed that the cause of the drought was the construction of the dam, and said the dam's reservoir was "depriving" the natural lakes downstream of water. The recent floodings, however, effectively "drowned out" all talk about the dam creating a drought. The achievements of the Three Gorges Project, in the face of the worst flood in decades, is there for all to see.

But the flood season is far from over. "Controls will not be eased back any time soon, as rainfall is again expected on upper reaches of the Yangtze," Three Gorges Corporation informed the public. And Premier Wen Jiabao, visiting the devastation in the southern provinces, has called for vigilance during the next few days as rains are still forecast for most of the country.

But the people of the Yangtze Valley can rest assured that this great bastion at the foot of the Three Gorges is keeping careful watch over the flow of water, protecting the nation from its worst ravages.

Yangtze Water to the Arid North China Plain

For the Chinese government, the Three Gorges Project has another important function: to bring the water of the Yangtze to the arid northern plains region. China is generally water-short, due to an arid climate and insufficient water-management programs.

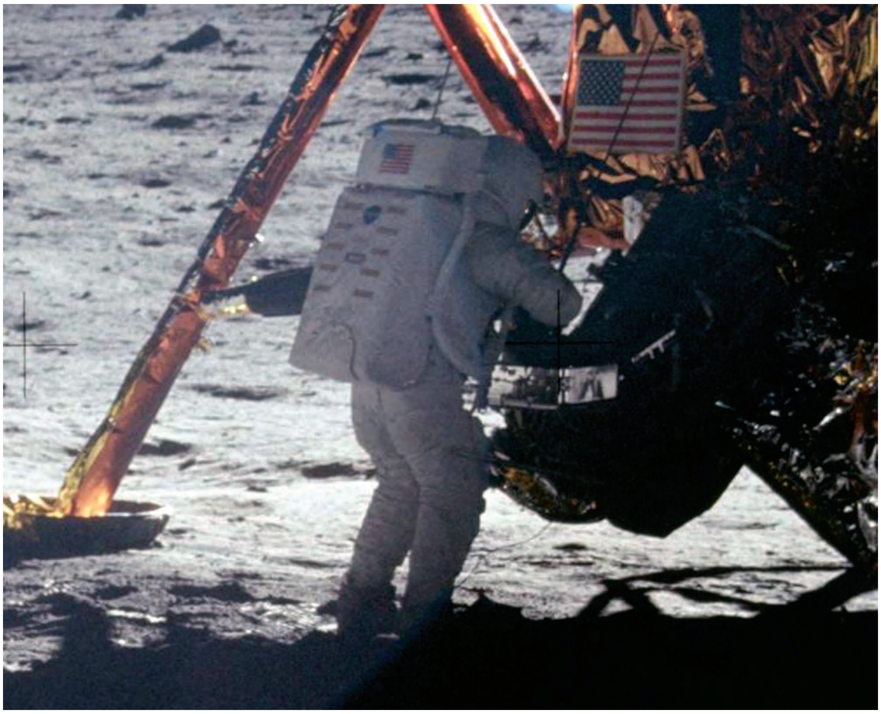
In spite of the massive flooding this year, the North China Plain is generally extremely arid. This region contains one-third of China's population, and cultivates two-fifths of its farmland, but contains less than 8% of the country's water resources. The region depends upon groundwater for 60% of its water usage. At the present rate, experts fear that the groundwater will be exhausted in 30 years. Therefore, the government has launched the South-to-North Water Diversion Project, to bring water from the Yangtze to the heavily populated northern cities and to the Yellow River.

Three South-North routes have been laid out, but construction has only started on two of them. The easternmost branch will follow an ancient water route, the Grand Canal, which will bring water from Hangzhou, a city northwest of Shanghai, to Beijing. The Grand Canal has been in use for maritime traffic since ancient times, but requires a significant makeover and cleaning, as it has become heavily polluted through the centuries. Additional water can be pumped into the canal from the Yangtze River when it reaches it on its way north from Hangzhou.

The central route will be built largely from scratch, taking water from the Danjiangkou reservoir, which is fed by the Han River, a tributary of the Yangtze, and tunneling under the Yellow River to bring water to Beijing. To alleviate concerns that this might significantly drain the water in the Han River, there are proposals to build a second tunnel from the Three Gorges reservoir to the Danjiangkou reservoir tunnel to maintain its level.

The third, westernmost, leg of the project remains to be finalized. There are additional concerns here, as it would bring water through the Ningxia-Tibet Plain, a sensitive ecological area, and one with difficult mountainous terrain which would have to be tunneled. Here the Greenie opposition converges with the ethnic Uyghur and Tibetan independence movements to give the authorities additional political headaches. The western leg is aimed at replenishing the Yellow River with water from the upper reaches of the Yangtze and its tributaries, for irrigation in the Gansu-Ningxia region.

The Three Gorges Dam project has been labeled the greatest water-management project in the world—and until the realization of the NAWAPA project in the western United States and Canada, it will no doubt remain so.



NASA

Neil Armstrong's "small step" off the lunar lander on to the surface of the Moon on July 20, 1969 fulfilled a dream of generations. It was, Armstrong always stressed, the dedicated work of hundreds of thousands of Americans, which made the first lunar landing possible.

Neil Armstrong: 1930-2012 The Mission and the Man

by Marsha Freeman

The death of former Apollo astronaut Neil Armstrong, on Aug. 25, obliges us to remember who we are, and where we are going. His footprints on the Moon, made on July 20, 1969, were celebrated around the world as the greatest technological triumph of the 20th Century, and the fulfillment of the dream of past civilizations. It was the quintessential expression of what it means to be human.

The Apollo program was an expression of the optimism for the future of President John F. Kennedy, and of a generation which had defeated fascism in the Second World War, and saw the remainder of the 20th Century as an opportunity to take man to new heights. For Armstrong, it was not his personal accomplishment, but a product of the tireless efforts of nearly a half million Americans who made the success of his mission possible, and whom he felt deserved the credit.

The Apollo 11 mission was watched with breathless anticipation by hundreds of millions around the world, some of whose governments had brought access to television to their nation, just so their people could see history in the making. The plaque that the Apollo 11 astronauts left on the surface of the Moon, announced that they had come, not for the greater glory of the United States, but "in peace for all mankind."

But the first lunar landing also came at a time when American society was in great upheaval; when the Constitutional foundations of this Republic, which were the foundation for the success of Apollo, were being buried under anti-science, anti-social anarchy, and political mediocrity. The very concepts that drove the Apollo program—that there are no limits to human creativity; that it is the responsibility of the Republic to provide for the "general welfare" of its citizens, and that this is realized through great national projects; that it is technological progress that is the measure of the health and wealth of our society—were all being challenged.

When, in May 1961, President Kennedy instructed NASA to "land a man on the Moon and return him safely to the Earth" by the end of the decade, knowledgeable people at the space agency thought there was a 50/50 chance that NASA could do it. When Neil Armstrong lifted off on July 16, 1969 to fulfill the President's Apollo mandate, he gave his mission the same odds for success.

But the President had given the nation a mission. He had announced it before a joint session of Congress, and before the American people. He said the mission would be dangerous difficult, and costly. And he advised that if the Congress were not prepared to support the effort to go all the way, it were better not to go at all. The Apollo program succeeded because the nation had a mission.

All of the Apollo astronauts trained long and hard for their flights. Any one could have been given the privilege of being "the first man." This assignment was given to Armstrong because he best symbolized what the first manned landing on the Moon would represent for all of human history.

Neil Armstrong had been fascinated by aviation as a youngster, and had his pilot's license at the age of 16. In 1949, he signed up for Navy flight training, and after the Korean War, earned an aeronautical engineering degree at Purdue University. Six years later, he joined NASA's predecessor, the National Advisory Committee for Aeronautics, and test-piloted an array of research planes. In 1962, he applied to become an astronaut.

Armstrong proved his mettle in the first in-space incident which could have ended in disaster, during the Gemini 8 attempt to rendezvous and dock with another spacecraft. Here was a man, having flown 78 combat missions in the Korean War, who could call upon what he knew to stay focused under stress.

But it was his "lack of ego," as described by Apollo flight control director Chris Kraft, which was a decisive factor in NASA's choice. For Armstrong, it was not his personal glory, it was the mission. After retiring from NASA, rather than seeking fame or fortune, Armstrong continued the mission. He had already inspired many thousands of young people around the world, who had seen him walk on the Moon, to follow in his footsteps. He became a professor of Aerospace Engineering at the University of Cincinnati, educating the next generation of scientists and engineers. He lent his expertise to smaller high-technology companies, to help them solve the engineering challenges they faced.

No one contributing to the Apollo program throughout the 1960s ever considered that the first handful of Moon landings would be the end of lunar exploration, but, instead, just the beginning. In his message to Congress in 1961, in addition to the lunar mission, President Kennedy had recommended increasing funding for the space nuclear power program, so man could go even farther than the Moon in the future.

House Committee on Science, Space, & Technology

After decades of staying out of the public limelight, Neil Armstrong traveled to Capitol Hill, to protest President Obama's cancellation of NASA's manned space exploration program. Here Armstrong (speaking), and Apollo 17 Commander Gene Cernan, testify at a hearing Sept. 22, 2011, to consider the future of NASA's human space flight programs.

In speeches in later years, Armstrong lamented the discarding of a long-range plan for space, beginning with the Nixon Administration's cancellation of the follow-on lunar program in the early 1970s. Then, in 2004, there was hope that the Constellation initiative of President George W. Bush would reestablish the return to the Moon and later manned missions to Mars, as the nation's goals for space exploration.

Former NASA Administrator Mike Griffin, upon learning of Armstrong's death on Aug. 25, stated that the "real lessons from his life lie in how he behaved in the 43 years after Apollo 11. He showed us how to be famous with dignity, how to be celebrated without becoming a celebrity, and how to do it with a gracious modesty and the unyielding courage to do the right thing as he saw it."

When President Obama cancelled the Constellation program in 2010, Armstrong had "the unyielding courage" to do what he did very rarely in public—speak out. Never one to come to the nation's capital seeking publicity, but generally at the behest of the White House to celebrate an Apollo anniversary, Armstrong traveled to Washington to "do the right thing," and testify before Congress, in the Spring of 2010.

'Descent into Mediocrity'

Campaigning for the Presidency in 2008, Barack Obama had proposed that NASA's Moon-Mars Constellation program be "delayed"; that instead of a space mission, those billions of dollars be put into some undefined programs in education. Under pressure from Space Coast political figures and citizens in the electoral swing state of Florida, the campaign was forced to backtrack somewhat. But the incoming Obama Administration was determined to kill the manned space program.

In the February 2010 submission to the Congress of the White House's proposed NASA budget for fiscal year 2011, the Constellation program was cancelled. The Congress was outraged. So was Neil Armstrong.

In April, Armstrong penned a letter to President Obama, also signed by Apollo 13 Commander James Lovell and Apollo 17 Commander Gene Cernan, warning the President that his cancellation of Constellation was "devastating" to America's leadership in space. Hiving off Earth-orbital space transportation to the private sector, and cancelling the Ares I rocket and Orion space capsule, meant that the U.S. "is far too likely to be on a long downhill slide to mediocrity," they stated.

In extremely rare public appearances in front of television cameras, Armstrong testified before the Committee on Commerce, Science, and Transportation on May 12, and before the House Committee on Science and Technology two weeks later. In direct juxtaposition to the statements of his Apollo 11 crewmate, Buzz Aldrin, Armstrong ridiculed Aldrin's statement, repeated by Obama, that there was no need to go back to the Moon, because we [meaning, Aldrin] had already "been there, done that."

"Some question why America should return to the Moon," Armstrong told Members of the House of Representatives on May 26. "I find that mystifying. It would be as if 16th-Century monarchs proclaimed that 'we need not go to the New World, we have already been there.' Or, as if President Thomas Jefferson announced in 1808 that Americans need not go west of the Mississippi, the Lewis and Clark Expedition has already been there.' Americans have visited and examined six locations on Luna," he stated. "That leaves more than 14 million square miles yet to explore."

Armstrong challenged each specific proposed policy change of the Administration, explaining that the end result would be that America would be abandoning its half-century of leadership in space exploration. Putting his credibility on the line, for a cause that he felt passionately about, he would neither mince words, nor compromise.

Immortality

During the May 26, 2010 House hearing, Rep. Michael McCaul, Republican from Texas, addressing Armstrong, said: "One thousand years from now, no one in this room will be remembered, except for you." While it is certainly the case that Armstrong has achieved a secure place in the history of civilization, there is no assurance that his immortal contribution will not be lost for generations into the future, without concerted action to change the present.

In 2005, actor Tom Hanks, an enthusiastic supporter of space exploration who had portrayed Commander Lovell in the film "Apollo 13," produced and narrated a movie, "Magnificent Desolation: Walking on the Moon 3D." His reason for making the film was his concern that the lunar landing, which he describes an "an evolutionary step" in mankind's development, and Neil Armstrong himself, were losing their immortal place in universal history.

Hanks makes this point clear in the opening scene of the film, where children at the California Science Center are asked to name the first man who stepped on to the Moon. The responses are disappointing.

Today, as Armstrong has eloquently insisted, the nation is on the verge of throwing away, not only a half-century of stunning breakthroughs in science and technology, but the promises for the future that were the fruit of those accomplishments.

In 2005, at the age of 75, Armstrong was asked by CBS's Ed Bradley if a later mission to Mars was something he would consider, at this point in his life. "I don't think I'm going to get the chance," he responded. "But I don't want to say that I'm not available."

With the passing of Neil Armstrong, one is reminded of the words spoken by Secretary of War Edwin Stanton, early on the morning of April 15, 1865 as he left the bedside of the just-deceased President Abraham Lincoln: "Now, he belongs to the ages."

And now is the time to take responsibility for ensuring that the accomplishments of Neil Armstrong and the Apollo program are but the stepping stones to the missions of exploration that lie in the future.

Curiosity Will Open a New Chapter In Man's Understanding of Mars

by Marsha Freeman

NASA/JPL-Caltech

Gale Crater was chosen as Curiosity's landing site, because the 3.4-mile high Mount Sharp is located at its center. The aim is to drive the rover to investigate the history of Mars, through the lower layers of the mountain, which would be oldest. If the rover can negotiate up Mount Sharp, we will see changes that have taken place more recently on the planet, as well.

The successful landing of the Mars *Curiosity* rover early on Aug. 6 opens a new chapter in what has been a continually re-written history of Mars. *Curiosity's* current mission builds upon a 50-year legacy of breakthroughs in planetary exploration.

Mars has undergone dramatic changes over billions of years, in its geology, chemistry, topography, hydrology, and atmosphere. But in the past few decades, Mars has experienced *revolutionary* changes, in the mind of man. Through a carefully crafted series of unmanned missions to the Red Planet that began nearly a decade ago, man has sent increasingly complex representatives of his extended sensorium, to observe and probe a planet that might have once supported life. It is we who have "changed" the planet Mars.

From Earth-based telescope observations, Mars was thought by Italian astronomer Giovanni Schiaparelli in 1877 to have "channels," then mistranslated as "canals," which were thought to have been built by intelligent beings. But man's first preliminary look at Mars, from quick fly-bys of the planet in the mid-1960s, revealed what looked, disappointingly, like the lifeless Moon—barren, dry, cold, bombarded for millennia by asteroids and comets, devoid of any possibility that there could have been life.

Then, in 1971, Mariner 9 orbited the planet for the first time, and for almost a year, took a closer look. It showed us a new Mars, one that has the largest volcano in the Solar System; channels and dry lake beds, most likely formed by liquid water; indications of a warmer past, and an environment that might have been hospitable to life. From the Mariner 9 results, an ambitious Viking mission was planned, to land spacecraft, for the first time, on the surface of Mars, and carry out an *in situ* investigation of this increasingly mysterious place.

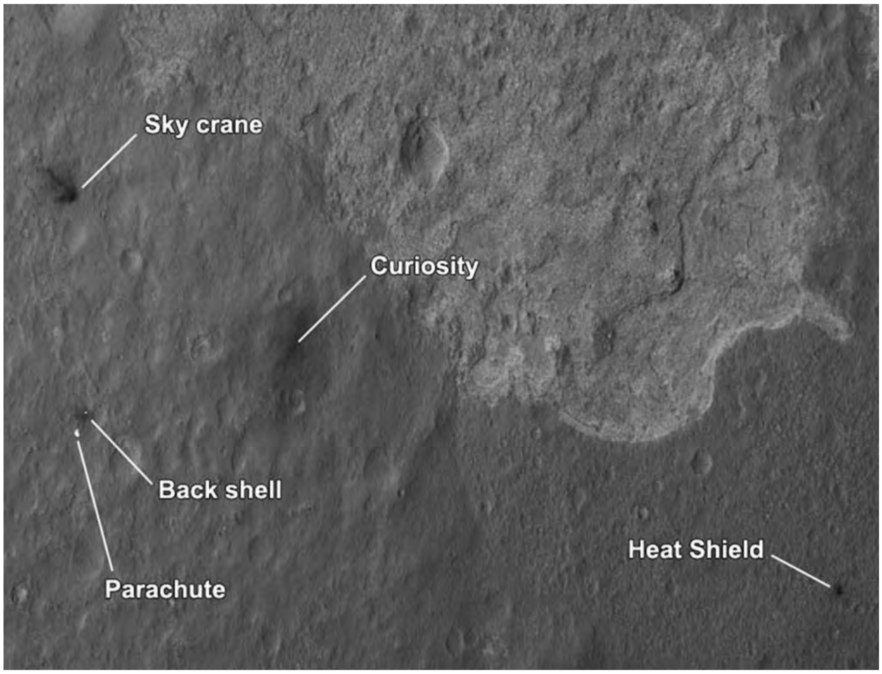
Looking for Life

Viking's mission, launched in 1975, was an extremely ambitious one: to look for evidence of life on Mars. Based on a very preliminary understanding of the complex chemistry and other features of the planet, Viking's scientific instruments, investigating Mars' surface, only provided contradictory results as to whether or not organic material, which could indicate the presence of past or present life, were found. The "consensus" in the scientific community, that no indication of life was found by Viking, put on the back burner plans for any future missions to pursue the direct detection of life.

But interest in understanding the red planet—the one most similar to Earth in our Solar System—suffered only a temporary hiatus. If life never existed on Mars, "Why not?" would be as important a question to answer as, "How did it?" Scientists stepped back from the "life" question, to begin an effort to gain a more comprehensive understanding of Mars. "Follow the water," based on the proposition that liquid water is prerequisite for life, became the theme for the next two decades.

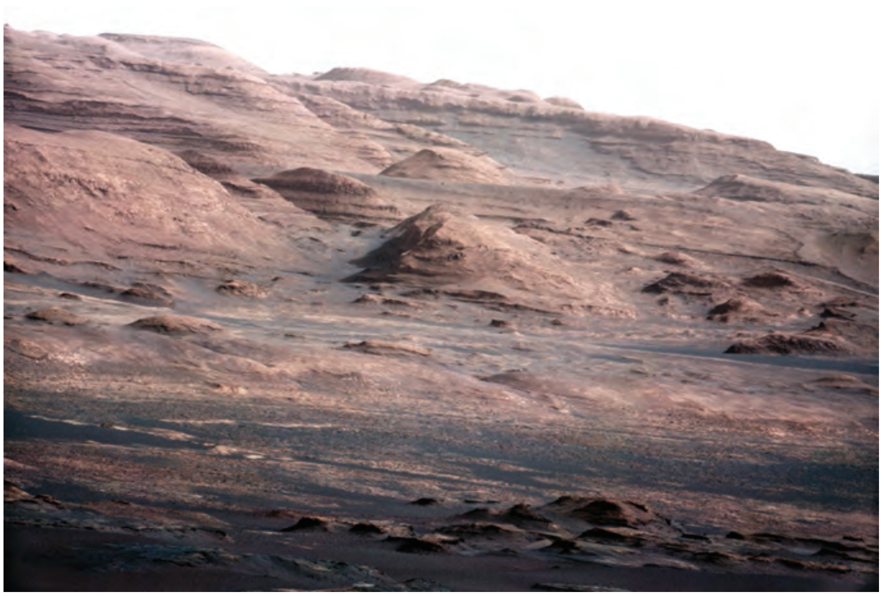
Mars Global Surveyor, launched in November 1996, arrived at the Red Planet in September of the following year. Just four days after being inserted into orbit around Mars, the spacecraft discovered a remnant magnetic field there, possibly a requirement for life. Over its nine-year mission, the orbiter discovered extensive layers in the planet's crust, ancient deltas, channels which appear to exhibit relatively recent activity, and minerals that form under wet conditions. It also served as a communications relay for the Mars Exploration rovers, Spirit and Opportunity.

Just a few months before Global Surveyor began its journey, on Aug. 7, 1996, scientists had announced a stunning observation. They had been given a gift—a piece of Mars that had been ejected from the planet billions of years ago, eventually to land in Antarctica. Meteorite ALH84001 (a piece of which can be seen in the National Museum of Natural History, in Washington, D.C.) was found to contain carbonates, and tiny structures, evocative of minuscule worm-like creatures on Earth. Although, still today, the debate continues over whether ALH84001 contains fossil evidence of life on Mars, the meteorite helped to spur the next series of Mars missions that were being planned.



NASA/JPL-Caltech/Univ. of Arizona

NASA's Mars Reconnaissance Orbiter (MRO) captured this photograph of the major elements used in the complex landing sequence of the rover. With the rover near-center, the Sky Crane, which lowered the rover gently down to the surface, is visible. The back shell and heat shield were jettisoned before the Sky Crane was deployed. The parachute was the largest planetary parachute ever built. MRO took this photo about 24 hours after landing.



NASA/JPL-Caltech/MSSS

Curiosity landed in Gale Crater in order to investigate the geological history of Mars. This image, taken on August 23 with the rover's Mast Camera, shows the base of Mount Sharp, the Rover's scientific destination, with its layered terrain, possibly laid down by the action of flowing water. Between Curiosity and the mountain are a dark sand dune field, and redder sand, suggesting an array of different geochemical compositions.

Mars in two decades, and the first-ever rover, made it to the surface of the planet. The Pathfinder mission, and its diminutive, 25-pound rover Sojourner, were designed mainly as a technology test-bed for more complex future missions, but contributed our first up-close look at the surface since Viking. Pathfinder sent back extensive data on wind and weather on Mars, more than 17,000 images, and more than 15 chemical analyses of rocks and soil.

After two mission failures in 1998 and 1999, the next U.S. craft to arrive at Mars, in 2001, is the one that, today, is the prime communications relay satellite for *Curiosity* data to be sent to Earth—Mars Odyssey. Early on, its gamma-ray spectrometer provided strong evidence for large quantities of frozen water, mixed in to the top layer of soil, near the North and South poles. Later, a site in this region was chosen as the target for the near-polar Phoenix Mars Lander.

Odyssey's cameras have identified minerals in Martian rocks and soils, and compiled the highest-resolution global map of Mars. Its observations helped to identify potential landing sites for the Spirit and Opportunity rovers, the Phoenix lander, and *Curiosity*. For over a decade, Odyssey has monitored the atmosphere of Mars which data was critical for predicting the possible range of weather conditions during *Curiosity*'s highly-complex landing.

The Curiosity Mars Rover

Curiosity, weighing nearly 2,000 pounds, has a robotic arm with a reach of seven feet, and stands seven feet tall. Its mission is to investigate Gale Crater, to assess whether the area could have been a habitat for life.

Atop the mast is the Mastcam, two color cameras which will show the rover's surroundings in exquisite detail.

ChemCam, mounted on the mast, will investigate rocks, using a laser to create a glowing plasma, or ionized gas, from a small piece of the rock's surface. The light from the plasma will be studied by three spectrometers, to determine their elemental composition.

The **Rover Ultra High-Frequency Antenna (RUHF)** and the **High Gain Antenna** will send and receive data to and from orbiting spacecraft, and directly to Earth.

The **Multi-Mission Radioisotope Thermoelectric Generator (MMRTG)** will allow the rover to operate its suite of 10 scientific instruments, over a two-year period. As the generator's 10.6 pounds of plutonium dioxide decays, the heat will be converted to 110 watts of electricity to power instruments and recharge the rover's batteries.

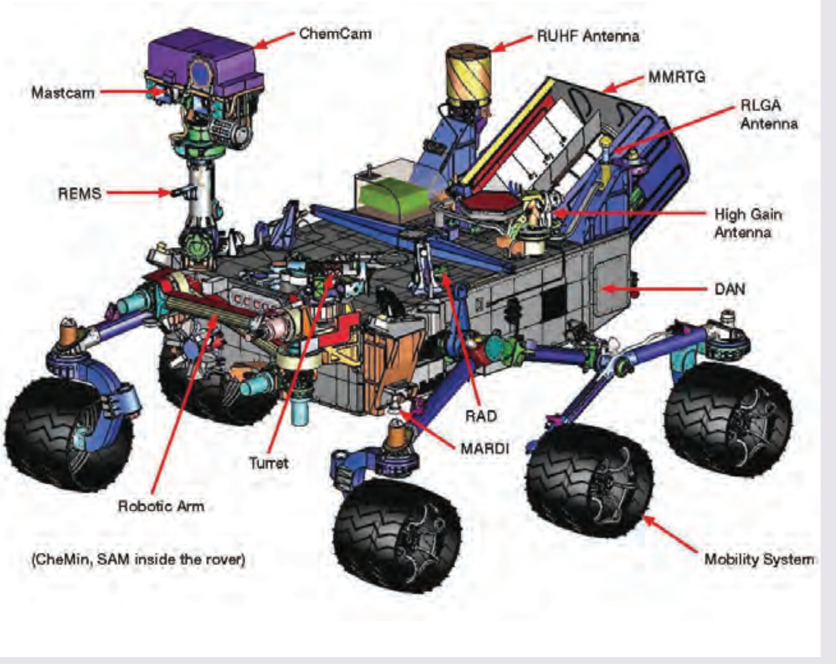
The **Dynamic Albedo of Neutrons (DAN)** investigation, contributed by Russia, will detect water bound in underground minerals, using neutrons to see how they scatter to identify hydrogen.

The **Radiation Assessment Detector (RAD)** has already measured galactic and solar radiation during the trip to Mars, and will provide a detailed profile of radiation on the surface.

The **Chemistry and Mineralogy (CheMin)** experiment will analyse powdered rock and soil samples that are delivered by the rover's robotic arm. It will identify the full range of minerals in the samples.

The **Sample Analysis at Mars (SAM)** investigation will use three analytical tools to study the chemical state of carbon compounds in the soil and the atmosphere.

The **Rover Environmental Monitoring Station (REMS)** is the Spanish-built weather station, recording wind, temperature, pressure, humidity, and ultraviolet radiation.



Spirit and Opportunity, Mars' first mobile field geologists, landed in early 2004, and confirmed the past presence of liquid water on Mars. During its investigation of the Columbia Hills, Spirit discovered rocks and soils bearing minerals providing evidence of extensive exposure to water.

Opportunity's findings were a clincher: inside a small crater, the roving geologist examined an outcrop of bedrock. Not only had the rocks been saturated with water, but they had been laid down under the surface of gently flowing water. The presence of the mineral hematite, which had been identified from orbit by Mars Global Surveyor, was verified by Opportunity. Some hematite presented itself in the form of nearly-perfect spherical shapes, termed "blueberries" by the scientists, likely formed in flowing water.

Intriguing Observations

Following the excitement of the "new" Mars that was emerging before our eyes, the European Space Agency (ESA) decided to embark on its own Mars exploration program, and in June 2003, ESA's Mars Express went into orbit around the planet. The spacecraft has been able to identify deposits of clay minerals, similar to what *Curiosity* will encounter at Gale Crater, indicating a past wet environment. One intriguing observation by Mars Express was the detection of methane in the atmosphere. Since methane from the past would break down too rapidly to be detectable in the atmosphere today, it is apparently still being produced there. Although there are various ways that methane can be produced on Mars, one is by life.

Since 2006, the Mars Reconnaissance Orbiter (MRO) has been on station. It is now beaming back data from *Curiosity*. MRO has shown us three distinctly different time periods of Mars, and that it is still a dynamic world. It has observed dust storms, new craters, and avalanches. MRO has tracked the cycling of water from Mars' poles through its atmosphere, shown the effect of cyclical variations in the tilt of its axis of rotation, and deep deposits of carbon-dioxide ice buried in the solar cap.

In 2008, the *Mars Polar Lander* verified deposits of underground water ice, first detected by Mars Odyssey from orbit. But its groundbreaking surprise observation was the detection of perchlorate, which is food for some microbes, and a chemical that can lower the freezing point of liquid water, perhaps enough to allow liquid water to exist in otherwise below-freezing environments.

The team of more than 700 scientists around the world who conceived *Curiosity* have waited nearly a decade for the mission's realization. In April 2004, NASA announced an opportunity for researchers to propose science investigations for the mission. Eight months later, NASA announced the selection of eight experiments, and also scientific investigations, through international agreements, by Spain and Russia. Over the next few weeks, their wait will be over.

It is the past discoveries about Mars, and the infrastructure that has been built in orbit around the planet over decades, that have enabled the breakthroughs that *Curiosity* will make.

Shuttle Opened the Next Space Frontier

by Marsha Freeman

NASA

Over its 30 years of service, NASA's Space Shuttle fleet's most long-lasting accomplishment was the construction of the International Space Station, seen here in May 2011, with the Shuttle orbiter Endeavour docked to it, on the left. Over the coming decades, what is learned on the Station will lay the basis for deep-space missions to come, such as those of Mars exploration.

The transport on April 17 of the Space Shuttle orbiter *Discovery*, from its home base at the Kennedy Space Center in Florida, to its retirement home near Washington, D.C., allowed the American public to reflect upon what this unique space exploration capability had accomplished over its 30 years of service.

But the reason that thousands of people in the Washington area and beyond took their children out of school, and stood on rooftops, bridges, and highways as *Discovery* circled overhead, was not to reminisce, but because it reminded them that space exploration defines the task for the future, a future that is being robbed by the Obama Administration. If there were any feeling of melancholy among the Shuttle workers accompanying *Discovery* or the citizens who saw her that day, it was not because the Shuttle is being retired, but because there is nothing to replace it.

Over three decades, the Space Shuttle fleet of five orbiters carried out extraordinary missions: launching science probes to the farthest reaches of the Solar System; deploying telescopes, including the Hubble Space Telescope, that could peer farther into the Universe than any instrument before them; repairing errant satellites; and opening space travel, for the first time, to scientists, engineers, school teachers, and others from dozens of nations around the world.

But the Space Shuttle's true legacy is what it has done to help create the future.

Preparing for Mars

After the first manned landing on the Moon, in July 1969, NASA put for-

EIRNS/Marsha Freeman

All of the astronauts who have commanded missions aboard Discovery were present at the orbiter's roll out. The mission for the fleet now, they all stressed, is to inspire the next generation of space explorers.

EIRNS/Stuart Lewis

Over its lifetime, Space Shuttle Discovery completed 39 missions in orbit, traveled more than 140 million miles, and spent 365 days in space. The wear and tear on the vehicle was clearly seen when it was rolled out (right), for the ceremony to transfer it from NASA to the National Air & Space Museum. The Enterprise, in pristine condition (left) never flew in space, but was used for aerodynamic testing, and is externally identical to the flight-worthy orbiters. It will be on display at the Intrepid museum in New York City.

ward a three-phase program to build upon the accomplishments of Apollo: As lunar exploration continued, a reusable space transportation system to low Earth orbit would be used to build an orbiting space station. *This would lay the basis for later manned missions to Mars*.

The Space Shuttle fleet was the enabling capability to build the permanently manned International Space Station (ISS), which is the home and workplace for six crew members. On board, experiments underway are discovering the deleterious effects of microgravity on human physiology, the increased virulence of harmful bacteria and viruses, and palliative measures that could keep crew members healthy.

Partial-gravity centrifuges on the station could give us a preview of the challenges that living in a one-third Earth-gravity on Mars will present to future colonists. There are discussions underway to simulate the multi-minute lagtime in communications that will exist between a crew on Mars, and Mission Control in Houston. New technologies, such as plasma rockets for propulsion, will be given a trial-run on the station, before they are deployed to deep space.

It is at the ISS that mankind will prepare for missions back to the Moon, and later, to Mars.

Inspiring the Next Generation

Throughout the ceremonies and celebrations for *Discovery*'s transfer from NASA to the Smithsonian Institution's National Air & Space Museum, the top NASA leadership continued its campaign to try to deny the indefensible shutdown of the nation's manned space program, by the Obama Administration. By all accounts, very few people were convinced.

At the *Discovery* transfer ceremony on April 19, former astronaut and former Sen. John Glenn expressed his disappointement that the Shuttle fleet was being prematurely retired, and that the orbiters will now be museum exhibits. He had personally appealed to the White House after President Obama came into office, to reverse President Bush's policy to retire the Shuttle fleet, before there were a replacement.

Not only did the Obama Administration not reverse that foolish decision, it proceeded to *cancel* the next-generation Constellation manned space-flight program.

The space program represents "America's pioneering nature," Glenn said, and the main job of the Space Shuttle orbiters now, is to inspire the next generation of explorers.

War Against The Weak: Unfortunately, a Weak Work

by Denise Ham

War Against the Weak, Eugenics and America's Campaign To Create a Master Race
Edwin Black
New York: Thunder's Mouth Press, 2004
Paperback, 592 pages

The world has recently celebrated the birth of the 7 billionth baby–or, at least some of us celebrated. In Russia, Vladimir Putin presented a bouquet of flowers to a mother in Russia that may have born that child; while elsewhere, there is a steady stream of nazi-style propaganda against population growth with demands for the reduction of the world's population to only 1 billion people.

The Mythology of 'Overpopulation'

The first written epic regarding "overpopulation" was written in Babylon and is known as the Atrahasis epic. It was composed around 1600 B.C. and had 1245 lines on 3 clay tablets:

Twelve Hundred years had not yet passed
When the land extended and the people multiplied.
The land was bellowing like a bull,
The god got disturbed by their uproar.
Enlil heard their noise
And addressed the great gods:
"The noise of mankind has become too much for me,
With their noise I am deprived of sleep.
Let there be a pestilence [upon mankind].

The myth continues and explains how the gods inflicted plagues, floods, and war to destroy humanity. The capricious gods then decided to allow the human race to flourish again.

According to this work, man is merely a beast, created to feed and glorify the gods. The gods then created priestesses to impose their will, in determining who shall and who shall not procreate. They even created a special demon to destroy infants and children.

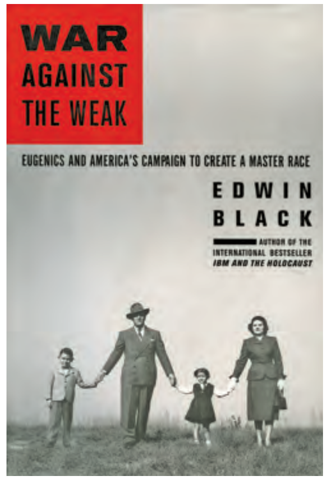
"[Let there be] fertile women and barren women. Let there be the eradicator... among the people and let her snatch the child from the lap of the mother. Establish ughabtu-women, entri-women and igisitu-women and let them be taboo and cut off [from] child-bearing." [1]

Later, Homer refers to the Olympian, King Zeus, who wanted wars, famine, and disasters to strike Man, so that humanity could be culled like cattle. Zeus, it was said, created Helen (of Troy) to be so beautiful, that Paris would steal Helen from Menelaus and start the Trojan war. The war lasted a decade, Troy was destroyed, and only Odysseus survived the ten-year journey home.

The overpopulation card has been played going back thousands of years, and it is about time people understood that those individuals who are dealing the deck are oligarchical cheats.

In his book, *War Against the Weak,* Edwin Black documents in great detail the American side of the eugenics movement, and as far as that goes, he does expose those in powerful places

1 "How many people can the earth support?" by Joel E. Cohen, 1995.



who used their own hatred of mankind to sterilize men and women based on class, race, and intelligence.

For example, who said the following?

"I agree with you... that society has no business to permit degenerates to reproduce their kind.... Some day, we will realize that the prime duty, the inescapable duty, of the good citizen of the *right* type, is to leave his or her blood behind him in the world; and that we have no business to permit the perpetuation of citizens of the *wrong* type."[2]

Sound like Adolph Hitler? Himmler? Dr. Mengele? No, this is a quote from President Teddy Roosevelt, in a letter to Charles Davenport, the Director of Eugenics Record Office and Secretary of the American Breeders Association (part of the Department of Agriculture). Davenport, a zoologist, and the recipient of distinguished degrees from Harvard and other universities, was a leading figure in the American side of the British born "eugenics movement."

Davenport raised a considerable amount of money to create the Station for Experimental Evolution at Cold Spring Harbor in New York. The money came from the Rockefellers, the Carnegie Institute, and other "philanthropists." Mrs. E. H. Harriman donat-

2 Emphasis mine.

ed over half a million dollars in the first few decades, while John D. Rockefeller gave over $35 million, and in 1911, the Carnegies doled out over $10 million.

Rockefeller wrote to Davenport about a plan to imprison female "feebleminded criminals" for longer periods of time to keep them "from perpetuating [their] kind ... until after the period of child bearing had been passed.

Davenport told the American Breeders Association: "Society must protect itself; as it claims the right to deprive the murderer of his life so also it may annihilate the hideous serpent of hopelessly vicious protoplasm... such mongrelization as is proceeding on a vast scale in this country.... Shall we not rather take the steps... to dry up the springs that feed the torrent of defective and degenerate protoplasm?"

Here is the rub: Black says right on the jacket of his book, "... eugenics began in laboratories on Long Island, but it ended in the concentration camps of Nazi Germany," and "it started in 1904, when a small group of U.S. scientists launched an ambitious new race-based movement that was championed by our nation's social, political and academic elite." In actuality, the eugenics movement was born and bred in Britain. Black has scant references to Thomas Malthus or Charles Darwin and he mainly refers to the way in which "British eugenic science and doctrine were almost completely imported from the United States." (See page 209) This is a serious error in historiography. Not only did the British use race science to justify their imperial looting of much of the world, but they used this filth to undermine and attempt to destroy the promise which the United States represented for the world — a republic which sought mutual trade and development with other countries.

Thomas Malthus, allegedly an English reverend, wrote the famous *Essay on the Principle of Population*, first published in 1824. A few quotes will give you a whiff of his view of Man:

"We are bound in justice and honour formally to disclaim the *right* of the poor to support. To this end, I should propose a regulation to be made, declaring that no child born from any marriage, taking place after the expiration of a year from the date of the law, and no illegitimate child born two years from the same date, should ever be entitled to parish assistance ...

The infant is, comparatively speaking, of little value to society, as others will immediately supply its place."

In Book IV, Chapter 5, he wrote:

"All children born, beyond what would be required to keep up the population to this [desired] level, must necessarily perish, unless room be made for them by the deaths of grown persons."

Malthus said that human population would grow and outstrip the potential output of agriculture and industry, just as the population growth of deer, mice or other animals grows until checked by famine or disease. He attacked the misguided doctors who sought to cure disease, and encouraged overcrowded slums in order to let nature "control" excess human population. But Malthus was not some misguided clergyman who failed to see how scientific discovery and technology could radically change the apparent "limits of growth" at any given time. It is truthful and revealing that Malthus was the first Professor of political economy in any British university, as he was an aggressive proponent of the economic system at the heart of the British Empire —deliberately keeping the colonial populations poor and uneducated, as in China, India, Egypt, Ireland and most of Africa.

Malthus explicitly argued that there must always be a large pool of starving, desperate poor, who would take any job at any wage. All the mumbojumbo of "population theory" was purely a cover for the policy of using human beings as cattle and perpetuating an economic and social policy based on that. This has always been the policy of the international oligarchy. The promotion of this garbage in the United States was part of an offensive to destroy the optimistic outlook of the American Revolution or accomplish the next best thing: to turn the United States into an empire like Great Britain. After the assassination of President William McKinley in 1901, America's anti-British leadership was crippled and the nation became vulnerable to British ideology, including race science.

In this still from The Black Stork*, Dr Haiselden refuses to operate to save the life of a developmentally disabled baby.*

The First International Eugenics Congress was held in London in 1912. Among the participants were Winston Churchill, Dr. Charles Davenport, Sir Francis Galton (the mentor of Teddy Roosevelt) and Dr. Charles Eliot, the head of Harvard University. The head of Stanford University, Dr. David Starr-Jordan, and Gifford Pinchot (the future Governor of Pennsylvania) were also in attendance.

Nine years later, in 1921, the Second International Eugenics Congress was held in New York City. Among those who sponsored the conference was Herbert Hoover, and the Presidents of Clark University, Smith College, and the Carnegie Institute of Washington.

In the aftermath of the real biological breakthroughs achieved by Louis Pasteur and others, the mortality rate in the industrial nations decreased dramatically, to the disapproval of the eugenicists. The planned depopulation of England and America was based, in part, on race, but not only included African Americans, but also the very poor among the white population. Other targets of the race genocide "...included alcoholics, petty criminals and those jailed for the non-payment of fines, the insane, the 'Constitutionally weak class,' those predisposed to certain diseases, the deformed, the developmentally disabled, and those with 'defective' organs including the blind and the deaf."

Since the end of WW II and the exposure of the atrocities committed in the name of race science, the eugenics movement has had to create a new

On *The Black Stork*

The Black Stork was a film written by Jack Lait, a reporter for the *Chicago American,* and was produced in Hollywood during the Woodrow Wilson administration. It should be noted that Wilson was not only an avowed racist, but he also praised the movie, *The Clansman*, also known as *The Birth of a Nation*. Due primarily to Wilson's support, the KKK grew by leaps and bounds, and had mass rallies in Washington, D.C.

The Black Stork is a true story based on the work of Dr. Haiselden, a man who would make Jack Kevorkian blush. Haiselden's co-thinker, Paul Popenoe, the author of applied eugenics, detailed how to stop feeblemindedness: "From an historical point of view... the first method which presents itself is execution.... Its value in keeping up the standard of the race should not be underestimated." Popenoe was the California head of the eugenics movement.

At about the same time, the President of the Eugenics Research Association made the point quite clear in his paper, *The Passing of the Great Race*:

"Mistaken regard for what are believed to be divine laws and a sentimental belief in the sanctity of human life tend to prevent both the elimination of defective infants and the sterilization of such adults as are themselves of no value to the community. The laws of nature require the obliteration of the unfit and human life is valuable only when it is of use to the community or race."

On November 12, 1915, Dr. Haiselden began the practice of letting babies starve to death, if they were deemed — by *him* — as too defective. The Hospital staff reacted with horror at this practice. One baby who appeared to have nothing wrong was killed in this manner. After Catherine Walsh, a friend of the baby's mother, went to Haiselden and confronted him directly as to why he had killed the baby. He laughed at her and responded:

"I'm afraid it might get well!"

This became a common practice in Chicago, and the despicable Haiselden brazenly spoke out in favor of infanticide. In 1917 the movie was released, entitled the *Black Stork*. Haiselden played himself in the film of a fictionalized account of a eugenically "mismatched couple," where he tells them they are likely to have a defective baby. The woman does give birth to a developmentally disabled baby, and Haiselden helps her starve the baby to death. In the film, the dead child's ghost rises in a cloud of smoke, and into the waiting arms of Jesus Christ.

The movie was popular for years, and played in theaters around the country for more than a decade. It was advertised as a "eugenic love story." One advertisement for the film instructed readers to: "Kill Defectives, Save the Nation and see the 'Black Stork'".

At one point, after starving yet another innocent to death, Haiselden's infamy came to national attention and Haiselden was called before an inquest. He declared:

"I should have been guilty of a graver crime if I had saved this child's life. My crime would have been keeping in existence one of nature's cruelest blunders".

A juror shouted: "What do you mean by that?!"

Haiselden responded: "Exactly that. I do not *think* this child would have grown up to be a mental defective, I *know* it."

At the inquest they decided that a prompt operation might have saved the child's life, and that the possibility of the child living a normal life was greater than thought. Despite this, they refused to indict him for murder. The inquest decided that Haiselden was within "his professional rights to decline treatment." Haiselden considered this a victory and a legal vindication for eugenics.

After the court's decision, a local reporter asked if this was eugenics. Haiselden replied, "of course it's eugenics." (!)

terminology and rationales for their policies of population control and enforced underdevelopment of much of the world. For example, Prince Phillip, the Queen's consort, once said that he would like to be reincarnated as a deadly virus to "help solve the problem of overpopulation." He and his Nazi buddy, Prince Bernhard of the Netherlands, founded the World Wildlife Fund, which explicitly attacks Man as being responsible for the extinction of certain animals, because there are too many people.[3] The WWF is a well-funded political action group that tricks people into supporting them financially with pictures of cuddly polar bears on melting ice floes in the Arctic. The big lie is: Man is polluting the earth, and causing the death of these creatures, therefore Man is evil. The environment, pollution, food scarcity, rising energy prices, and political turmoil are the modern "reasons" given to justify this ancient oligarchical evil.

3. "The Coming Fall of the House of Windsor," *Executive Intelligence Review*, Oct. 28, 1994

I would recommend the *War Against the Weak*, but to get a more complete view of the history of race science, I would also strongly suggest that you read: *The Legacy of Malthus: The Social Costs of the New Scientific Racism*, by Allan Chase. This book was written a generation ago in 1975, and is an indictment of the British Oligarchy, or the modern day Zeus Olympians.

The Legacy of Two Mars Rovers: Inspiration

by Marsha Freeman

The Mighty Mars Rovers: The Incredible Adventures of Spirit and Opportunity
Elizabeth Rusch
New York: Houghton Mifflin Harcourt, 2012
Hardcover, 80 pp., $18.99

It takes more than hard work, years of dedication, and adequate funding to bring to fruition a stupendously successful mission on Mars: it takes a passion that carries a team through the delays, the broken hardware and failed tests, and the challenges that are seemingly impossible to conquer, because they are millions of miles away. Many books about Mars have been written, but there is only a small handful that shows the reader this magnificent and constantly-changing planet through the eyes of the mission scientists and engineers. This is one.

Steve Squyres, the Principal Scientist for the Mars Exploration Rover (MER) mission, is the lead character of Elizabeth Rusch's book. When in college, "flipping through photos for inspiration," while visiting Cornell University's "Mars Room," Squyres was amazed at what he found in the mid-1970s Viking images: a planet that he was convinced once had lakes. "I walked out of that room knowing exactly what I wanted to do with the rest of my life," he reports.

Later, Squyres wrote proposals for a mission that would not only sit on the red planet, like the Viking landers, but would, as a geologist like himself, roam the planet, equipped to investigate the most interesting features it would find. For eight years, NASA rejected his proposals. Then, in the year 2000, NASA gave him the go-ahead, to design, build, test, and direct and manage two Mars Exploration Rovers, which would land on opposite sides of Mars. These were later named *Spirit* and *Opportunity*, by nine-year-old Sofi Collis.

What *Spirit* and *Opportunity* have endured—a challenging, bouncing air-bag-landing on Mars, dust storms, long, cold, and dark winters, sand traps, and equipment failures—was also endured by Steve Squyres and the MER team. There were tears of joy when the rovers landed, and a heart-felt sadness when *Spirit* could no longer communicate with the Earth. The scientists, rover drivers, and engineers interviewed for this book, all reflect their view of these two robots on Mars as extension of themselves, of the human drive and ability to explore.

Although advertised as a children's book, in the publishers "Scientists in the Field" series, and a magnificently illustrated book that will certainly keep young readers enthralled, it is a valuable explanation for readers of all ages, of what these two roving geologists discovered during their multi-year mission on Mars.

The final page in the book is a preview of the Mars Science Laboratory, now just starting its two-year science mission on the red planet. Perhaps Elizabeth Rusch will write a children's book about the adventures of *Curiosity*, in the future.

THE GOD PARTICLE

(The Secret in the Rabbit Hole)

by Frederick Harris

He was a curious physicist
Who chased a bit of matter,
Down the rabbit hole he went
Working up a lather,

On a frenzied mission for
The smallest part of life,
Slicing, dicing particles
With an atomic knife.

Cornering an atom
He cleaved it through the core,
Then juicing up the cyclotron
He carved it up some more.

He cut it even finer till
Like waves upon the ocean
All the matter that remained
Was just a sense of motion.

And then it came, that fateful day:
He pierced the final cloud,
When eagle cried and lion roared
As he tore away the shroud,

Yet no brass band was heard to play
'pon bursting through the hole—
For though the triumph of his life,
He could not tell a soul!

He burned his notes and barred the door
To the ridicule he feared
(With cross and nail he'd be impaled
By the clique he called his "peers")

So he told them all his test had failed
And hoped they'd buy the lie,
But wise to ploys are the "good old boys"
Who wear the old school tie!

His terror soon became complete
When they knocked upon his lab,
And gathered round, with sneer and frown
And sharp pencils for to stab!

They even had his pension there
And a shredder set to "shred."
No corner office for his books –
A shopping cart, instead.

But as he faced his worrying fears,
An ember dared to glow,
And as it flared, his shoulders squared
For he knew what he did know.

That fire blazed with brazen light,
And again came eagle's cry
And standing tall, he faced them all
For the lion need not lie:

"It's true I found the smallest part
"Of matter in my test,
"And what I tell you now, I say
"Without the slightest jest.

"And after I have told you all
"I sail for other clime
"And forswear my role as scientist
"Both now and for all time."

"You see,
"When I broke the atom down,
"Down to its smallest bit
"I found it would change on me
"Depending on my wit!"

"If I thought that it should be
"It certainly was, you see,
"But if I thought it shouldn't be,
"Well, it disappeared on me!

"If I thought it should be blue
"It glowed a sapphire deep
"If I thought it should be wet—
"You bet—soggy as the sea;

"You ladies and you gentlemen
"I know I face derision,
"But truth be told, the basic part
"Is simply: a decision!"

They laughed and laughed while stripping off
Diploma and Degrees,
And tittered then in ivy halls
Of his "regrettable disease,"

But before he left to that "other clime"
His exile to endure,
He boarded up that rabbit hole
So the secret was secure.

END