21st CENTURY SCIENCE & TECHNOLOGY

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CELEBRATING

Vladimir Vernadsky's

150th Year Anniversary

21st CENTURY SCIENCE & TECHNOLOGY

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Features

On the Cover: Vladimir I. Vernadsky. Painting by A.E. Yeletsky, 1949, Vernadsky Institute of Geochemistry and Analytical Chemistry.

News

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EDITORIAL

Vernadsky Was Not An Environmentalist

As we celebrate the 150th birthday of the great scientist Vladimir Vernadsky, it is of utmost importance to correct the gross misrepresentations of his work, particularly in the West, and to use his actual concepts to present an alternative to the anti-growth outlook (and scientific apparatus constructed to support it) of such groups as the Club of Rome, which have been promoting this outlook since the late 1960s.

Vernadsky, who founded the science of biogeochemistry, fostered the development of radiochemistry, and coined the term "noösphere," observed that the evolution of living matter is proceeding in a definite direction. This direction was seen in such characteristics as increasing biogenic migration of atoms, increased energy use by life, and by the development of the nervous system: the "cephalization" noted by American scientist James Dwight Dana.[1] Instead of looking for the principle of "life" itself, which he believed usually led to philosophizing rather than useful scientific advancement, Verandsky studied living matter, the totality of living organisms. Just as the evolution of life and "living matter" moves in a definite direction, and is seen only in the record of living matter on Earth (Vernadsky did not see evolution in purely abiotic layers of the Earth), so does the development of humanity's social power. Vernadsky wrote, in his "Some Words About the Noösphere:"

"Mankind taken as a whole is becoming a mighty geological force. There arises the problem of the *reconstruction of the biosphere in the interests of freely thinking humanity as a single totality.* This new state of the biosphere, which we approach without our noticing, is the noösphere."

"[M]an beomces a *large-scale geological force.* He can, and must, rebuild the province of his life by his work and his thought, rebuild it radically in comparison with the past."[2]

This outlook, of developing the noösphere in accordance with man's reason, in the spirit of development seen in the biosphere across evolutionary time, runs directly contrary to the zero-growth outlook of environmentalist, back-to-nature, and similar groupings from the late-1960s to today. While Vernadsky opposed Malthus's claim that limited resources fundamentally constrained man's activity, his work was first popularized in the West by such writers as G. Evelyn Hutchinson (*An Introduction to Population Ecology*) and John P. Allen (creator of the failed Biosphere 2, and organizer of the first English-language publication of Vernadsky's *Biosphere*), who used their take on Vernadsky's concept of the biosphere to insist that humanity must live in a "balance" with nature, something Vernadsky never thought. Vernadsky, excited with the prospect of the use of nuclear energy, viewed resources as man-made, and saw our future as reaching out into the cosmos.

The idea of ending human growth, to prevent the use of finite resources, completely ignores key distinctions

1 On this directedness in evolution, see Benjamin Deniston, "Biospheric Energy Flux Density" in this issue.

2 Vladimir Vernadsky, "Some Words About the Noösphere" *21st Century*, Spring 2005, pp. 16-21.

between the abiotic lithosphere, the biosphere, and the noösphere. While evolutionary change may not be apparent in the non-living, living matter itself has transformed the resources and environments it operates in and on. The limits to growth of the early chemotrophs, living off sulfur compounds in ocean vents or within the Earth's crust, meant nothing to the later photosynthesizers, which were able to use the previously useless sunlight as a source of energy. The oxygen pollution created by these sea organisms could have been a call used by a modern environmentalist to slow down and limit population, but, instead, that free oxygen itself became a resource for the Krebs cycle of aerobic respiration. And photosynthesis didn't just make available more of the same sort of energy previously available to chemotrophic organisms; the biosphere as a whole had a much higher potential, as seen in the increased mass of both living matter and matter shaped by life, with the advent of photosynthesis.

And so it goes for human society. While a physicist might believe that the total energy of the universe is a fixed constant, this has not been true for the noösphere. Before the discovery of nuclear processes around the turn of the 20th century, uranium was simply a yellow ore, useful for coloring stained glass. Today, uranium (and thorium) are power sources that can dramatically reduce the actual cost of providing energy. As we move into the development of fusion power (a decade or two later than we could have!), we will not simply have *more* power in plentiful supply, but a higher form of power, capable of creating process heat to allow for creation of hydrogen fuel, isotopically engineered materials, and fusion-torch recycling that would put even Portland's current curbside recycling program to shame. By discovering principles of nature, we *change* nature, by changing the power of the noösphere, which is itself the greatest geological force.

So while the limits to growth and laws of thermodynamics may apply to electrons bumping around, or simple abiotic processes, they emphatically do *not* apply to the practice of human economy. Anybody maintaining that we must slow down our growth, to conserve resources, has endorsed a policy that will condemn mankind to extinction, by disavowing our heritage as a unique part of the natural, directionally developing world. Rather than slowing down to conserve what we have, we must instead bound forward rapidly, to bring the 2.7 billion people in poverty on this planet out of that condition, developing new resources and technologies on the way, as we get our space and fusion programs in gear to drive the noösphere forward in a way that would make Vernadsky proud.

That would make an excellent birthday gift!

EIRNS/Stuart Lewis

Benjamin Deniston

THE SDI PARADIGM TO SAVE MANKIND TODAY

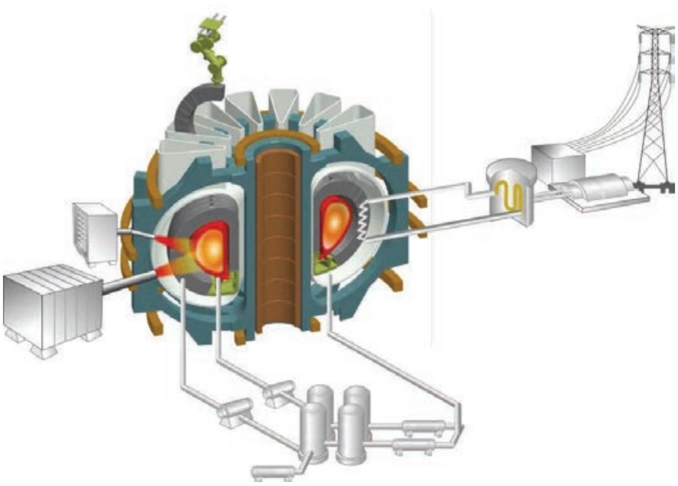
An extraordinary conference was convened by the Schiller Institute on March 23, on the occasion of the 30th anniversary of President Ronald Reagan's announcement of the Strategic Defense Initiative (SDI). The Institute was founded in 1984 by Helga Zepp-LaRouche, whose husband, Lyndon LaRouche, was instrumental in formulating the SDI, and organizing the President to adopt it.

The 350 conference attendees heard presentations covering the history of the SDI program, including the Soviet rejection of the President's 1983 offer of cooperation, the resistance to the joint program in the U.S., and the consequences of the failure to implement the SDI. But today, the offer of cooperation is again on the agenda. *21st Century Science & Technology* author Benjamin Deniston described the magnitude of the threat to mankind from celestial objects, and mankind's unpreparedness to mitigate them. A video presentation, provided by the Russian Committee on Implementation of the International Global Monitoring Aerospace System (IGMASS) project, stressed the global nature of natural disasters as well as cosmic threats, and the internationally coordinated response that is required. (See the Fall/Winter 2012-2013 issue of *21st Century Science & Technology.*)

PRINCETON FUSION SCIENTISTS TO AID SOUTH KOREAN DEMONSTRATION REACTOR DESIGN

South Korea's National Fusion Research Institute has signed an agreement with the Princeton Plasma Physics Laboratory (PPPL) in New Jersey, for collaboration in designing the next-step fusion demonstration reactor. While the U.S. fusion program, and the Princeton program itself, face the budgetary shut-down of experiments and the loss of hundreds of scientists and engineers, South Korea is pushing ahead, developing a conceptual design for its K-DEMO machine. This device will be its last step before construction of a commercial magnetic fusion power plant. K-DEMO is planned as the follow-on to the International Thermonuclear Experimental Reactor (ITER), currently under construction in France, which includes South Korea as a partner.

According to PPPL, the agreement calls for Princeton specialists to provide engineering analysis of the Korean design. Princeton will be able to use the agreement to explore cutting-edge designs and technologies for fusion (which are not being invested in, in the U.S.), and South Korea will gain access to the decades of U.S. experience in fusion design and engineering. Princeton helped South Korea design its currently-operating KSTAR superconducting tokamak in the 1990s, and participates in experiments on KSTAR. An interview with the head of the South Korean fusion program, Dr. Gyung-Su Lee, appeared in the Winter 2009 issue *of 21st Century Science & Technology.*

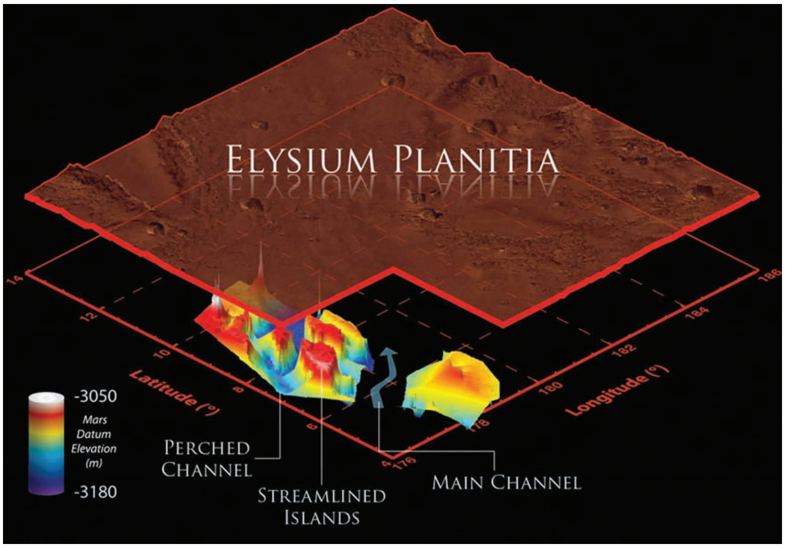


Princeton Plasma Physics Lbaoratory

A schematic illustration of the K-DEMO fusion reactor.

SUBSURFACE WATER CHANNELS SHOW MARS WAS WETTER MORE RECENTLY THAN EXPECTED

Scientists reporting new results at the 44th Annual Lunar and Planetary Sciences Conference in Texas March 18-22, described new data and results which have enabled them to reconstruct the pathways of ancient water channels below the Martian surface. Using the Mars Reconnaissance Orbiter's Shallow Radar (SHARAD), a 3-dimensional map was created which indicates that catastrophic flooding took place in the Elysium Planitia within the past 500 years. This remarkable finding puts a "wet and warmer Mars" dramatically closer in time to the modern era than previously thought. "The radar picked up multiple 'reflectors,' which are surfaces or boundaries that reflect radio waves, so it was possible to see multiple layers," explained Lynn Carter, from NASA's Goddard Space Flight Center. "We have rarely seen that in SHARAD data, outside of the polar ice regions of Mars."



Imaging reconstruction of ancient water channels indicates "a wet and warmer Mars" than previously thought.

At the conference, *21st Century Science & Technology's* Ian Overton reports, members of the Curiosity rover team reported that new near infrared data from the rover's Mast Camera, and data from the Dynamic Albedo of Neutrons instrument, indicate that the degree of soil saturation of water is more widespread in the Gale Crater region than previously believed. Rebecca Williams, from the Planetary Science Institute in Tucson, reported that the rounded pebbles seen by Curiosity "provide the first direct observation of an ancient Martian stream bed," in Gale crater.

NEW TECHNOLOGY COULD REVOLUTIONIZE THE PRODUCTION OF FLU VACCINES

The World Health Organization estimates that were a flu epidemic to emerge, similar to the 1918 global pandemic, between 20 and 50 percent of the world's population would be affected. And each year, even with the less-lethal seasonal outbreaks of flu, thousands of lives are lost. In 2009, in response to the H1N1 swine flu outbreak, the Defense Advanced Research Projects Agency began the Blue Angel project, to improve the response to pandemic influenza. Today's egg-based production techniques can take up to six months to produce a viable vaccine. The goal of the DARPA program was to produce large quantities of high-quality vaccine-grade proteins for immunization in less than three months.

In recent tests, under Blue Angel, researchers at Medicago Inc., produced more than 10 million doses (in an animal model) of an H1N1 influenza vaccine candidate in one month. Instead of using eggs, tobacco plants were used, to produce the recombinant proteins that are key to vaccines. Viral genes introduced into the tobacco plants generated proteins within 14 days, with vaccine-grade proteins generated within four weeks. Next would come clinical trials to test the effectiveness of the vaccine on humans, which is awaiting approval from the Food and Drug Administration.

photo: DARPA

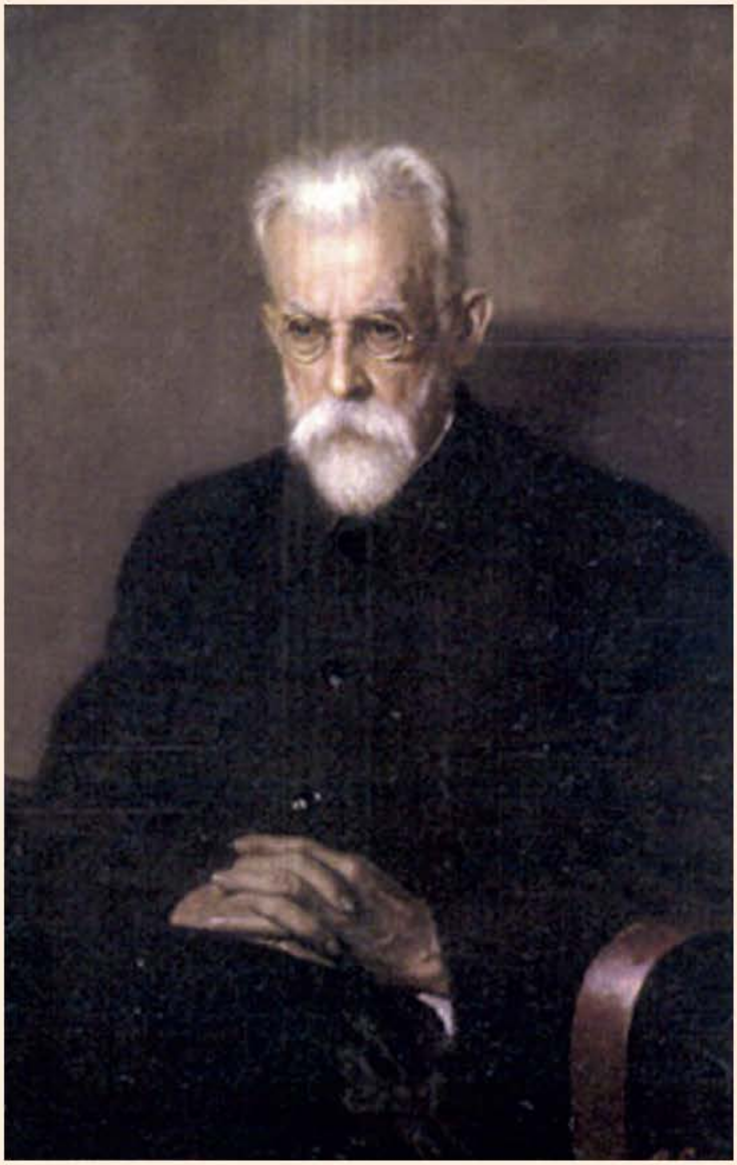
A DARPA-funded vaccine company working on ways to quickly develop immunizations for potential pandemics, has successfully made over 10 million doses of H1N1 flu vaccine in a single month.

150 Years of Vernadsky

Introduction

by William Jones

In this issue, *21st Century Science and Technology* magazine celebrates the 150th anniversary of the birth of the scientist and visionary Vladimir Ivanovich Vernadsky (1863-1945), by publishing a number of celebratory contributions relating to Vernadsky and his work from scientists working in the Vernadsky tradition in Russia and Ukraine. The Vernadsky anniversary is being celebrated at the highest level in Russia and Ukraine this year, and it is fitting, given Vernadsky's global importance, to do so in the United States. Despite his ground-breaking work in establishing new fields of science such as geochemistry, biogeochemistry, and radiogeology, as well as his work in organizing science in both Russia and Ukraine, both during Imperial as well as in Soviet times, creating the Radium Institute in St. Petersburg and the Academy of Science and several universities in Ukraine, knowledge of the man and of his work in the United States is still either unknown or distorted. Vernadsky was a visionary in science. Not in the sense that his "science" was subordinate to some philosophical or religious notions, but rather because he viewed man's scientific activity, beginning with man's first controlled use of fire, as a significant, new, and powerful geological



Vladimir Ivanovich Vernadsky (1863-1945) force in the universe: indeed, in Vernadsky's view, the most powerful.

While scientists and scholars may be aware of Vernadsky's work in providing a firm basis to the concept of the biosphere, a term which he brought into the mainstream of science in his 1926 monograph, entitled *The Biosphere,* there is only slight recognition in the U.S. of his scientific concept of the noösphere ["noös"—mind], that is, the realm in which man emerges in the biosphere and with his creative thought, begins to assume a dominant role in transforming and extending that biosphere. While Vernadsky was a visionary in the sense that he saw, further than his contemporaries, the tremendous potential of the discoveries that were being made in the first half of the 20th century, he was at the same time a very astute and active political figure. In his early years, he was instrumental in establishing the Constitutional Democratic Party (Kadets), at a time when political parties were not allowed in Russia. He served for many years in the Duma as a member of the Central Committee until the Bolshevik takeover of 1917, when members of the Kadets were being thrown into prison and generally harassed and suppressed. His commitment to the advancement of science in Russia, and in the Slavic world in general, led to his returning to Soviet Russia to work under the new regime. It was during this period of the last twenty five years of his life, that he made some of his greatest contributions.

Vladimir I. Vernadsky on expedition, c. 1910.

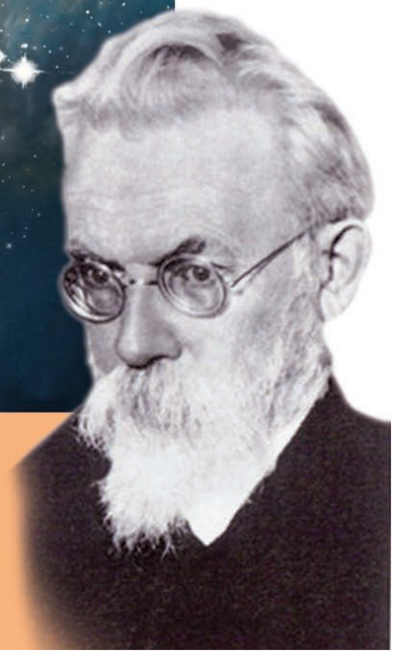
While he was generally recognized by the Soviet leadership as one of the most gifted scientists of his age, receiving the prestigious Hero of Socialist Labor award toward the end of his life, he was also a man of strong principle. He never accepted the tenets of the official "dialectical materialism," and his view of man and the biosphere and the noosphere were officially denigrated by the Soviet bureaucracy as "vitalism." When friends or colleagues were threatened with being shipped off to the Gulag, Vernadsky actively lobbied the Soviet leadership to keep them from being sent away, or at least, to ensure they were provided with the opportunity to continue working in their scientific field in exile. In this endeavor, while not always successful, he was absolutely fearless. Because of his opposition to dialectical materialism, most of Vernadsky's works of a more philosophical nature were not published until long after his death. It is hoped that this 150th anniversary will lead to the publication of all of Vernadsky's works as well as his personal papers, in his native language, and that a good portion will be rendered in competent English editions.

Vernadsky is not only important as an historical figure in science. As Academician Galimov indicates in his paper, Vernadsky is a part of our modern world. Having seen much further than his contemporaries, his thought still remains a fertile source for science today. In fields such as astrochemistry and astrobiology—fields only created in the last couple of decades—Vernadsky was already doing pioneering work, and his thoughts still serve to stimulate those working on these problems. But more importantly, the perennial optimism that provided him with solace even during the worst days of the war might well serve as a powerful antidote to the pall of cultural pessimism that has fallen over so much of science in the Western world. While he was not unaware of problems that can occur as man proceeds consciously to transform nature, he was also confident, as Academician Marov indicates in his essay, that man has, with his power of creative thought, which lies at the basis of all technological development, the means to overcoming any apparent "limits to growth."

Vernadsky was a firm believer in the notion of progress, seeing its effects in the unfolding of the biosphere, and, then, as a work of reason, in the productive activity of man in his development of human civilization. But for man, with his free will and his reason, progress becomes more of an imperative to realize rather than a blind "law of nature." Colonel Ignatenko, in his paper, emphasizes the morality Vernadsky saw as an inherent factor in the development of the noösphere, in terms of discoveries in economic science. Vernadsky's commitment to the development of nuclear energy was paradigmatic for his view of man's progress, from simple sources of energy in wood and coal to the ever denser resources, unleashed with the discovery of the atomic nucleus.

Vernadsky combined rigorous research with profound thought, which soared above the common assumptions of his day. He is, therefore, a scientist and thinker who should not merely be celebrated and admired, but whose ideas should be promoted and developed.

Milky Way galaxy



V.I. Vernadsky by A.E.Yeletsky, 1949.

150 Years of Vernadsky

In celebration of the year of Vladimir Ivanovich Vernadsky, it is crucial to further his hypothesis on the nature of progress and direction in evolution, for both its scientific subject, and even more for the implications of that scientific principle for society today.

V.I. Vernadsky and The Contemporary World

by Academician Erik Galimov

Since 1992, Academician Erik Galimov has been the director of the Vernadsky Institute of Geochemistry and Analytical Chemistry, of the Russian Academy of Sciences. The Institute was created by Vernadsky, and named for him after his death. Galimov is the editor of the journal Geokhimia [Geochemistry International]. *He has contributed to the fundamental understanding of isotope fractionation, the science and resources of the Moon, Mars exploration, and in 2012, Galimov's most recent book, written with co-author Anton Krivtsov,* Origin of the Moon: New Concept: Geochemistry and Dynamics, *was published by De Gruyter, Inc. Academician Galimov is a Member of the Presidium of the Russian Academy of Sciences.*

This article is adapted from Academician Galimov's presentation at the meeting of the Presidium of the Russian Academy of Sciences in 2003, on the occasion of Vernadsky's 140th anniversary. It has been translated from the Russian by William Jones.

This year we are marking the 140th anniversary of the birth of V.I.Vernadsky. Normally, such a jubilee would deal with a personality whose achievements and activity occurred in a fairly distant past. The contemporaries of V.I. Vernadsky, born around the same time, were physicists Marie Skłodowska-Curie and Max Planck, chemist Svante Arrhenius, and geologist Jakob Johannes Sederholm. We recognize and honor them in their role in the history of science. But when we speak of Vernadsky, we are not speaking about history, but almost always about problems of the present. From where derives that surprising modernity of V. I. Vernadsky?

Vernadsky combined in his person the qualities of researcher and thinker. He held strictly to the facts, demanding experimental or computational verification for every conclusion. He always characterized his generalizations as "empirical." His usual comment was: "We must not exceed the bounds of the known facts." At the same time, generalization was precisely his style. He arranged and combined the facts into the form of conceptions, from which he made forecasts. Therefore, the results of his work were directed toward the future. Thus, our feeling of his modernity.

Very often Vernadsky raised problems which did not seem pressing at the time.

Today, when we work diligently to identify the priorities in science and want to define its development by means of our present logical understanding, it is useful to keep in mind one bit of advice from Vernadsky: "New sciences which are continually being created around us, are created in accordance with their own laws, laws which do not stand in any relation to our will or to our logic. On the contrary, when we examine the process by which any new science comes into being, we see that this process does not correspond with our logic. The course of the history and development of science, the course of the elucidation of scientific truth, does not at all correspond to that which, it would seem, ought to have come about according to our logical understanding."

The major scientific achievements of V.I. Vernadsky are widely known. They were his creation of a body of thought concerning the role of living matter in geological processes, the foundation of modern geochemistry, his teachings on the noösphere, etc., which I will touch upon.

But I would like to begin with an important, although little known area of Vernadsky's scientific thought.

V.I. Vernadsky first began to look at the geology of the Earth as a product of its history as a planet in the Solar System. He said that one could not consider the Earth apart from its relation to the cosmos.

Keep in mind that at that time, geological surveys only encompassed the upper structural layer of the Earth's crust. There were no data regarding the deeper structure of the Earth, the composition of the Earth's mantle, or its core. There were no data regarding the structure of the ocean bottom. Consequently, any approach to a comparative global study of the Earth with other planets of the Solar System was absolutely extraordinary.

In November, 1930, Vernadsky wrote in his diary: "We now see as a clear and practical task of the near future, the capture by man of the Moon and the planets."

Of course, Vernadsky understood that matter from other planets that would be necessary for a comparative analysis would not be in the hands of investigators any time soon. But there were other ways of doing this, namely, through a comprehensive investigation of meteoritic material. Meteorites are fragments of bodies of the Solar System which have fallen to Earth. Vernadsky organized the collection and the classification of meteorites, launching an effort to expand the collections. In the 1920s and 1930s, regular scientific expeditions were conducted to the sites of meteorite impacts. In 1935 a Meteorite Commission was organized, and later, in 1939, it was transformed into the Committee on Meteorites (KMET) under the USSR Academy of Sciences. V.I. Vernadsky became the chairman of the Committee. In 1941 publication of the journal *Meteoritika* began.

Vernadsky placed great importance on the study of the nature of the Tunguska meteorite (1908). He gave his support to organizing an expedition to impact area. This resulted in the collection of extensive factual data. At that

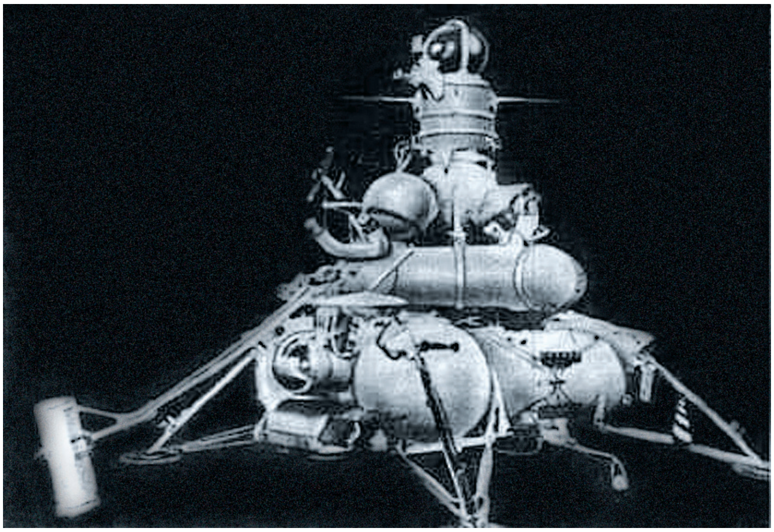
The Museum of Extraterrestrial Material of the Russian Academy of Science.

Vernadsky organized the early investigation of meteoritic material, and in 1939 became chairman of the Committee on Meteorites of the Academy of Sciences. Under the initiative of Academician Galimov, the Laboratory of Meteoritics was formed in 1998. The Laboratory holds the Russian lunar sample collection, and the meteorite collection of the Academy of Sciences. Pictured is part of the collection of the Museum of Extraterrestrial Material in Moscow.

time, Vernadsky gave his interpretation of the event, which is fairly close what we now know. He wrote: "…the mass of matter from space which penetrated the Earth's atmosphere, did not fall to the ground, but left only a residue of matter in the form of very fine dust." Possibly this was a result of "the penetration into the Earth's gravitational field, not of a meteorite, but of a huge cloud, or clouds, of cosmic dust, moving with cosmic speed."

It was only 20 years ago that it became clear, thanks to the discovery of isotopic anomalies, that meteorites contain particles of the pre-solar cosmic dust originating in the vicinity of the Sun. And yet, Vernadsky was already writing about this in the 1930s.

"Cosmic clouds apparently consist of particles, that would appear to be similar to those we find in meteorites… It is quite possible that cosmic clouds are related in some way to comets. In the instances where these clouds fall to the Earth with cosmic speed under the influence of the Earth's gravitational, and possibly even its magnetic field, they can create craters or depressions…"


National Space Science Data Center, Goddard Space Flight Center

Luna 16 was the world's first robotic spacecraft to land on the Moon and return a sample of lunar soil to the Earth. That Soviet mission, in September 1970, followed the Apollo 11 and 12 U.S. manned missions. Luna 16 brought back, in an hermetically sealed container, 101 grams of material collected in the Sea of Fertility, on the Moon.

The idea of the common nature of matter from ordinary chondrites and that of the Earth, was further developed in Russia by a person who continued the work of V.I. Vernadsky, Academician Alexander Pavlovich Vinogradov, who from 1947 led the Vernadsky Institute of Geochemistry and Analytical Chemistry. This idea appeared fruitful, to the greatest degree. It opened the way to an understanding of the nature of the structure of the Earth's geospheres, and to prediction of the composition of the Earth's mantle and core. Later, when we received samples of lunar soil from the Soviet robotic stations Luna-16, Luna-20, and Luna-24, and from the American Apollo missions, it was revealed that the basalts of the Moon just slightly differed from basalts on the Earth, and that the chemical structure of the Moon, as well as the chemical structure of the Earth, can be deduced from the chondrite model.

Vernadsky considered the Earth as being in energetic and meteoritic exchanges with the cosmos and with other bodies of the Solar System, and that geological history ought to be reconstructed with consideration of that factor.

It is interesting that today we are able to find and analyze lunar and Martian fragments which have fallen to Earth. When we talk about the chemical and mineralogical composition of the Martian soil, the question sometimes arises, where did that data come from, as we have not yet been able to bring back soil from the surface of Mars? The fact is that the Earth has received dozens of meteorites, which, from a number of indications, are of Martian origin. This includes the so-called SNC meteorites. They have characteristic correlations of the three isotopes of oxygen, ^{16}O, ^{17}O, ^{18}O which differentiate them both from Earth and from other types of meteorites. In order to definitely determine that they are of Martian origin, we have to bring back to Earth at least one sample from Mars. If it falls into the category of this three-isotope oxygen diagram of the SNC meteorites, then we will be able to consider that we possess matter of Martian origin, in our museum at the Vernadsky Institute of Geochemistry and Analytical Chemistry.

Lunar meteorites have been discovered in Antarctica, which correspond in their composition to samples studied from the lunar surface. Furthermore, it is proposed that we conduct a search on the Moon for ancient samples from Earth. The collision of large meteorites with the Earth's surface could have dislodged chunks of rock and deposited them on the Moon. We know that no rocks more than 4 billion years old have been preserved on Earth. A chronicle of the first 500 million years of the Earth's history has been completely lost. But it is possible that fragments of ancient rock, carrying invaluable information on the early pre-geological history of the Earth, might be found on the Moon.

Also, on Vernadsky's initiative, the first collection and investigation of cosmic dust in the Arctic snows and its maritime sediment was organized.

His idea of studying the Earth as one planet in the Solar System, which at one time may have appeared exotic, is now fully recognized and accepted, and serves as the working concept for international scientific organiza-

National Space Science Data Center, Goddard Space Flight Center

In 1972, Luna 20 returned a second cache of soil from the lunar surface. Pictured here is the sealed container holding the extraterrestrial material, which landed in the snow, waiting to be retrieved.

tions. Obviously, problems concerning the origins of planetary atmospheres, the origins of the Earth's oceans, and the mechanism by which planetary cores are formed, are problems which are impossible to solve simply by focusing on the Earth alone.

This is particularly the case with regard to the problem of the origin of life. After fifty years of the triumphal development of molecular biology, it suddenly became evident that the final word in resolving this issue had to involve biogeochemistry and planetology. The search for forms of life beyond Earth, finding clues pointing to the existence of life now or previously on other planets, is an officially declared goal of the U.S. planetary program. The American program includes an intensive investigation of Mars, providing for the launch of spacecraft every two years

Unfortunately, Russian opportunities in this field are somewhat more modest. An important future mission would be to Phobos, a moon of Mars, in order to bring back soil, investigate its characteristic organic composition, and determine the isotopic components of its oxygen. This would permit us, as was earlier indicated, to draw a decisive conclusion regarding the origin of the SNC meteorites, and would at the same time answer the important question of how Phobos was formed as a Martian moon.

V.I. Vernadsky returned repeatedly to the problem of the origin of life, but approached it very cautiously, since here, as in other areas, there arise a variety of speculation and colliding world views. For some time he supported the panspermia thesis. This was closer than anything to his understanding of life as a cosmic phenomenon, eternal in its existence. Following Vernadsky in a better and more accurate formulation, we ought to speak, not of the "origin of life," but rather of the genesis and evolution of the biosphere.

The conditions, the mechanism, and the time of the genesis of the biosphere on Earth are not dependent upon one's concept of the origin of the phenomenon of life. Nevertheless, it is important to note that V.I. Vernadsky looked at this problem as a cosmic problem, closely linked to an understanding of the mechanism by which the planet was formed. And that is exactly how the problem is posed today.

Regarding the contributions of V.I. Vernadsky to world science, it is of course impossible not to underline once again how he introduced into science an understanding of the role of living matter in geological processes, including on a planetary scale.

The very term "living matter" was unexpected and unfamiliar, and became a subject of debate. Vernadsky wrote in this connection:

> What we study in terms of living matter is not a biological process, but a geochemical one... We need to encompass as completely as possible the matter which is changed by life processes, however accidental this might be from the standpoint of the functions and morphology of a given organism. But we are studying a mass phenomenon, using statistical methods, and thus anything truly accidental is balanced out, and we obtain a representation of the average phenomenon.
>
> If we use the term "living matter" in this sense, reducing it to mass, composition, and energy, we shall see that this term is quite adequate for a whole array of fundamental scientific questions... Living matter, like the biosphere, possesses its own special mode of organization, and may be viewed as a lawfully expressed function of the biosphere.

From the lines quoted above, it is evident that for Vernadsky, life was not only a quantitative factor, but was also important in itself. The tremendous role of life in planetary processes boggles the mind. The factor of life determined the formation of the granite in the Earth's crust, and the oxygen content of the Earth's atmosphere. Life, through photosynthesis and the production of reduced carbon, sets in motion the oxidation-reduction cycle in the Earth's crust. This regulates the global processes of ore-formation. The biosphere itself is not simply the geological envelope, but the receptacle of life. The biosphere refashions the Earth's geology in such a way that it acquires

NASA/JPL-Caltech/University of Arizona

This stunning image of the Martian moon, Phobos, was taken in 2009 by the High Resolution Imaging Science Experiment camera, aboard NASA's Mars Reconnaissance Orbiter. An important mission, Academician Galimov proposes, is to return soil from Phobos, to help determine the origin and the history of Mars, as well as its small moon.

properties which it would not have in the absence of life. Living organisms beget processes which occur with unusually high speed, in unusual directions.

The crowning doctrine of the biosphere, which makes it a genuine philosophical conception, is the concept of the transition of the biosphere into the noösphere. Until the appearance of man, evolution was a disorderly process. With the appearance of mind, a new organizing factor enters the biosphere. The activity of man acquires a geological stature, and is in a position now to direct the evolution of the biosphere, and, if you wish, geological evolution.

This concept of V.I. Vernadsky did not immediately gain attention. Pollution, climate change, and environmental disasters were for some time considered as isolated phenomena unconnected to the results of technogenesis. But with time it became evident that they were related to our entry into the noösphere, with its new and still unknown laws.

We have seen that the Cyclops-like powers, which man has attained, can create not only satisfaction but also concern. But we must say that V.I. Vernadsky viewed the transition from the biosphere to the noösphere optimistically.

These are some of his conclusions.

"The noösphere is a new geological phenomenon on our planet. In it, for the first time, man becomes a large-scale geological force. He can and must rebuild the province of his life by his work and thought, rebuild it radically in comparison with the past. Wider and wider creative possibilities open up before him… We are living in an exceptional time in the history of our biosphere, in the psychozoic era, when a new state of the biosphere is being created—the noösphere, and when the geological role of man begins to predominate in the biosphere and broad horizons for his future development open up… Science is a creation of life. Scientific thought takes from the life around it material from which it adduces scientific truth…This is the fundamental expression of the life of man in his surroundings—in the noösphere. Science is the manifestation in human society of the action of the aggregate of human thought."

Was Vernadsky correct in his optimism? There are also other, pessimistic predictions, which regard the noösphere as the final stage of the development of the biosphere of our planet. Humanly speaking, I would like to believe that V.I. Vernadsky is right.

Vernadsky was a philosopher of science. That which he called an empirical generalization, was in fact a philosophical comprehension of the known facts.

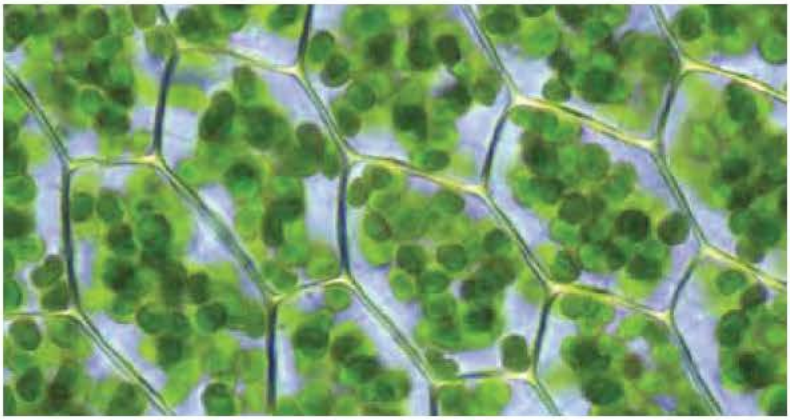
The philosopher-scientist to a much greater degree exerts an influence on the development of his own nation than the specialist-scientist. In his understanding and exposition of them, scientific facts acquire a meaning transcending the bounds of the particular sphere of knowledge. They become intertwined with the social and historical background.

The cultural, social, and historical context is always of a national character. From Vernadsky himself we have the words: "Scientific achievements may be universally binding and unifying for everyone. But philosophical ones? I don't think so."

It is possible that this explains why V.I. Vernadsky is relatively little known in the West, where scientific schools are generally focused on more pragmatic and concrete approaches. The world of Western science grasps work done in the East or in Russia only when it contains specific facts, calculations, etc., having, in Vernadsky's words, the character of being "universally binding." But with regard to generalization, to philosophical interpretation of facts, or even simply to the interpretation of those facts, they trust more their own judgment.

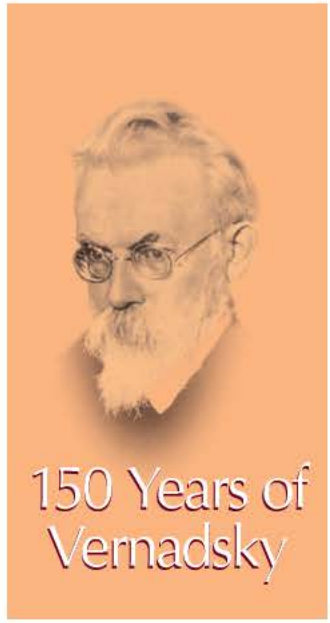
There is no need, however, for us to seek an international certificate of recognition for our great compatriots. We must be able to evaluate ourselves the contributions of those who formed our world view, our national character, and determined our style in science and culture.

Vladimir Ivanovich Vernadsky:



Kristian Peters/creative commons

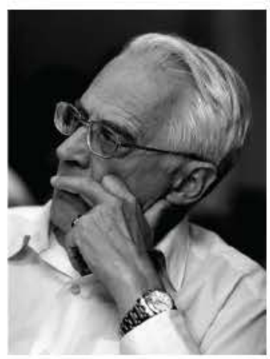
Plant cells of the moss Plagiomnium affine, *showing visible chloroplasts.*



The Science of The Biosphere and Astrobiology

by Academician M. Ya. Marov

The figure of the renowned Russian scientist Vladimir Ivanovich Vernadsky must be included in the category of remarkable phenomena of the 20th century. The native talent and inquisitive mind of this naturalist, combined with his truly encyclopedic knowledge, enabled him to delve, in his multifaceted activity, into a whole array of scientific fields and to leave deep traces in all of them. Moreover, by rethinking natural phenomena, and drawing philosophical generalizations from them, he laid the foundations for new areas of contemporary knowledge. He made an immense contribution to geochemistry and to the study of the history of the chemical elements in the Earth's crust, to mineralogy and to the study of the Earth's water cycle, as well as to the study of the nature of symmetry and of time. He laid the foundations of radiochemistry as one of the major fields in the development of nuclear power. He was the first to investigate the crucial problem of the close relationship



Academician Marov is the head of the Department of Cosmochemistry, at the Russian Academy of Sciences' Vernadsky Institute of Geochemistry and Analytical Chemistry. His principal scientific interests have been in the fundamental problems of hydrodynamics, gas kinetics, and space physics, with an application to Solar System studies and planetary cosmogony. He has authored more than 250 technical articles, and 15 books and monographs. This introductory article has been translated by William Jones.

*A more comprehensive treatment of Vernadsky's contributions to the science of the biosphere and astrobiology by Academician Marov will appear in the Summer issue of 21*st Century Science & Technology.

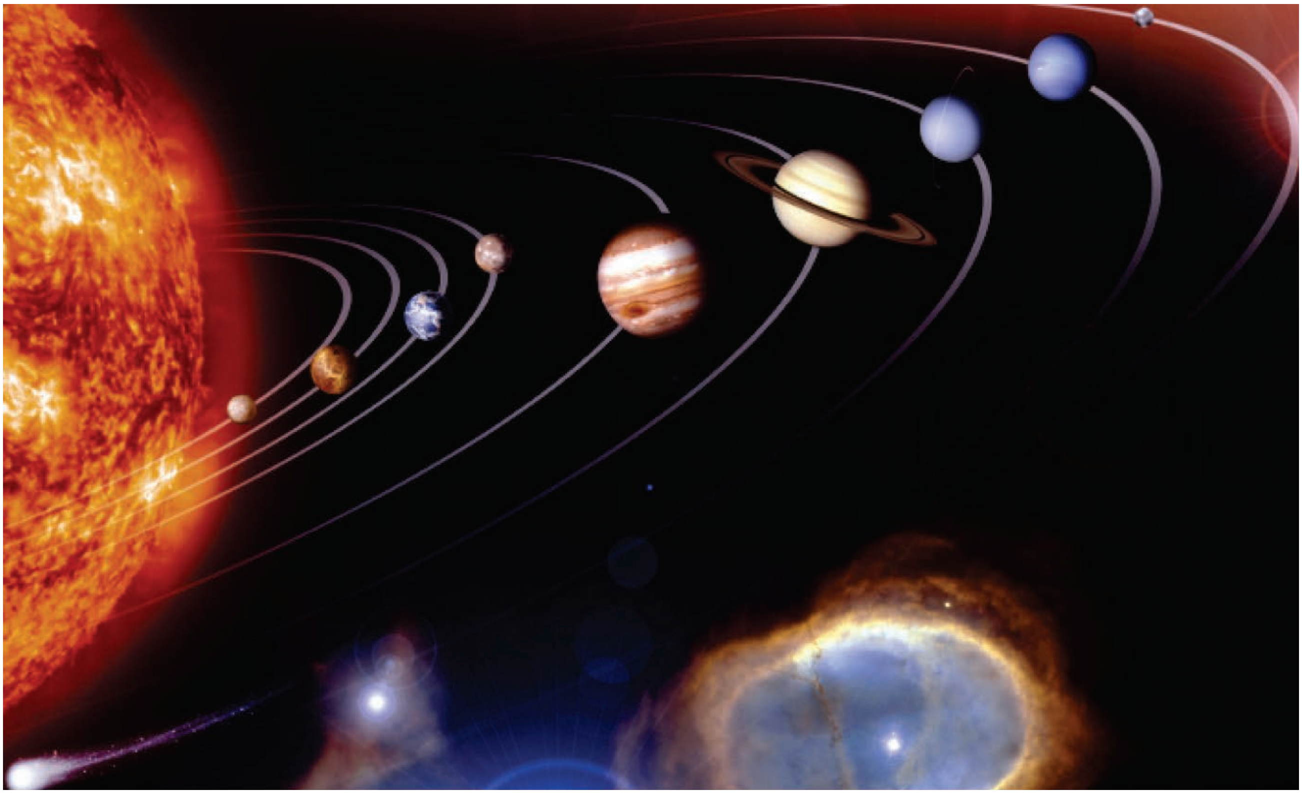


Figure 1
Schematic view of the Solar System and planetary nebula to be left behind after the Sun (a G2 star with the lifetime about 10 billion years) exhausts its nuclear fuel, approximately five billion years from now, according to Encyclopedia of Astronomy and Astrophysics (2002).

between the activity of man and living organisms, on one side, and geological processes, on the other; this investigation provided the basis for his concept of the biosphere. He is also credited with investigations into the history of the foremost branches of science and of methods for the compilation of scientific knowledge. He was the first chairman of the Commission on the History of Science, which was created by the Soviet Academy of Sciences in 1921 and reorganized in 1932 as the Institute of the History of the Natural Sciences and Technology. He was a passionate publicist, whose articles expressed his anxiety and concern for the interests of the nation and the world.

Here we are able to touch briefly upon only one aspect of the tremendous legacy of V.I. Vernadsky, namely, his teachings on the biosphere, a science which embraces a grand retrospective survey of the Earth's evolution—one that is closely and fundamentally connected with its cosmic surroundings and life's origin. This field of investigation, which extends far beyond the bounds of the Solar System and has undergone vigorous development during the last decades, borders directly upon astrobiology and the broad array of current problems embraced by that science.

Astrobiology is one of the most fundamental areas of contemporary natural science. It is directly connected with both biology and astronomy, in that it investigates not only the essential problems of the origin of life, and of its physical and chemical basis and properties, but also examines basic notions concerning the chemical evolution of matter and the possibilities for the genesis of life under a variety of conditions of the natural environment and on different bodies in the Universe. The tremendous progress in molecular biology, genetics, and biochemistry, which has led to the deciphering of the genome, together with the investigations in astronomy, astrophysics, and space science, which have made possible the detailed study of the bodies of the Solar System and the discovery of planetary systems beyond the Solar System, as well as an understanding of their genesis, have placed this inter-disciplinary field of study on a new scientific basis. In that connection, it is extremely important to examine

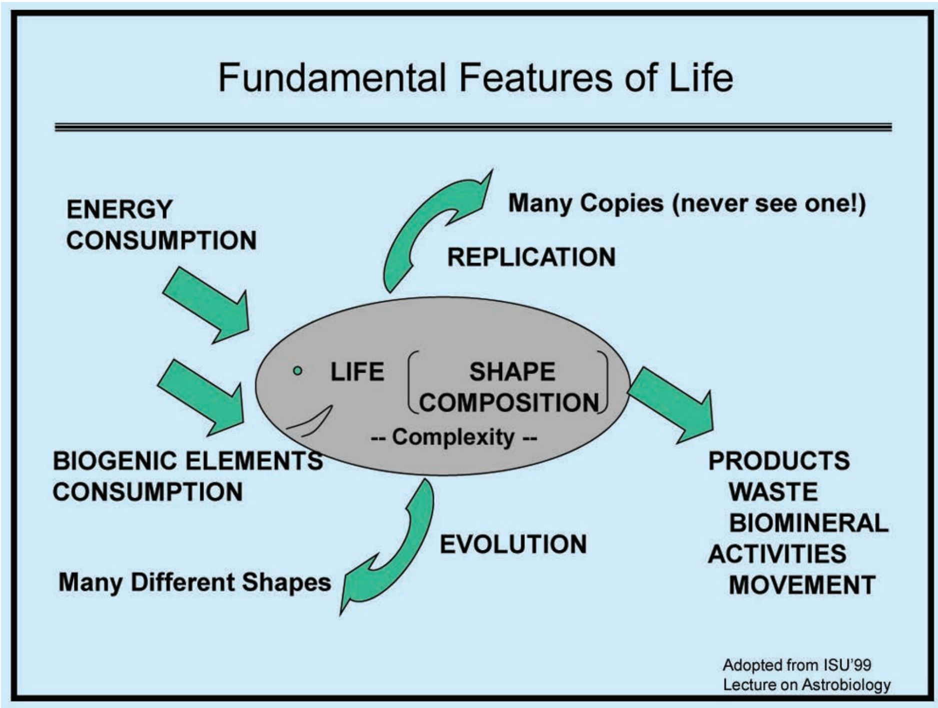


Figure 2

Schematic representation of the fundamental features of life.

Source: International Space University

the relationship of astrobiology with geochemistry, that is, with the migration of chemical elements on the planet and the problem of the appearance of life, which Vernadsky viewed as directly connected to the origin of the biosphere. In a broader sense, one could well refer to an interrelationship of the evolution of the upper envelopes of the planet with the concept of biogeochemistry, which Vernadsky introduced, and, when it comes to studying the evolution of chemical elements in cosmic space, also with cosmochemistry (astrochemistry).

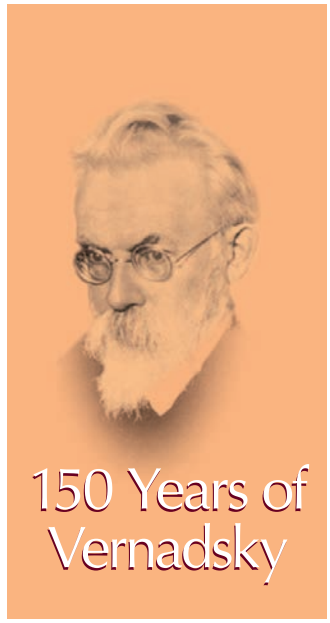
In the chapter entitled "Geochemistry and the Study of Life," written in 1911 and published as part of his fundamental work *The Life-Permeated Envelope of Our Planet*, Vernadsky writes: "Scientific knowledge is entirely imbued with formulations derived from scientific notions about man and living nature, of which man is an inseparable part, and about the living environment around him, i.e., that part of the planet, which we call the biosphere… Basing himself on this knowledge, man advances scientifically into areas of the visible Cosmos unfamiliar to him or into the deeper, inaccessible layers of the planet he inhabits. This scientific knowledge has never been comparable, either in depth or in its diversity of phenomena, with what is revealed to man in his study of himself and the environment he lives in. The progress of scientific knowledge is connected not only with the quantitative expansion of our picture of the Universe, but also with its qualitative transformation through man's refining of his methods of empirical observation and deepening of his mathematical and logical analysis. As man does this, he brings to that picture, including to outer-space phenomena and to deep inside the planet, the knowledge he has formed from studying himself, living nature, and his native biosphere." And further, he writes: "At present, man has direct scientific knowledge only of the biosphere, and of himself and the living organisms in it—he knows scientifically only the thin outer envelope of the planet, and all of his knowledge is connected to it. The domains both above and below that thin envelope remain inaccessible to him. Cosmic phenomena above him are reflected in his sense organs, and in the creation of the biosphere, a special part of the planet produced by the influence of cosmic phenomena—by forces outside the planet. The biosphere is that vehicle, through which man studies the Cosmos."

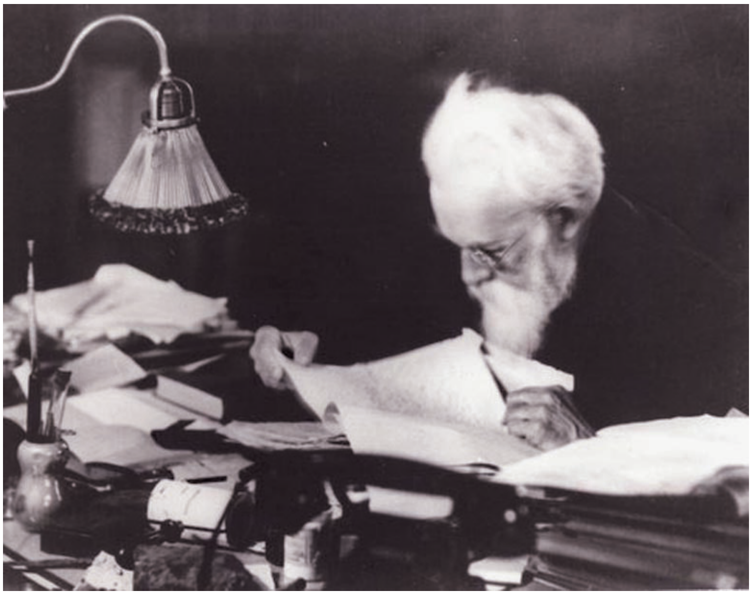
These are words of profound meaning, which identify numerous problems of the world around us and its evolution. Vernadsky gave insight into the appearance of geochemical function and its diversity, caused by the different morphological classes of living organisms responsible for cyclic mass-exchange processes. This is also closely related with the problem of whether the source of life's origin was biogenic or abiogenic, to which Vernadsky paid much attention.

In a longer contribution, to be published in the Summer 2013 issue of *21st Century Science & Technology*, we will discuss these problems in more detail, utilizing Vernadsky's basic concept of the biosphere as one of the geospheres of our planet and as the key paradigm for the biogeochemical processes in our natural surroundings. Taking this into consideration, we will then attempt to approach the question of the origin of life from the standpoint of modern astrobiology.

The Vernadsky Strategy

by Alexander A. Ignatenko





Vernadsky in his office in Moscow in 1940.

All the woes people experience stem not so much from not doing the right things, as from doing the wrong things.

—L.N. Tolstoy

The year 2013 truly deserves to be called the Vernadsky Year. This jubilee, the 150th anniversary of the birth of Vladimir Ivanovich Vernadsky, was heralded in 2012 by the 90th birthday of the contemporary continuer of his work, the well-known American scholar and public figure Lyndon LaRouche.

LaRouche discovered a beautiful metaphor, which underscores the urgency of bringing Vernadsky's ideas to life: the Vernadsky Strategy. He gave this title to a 2001 article.[1] I borrowed it as the title of a collection of essays, published in 2003. Thus "the Vernadsky Strategy" exists as a topic. Under this topic come Vernadsky's thoughts about the federalization of cooperative labor, the social state (in the sense of a state dedicated to the general welfare), and relationships among labor, capital, and creativity. We

1. Lyndon H. LaRouche, Jr., "Current Strategic Studies: The Vernadsky Strategy," EIR, May 4, 2001.

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honor Vernadsky: preserving his memory, we study and promote his legacy.

It was here in our Poltava Region of Ukraine, on a research expedition with his teacher Vasily Dokuchayev in 1890, that Vernadsky expressed his *intuition* of the idea of *living matter*, that central concept of his teachings on *the biosphere*, and *his eyes were opened to the idea of the noösphere*, that is, the place and role of the mind in historical and cosmic processes. He proposed to evaluate any historical epoch by the intensity of activity of the mind, as the regulator of changes in these processes and the creator of harmony amid global chaos.

Viewing applied science and organized labor as factors in society's development, he laid out the task of developing a universal unit for the quantitative expression of the natural productive forces, something which is of particular urgency when necessity arises to move forward *in haste* ("On the Tasks and Organization of the Applied Scientific Work of the Academy of Sciences of the USSR," 1928). This effort was subsequently advanced by Pobisk G. Kuznetsov (1924-2000) and by LaRouche (in the concept of continental development corridors).

The Biosphere Becomes the Noösphere

Seeking to bring new ideas to mankind, Vernadsky formulated the idea of the conversion of the biosphere into the noösphere. The circumstances of his communicating the idea of the noösphere to the public were defined by his goal of drawing conclusions of a social nature from the discoveries of science, since culture, which embraces the entire surface of the Earth's crust, is a product of scientific thought and scientific creativity (Ψ, 1938). He linked this idea with victory in the War and the arrival of a new era, if we were to draw the proper conclusions from what was happening. He set forth the idea in a short article titled "Some Words about the Noösphere"[2] (1944), which he sent to his son in the USA:

"In our century there is a completely new understanding of the biosphere. It is emerging as a planetary phenomenon that is cosmic in nature.… One cannot with impunity oppose the principle of the unity of all men as a law of nature.… The historical process is being radically changed before our very eyes.… Mankind, taken as a whole, is becoming a mighty geological force. And mankind, its thought and labor, are faced with the challenge of reconstructing the biosphere in the interests of free-thinking humanity as a single totality. This new state of the biosphere, which we are approaching without being aware of it, is the 'noösphere.' … Now we are experiencing a new geological evolutionary change in the biosphere."

He was not understood in either the USSR or the USA at that time. But are he and his optimism comprehended, even now? Or is Schopenhauer correct, in viewing optimism as a foolish, irresponsible outlook—a bitter mockery of the inexpressible sufferings of humanity?

For Vernadsky, "Human civilization is caused by a spontaneous planetary process, the laws of which are accessible for study, and we are approaching an understanding of them. Civilization cannot be halted, nor can it change its direction. Unconsciously, mankind, in creating its history, is producing a phenomenon of great power. When people talk about a return to the epoch of barbarism, they are forgetting this side of human existence: the nonrandom and inexorable nature and direction of collective human work" (letter to I.I. Petrunkevich, Nov. 2, 1923).

The reconstruction of the biosphere into the noösphere must be accomplished by people who are guided by reason. He associated the future of mankind, as a social organization of living matter, with a biologically new form of man, who would no longer be *Homo sapiens*, and would not depend on other organisms for his existence. "To solve this social problem requires addressing the very foundations of human power: it requires changing the form of alimentation and the sources of energy employed by man" ("Human Autotrophy," 1925).

This was for the future. In the meantime, he associated (*Diaries*, 1944) the affirmation of these findings, in human life, with the changes made by the state in the organization of life, and changes in the nature of the state itself, which had been initiated by his country. After Victory over fascism, this would emerge as the direct and necessary growth of the scientific worldview, representing the profoundest and most powerful form, in all history, of the influence of scientific thought on the course of society. Scientific thought had defined the phenomenon of "the social state for all people on the planet."

The United Nations declared this idea as a Millennium policy goal (1992), and many nations have incorporated it into their constitutions. Vernadsky located the principled basis of such a policy in the search for solutions to "the fundamental events of our planet as a whole, expressed in the elimination of wars, on the one hand, and, on the other, in directing the social system toward the scientific quest as the main task of life" (letter to his son, January 24, 1944).

In accordance with the laws of dissymmetry, the new world order of neoliberalism, under the name of "the information society," arose and spread across the planet as a reaction against any such deliberate, scientifically grounded affirmation of the social state. Within 25 years, the rejection of a social policy on the part of the state, in favor of the absolute rule of the free market, brought about a *civilizational* crisis of humanity. Once again people began to talk about class stratification, the threat of totalitarianism, and the degeneration of democracy, and neofascism reared its head. Enantiomorphism is at hand! The

2. V.I. Vernadsky, "Some Words About the Noösphere," *21st Century Science & Technology*, Vol. 18, No. 1, Spring 2005.

N.T. Anisimov (Kremenchuk, Poltava Region, Ukraine), "V.I. Vernadsky on the Banks of the Dniepr River," oil on canvas, 2003. Collection of the Kremenchuk Regional Museum.

At present, this reasoned interpretation of the coevolutionary situation requires that codetermination consciously be taken into account in formulating a concept of our stage of evolution, as being defined by the purpose and meaning of human life within it: the directional orientation of the hierarchically superior spontaneous process that subsumes the movement of society as such, interacting with it in the virtual state, demands that we make this purpose conscious, as a response to its action! The current view of the Ψ function in quantum mechanics (the wave function characterizing the *state* of an object), which couples together the dissymmetrization that creates a phenomenon, with the virtual state, makes the latter into a multivariant future which is directly connected with the recent past. This provides an explanation in physics, of Édouard Leroy's rational stratum of life (1927), Kirill Florensky's imaginary knowledge and pneumatosphere (1929), and the discoveries made by psychologists who have identified the ability of our mind to reflect external reality in advance—the creation of a model of the needed future in the zone of proximate action, or *the possibility, in principle, for us to construct our own future.*

"affinity of the liberals' democratic radicalism and caesarist absolutism," as S.L. Frank paraphrased Pushkin's essay "On the Nobility," must now be understood from the standpoint of the physical algorithms of evolution.

Building the Present from the Future

The United Nations has invoked the conception of sustainable development. The Rio+20 summit came and went almost without notice in June 2012, and without significant result: behind the pretty title of its declaration, "The Future We Want," alarming resolutions were adopted on a need to change the existing paradigm and reconsider the goals of development, for which purpose new development indicators should be determined. Are preparations under way to revise the Millennium goals, formulated earlier, or is this an acknowledgment of the pressing necessity of a change away from the existing inertial strategy of development—an acknowledgment dictated by a shift from one historical cultural epoch to the next one, in which the present must be built from the standpoint of the future, rather than being planned as a continuation of a present, which is retreating into the past? In other words, is this an attempt to understand the answer to the question of where time comes from, whether it is a challenge or a summons, and if we should go in step with it or resist it?

Vernadsky's answer is that the goal of life is man's development. He creates it himself, and constructs its meaning by approaching, scientifically, ever nearer to the truth!

The Social Economy

It is an indisputable fact that order in society, and its development, need to be guided by some generally valid goal, which is consistent with the essential qualities of man, his nature and evolution, which qualities may nonetheless be deformable, and are actually deformed, by his existence. Consistent with the social state is the *social economy*, providing those indivisible, shared-use social benefits that are not subject to competitive consumption; it affirms *consciousness of the human equality of people* (Tolstoy).The social economy requires guidance, in order to multiply its values and expand the area in which they are utilized. The most vital of these values are the environment and the universal culture of mankind.

The social economy does not mean a socially-oriented market economy that fulfills quasihumanistic objectives, such as defending players in the competition who have lost their combat qualities; rather, it is "social" in the sense of being truly human. It requires that the state establish and maintain order in society, and endows the state with the main function of governance and organization. Frictions between the old and the new, including resistance to the institution of what is new, even if it is demonstrably reasonable, may define either a cause for civil war, or a mission of growth: "We risk losing all that we have, / If we leave that which is, as it is," wrote Goethe.

The social economy takes as its point of departure the recognition that the market economy is limited, because the basic principle of the latter—consumption, which entails the destruction of products and their removal from economic exchange—is unable to provide for the general welfare. The commercial impulse hinders it from doing so.

The scientific alternative to a monetary economy is *physical economy*. From the standpoint of anthropocosmism and the noösphere, it is possible to forecast the future historical pathway of the development of humanity as a whole.

A.A. Kotlyar (sculptor), N.T. Anisimov (artist) (Kremenchuk, Poltava Region, Ukraine), memorial plaque to V.I. Vernadsky and V.V. Dokuchayev, on the building which was the hotel where they stayed during their scientific expedition in 1890. Granite and bronze, 2001.

Physical economy is based on neither moral philosophy nor political economy, but on physical and mathematical knowledge. It was developed by the author of the term *physical economy*, LaRouche, who promotes it through his political movement and locates its true meaning with reference to the phenomenon of the creative mind of man, who has "the power of introducing a higher state of organization, by the human will" *through historical credit*, which is not a monetary contribution to the future, but "human creativity, from generation to generation": by "incurring a debt which spans generations," for large-scale megaprojects (including in space), to ensure "the continuation of the activity of a life, through the transmission of an effort, an intended effort, to a second life, and a life beyond that" (webcast of September 30, 2011). This succession of generations is the imperative of truly sustained development!

"Creativity Permeates Economic Life"

Also important is Vernadsky's idea of the triune consubstantiality, with respect to their energetic character, of *labor, capital, and creativity* (*Pages from the Autobiography of V.I. Vernadsky*, 1916; published in 1981): "Value is created not only by capital and labor. Creativity is equally necessary for making an object of value. In purest form, the capitalist is the proprietor of accumulated value — of energy that is available in a form convenient for its conversion into practically-applied energy. The worker himself represents a form of energy, which may be directed into some enterprise. Neither the capitalist nor the worker, however, can accumulate active energy without the direct or indirect participation of the creative person. If capital achieves constant expansion, while the worker's labor constantly creates capital, still they are acting according to forms which have come into being through creativity. This conscious or unconscious creativity permeates all of economic life, which without it would be condemned to perdition, just as surely as it would be if it lacked capital or labor."

Vernadsky was not the first to perceive the triunity of labor, capital, and creativity. Charles Fourier stated this triunity indirectly, with respect not to production, but to distribution in compensation for the multiplication of social wealth.

The concept of fractality (B. Mandelbrot, 1975) helps in understanding this: the world and its phenomena have structural and functional scalar invariance, and hence are comprehensible to a mind *possessing the same character*. The logic of triunity as a fundamental characteristic of the structure of the universe, which has been sensed since time immemorial and appeared in primary form in religion, in the image of a consubstantial, uncommingled and indivisible Trinity, has been proven (B.V. Raushenbakh, "On the Logic of Triunity," 1990).The nature of the relations between the external and internal worlds (external: the spatio-temporal universe of the vortex attractor, expanding out of itself; internal: the self-perfecting mind-vector, with unit vectors of spirit-truth, rhythm-beauty, and connectedness-conscience), relations which correspond to these principles, makes it possible to *realize* this triunity in the socioeconomic domain of our life.

Earlier, as seen in a letter to his wife dated August 20, 1888, workers' strikes had made Vernadsky "ponder seriously the forms of local governance, which might and ought to be provided, for the sake of a better life in our country." And he pointed to a principle for organizing the relations between labor and capital, which today may be directly connected with the objectives of regional reforms: that the failure to recognize the equal worth of labor and capital would make it impossible to carry out such reforms: "Does not, then, the very question of organizing so-called labor-capital relations follow from the question of better organization of local self-governance, and a better way of federalizing potentially free collectives?"

Many thinkers have touched on federalization, and now it can be understood in its physical function of autonomy (the preservation of coherence) at all levels of policy: privatization,[3] regionalization on a planetary scale as well as within countries, and the sustainable development of a multipolar world—the simultaneous development of autonomy, rather than confrontational competition between poles of power.

When millions of people are starving to death, while so much is being spent on luxury and the raging stupidity of consumerism, which is no testament to development, but is—let us agree with the moral maximalism of Tolstoy (*What, Then, Should We Do?"*, 1882)—"a crime committed not just once, but constantly," such that one who enjoys luxury "not only abets, but directly participates in murder, the worst sin in the world," or "absolute evil," then it is time to place on the agenda of our lives the denunciation of liberal ideas of law, in order to correct the *deformation* of property relations that has been uncovered by the course of history and the logic of production.

The conflict between manager and owner may thus end in the latter's yielding to the professional competence of the former, as the owner is confronted with whether his ownership represents merely his private possession, or the entrustment to him of the responsibility to use it in fulfillment of a public mission. Property is always *public*, and its effective function (interaction with a division of labor by profession, a form of social labor) requires only that it, too, be divided up; historically, however, it has been subject to *illegitimate acquisition* after its creation by labor, and thus has been considered theft since ancient times: from Pythagoras ("Property is theft") through Pascal ("What is property? Theft that has been forgotten") to Proudhon and Marx! Something private may be legitimized, so as not to be theft, only by becoming part of its owner's *public mission to use it effectively in the public interest.*

Capital, which purchases and exploits labor, and creativity are of equal worth, by virtue of this *natural, consubstantial energetic triunity*, which resolves the problem of their relations. The problem lies in the state's *social level of development*, for private property can exist only within the state; it does not exist in nature.

The Noösphere Is Our Standard

Comprehending this makes Vernadsky's noösphere the standard for morally responsible, rational thinking, for which a global perspective is mandatory in the consideration of problems. This perspective requires understanding the use of synergistic co-determination: circular, or reciprocal, causality. It requires that laws adduced through Vernadsky's "empirical generalization of empirical facts," which are then used through deduction to distill an understanding of a new situation with the singularity of a new empirical fact, be changed and supplemented by new laws. This may be accomplished by overcoming the abstract formalism of the Aristotelian-Hegelian dialectic, superseding it with a trialectic, which takes into account the outcome of the dialectical movement—an Event, being a response of the environment to our action upon it. This Event changes the structure of the medium in which localization[4] originates and lives, moved by the dialectical transformation of *opposites*, which social psychology initially treated, perversely, as *contradictions battling one another and precluding any genuine dialogue of the opposing sides:* the Event, with which localization ends its life, creates a new structure of the medium and a new perceptual-conceptual situation for humans, the comprehension of which represents the resolution of an "ontological paradox," as demonstrated by Plato (L. LaRouche).[5] It (the comprehension) reveals a *new lawfulness* of motion: indeed, the Bartini-Kuznetsov LT-system of measurement[6] was discovered, elevating the dialectic to the trialectic.

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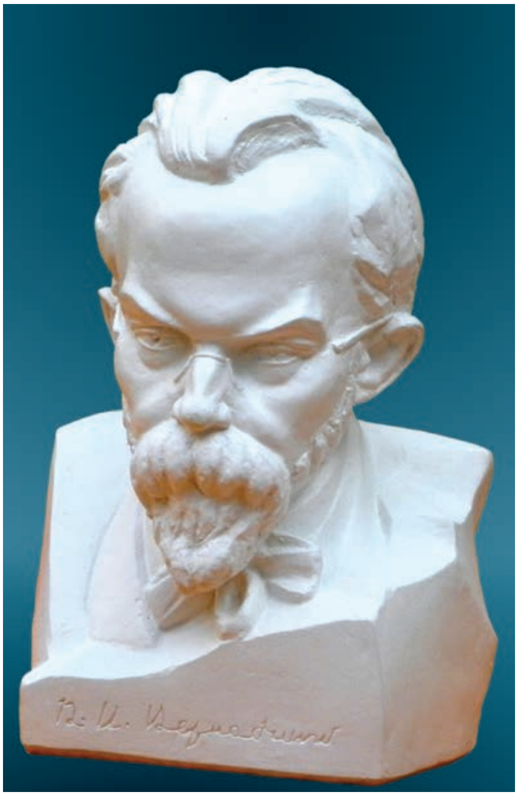
3. The author refers here to the need for partial replacement of an overbloated state sector of an economy by responsible private ownership of companies, rather than to the swindles imposed under the name of "privatization" in the post-Soviet area in the 1990s, when state property was carved up by a new, criminalized economic oligarchy and the new financial relations hitched these countries' economies to international speculative and criminal money flows.

4. The term "localization" is employed in the sense in which it is used in the synergetics school of Hermann Haken, referring to the origination of order and organization within chaos. In the present context, it denotes a structuring (organization) of some portion of the medium, which synergetics describes as self-origination and subsequent self-development until the moment of its destruction. –Author's note.

5. "The Science of Physical Economy as the Platonic Epistemological Basis for All Branches of Human Knowledge," Section 2.1, *EIR*, Feb. 25, 1994. Discussing the "hereditary principle" in formal systems, such as the economic systems of Adam Smith, Karl Marx, and John Von Neumann, which claimed to be "logically consistent formal systems," LaRouche noted challenges to such claims, such as the challenges contained in the work of Georg Cantor and Kurt Gödel. He then wrote, "As Plato demonstrated this famous ontological paradox by his Parmenides dialogue: that unifying conception of change which, as a generating principle, subsumes and thus bounds all of the members of a collection, cannot be itself a member of that collections." This essay was published in Russian as a book titled *Fizicheskaya ekonomika* (Physical Economy), Moscow: Nauchnaya Kniga, 1997.

6. The LT table of physical magnitudes and relationships (L stands for "length" and T for "time") was invented by Roberto Oros di Bartini (1897-1974), a famously innovative Italian-born Soviet aircraft designer. His Russian collaborator Pobisk Kuznetsov further developed the method during his work at the Scientific Council on Planning Large-Scale Systems on the Basis of Physically Measurable Magnitudes.

Thus the following task arises: to make use of a fact known to philosophy, and now scientifically confirmed, namely, that our mind, possessing an anticipatory function in creating a model of the future we need, while reflecting the outside world, also creates it. The problem comes down to whether this is done in a deliberate and reasoned way, or, rather, as the kind of subjectively advantageous creation seen in the *biased opinions* of that financial alchemist George Soros (*The Crisis of World Capitalism: Open Society in Danger*, 1998). Insofar as entrepreneurs use something like this in methods based on a targetted end-result, we would be able to create our future through reason, since the algorithms of self-organization have already been established in first approximation!



V.I. Volkova (Kremenchuk, Poltava Region, Ukraine), bust of V.I. Vernadsky. Plaster, 2005. Gift of A.I. Ignatenko to Lyndon LaRouche, 2009.

Vernadsky was right, when he wrote to his wife from Vernadovka: "There is one fact about the Earth's development, and that is the ever stronger power of the conscious mind" (June 29, 1893).

His ideas involve this principle of the sustainable development of society: coherent continuity across time, as a result of our consciously following Kuznetsov's law of historical development, which is based on Vernadsky's notion that life is a universal physical principle of the Universe. Pobisk Kuznetsov stated this law in terms of *the preservation of a nondecreasing rate of growth of the utilization of free energy.* It requires continuity in the succession of generations: the cultural dialogue of fathers and children must become relevant for overcoming the trap of cyclicality in history. Disjunctive synthesis (without the identity of opposites), which was the preceding form, prior to this dialogue, of realization of the actually *constructive* character of relations in the dichotomy of position-opposition, produces the coherent succession over time.

Hitherto, in the generational changeovers by which Vernadsky proposed to measure *historical time*, we have had not continuity, but rather a maelstrom of negation: struggle with one's past, instead of *preserving the vector of development of society and improvement of its social organization*, the essence of which is *justice.* For a start, justice could be in the form of equal access to resources, instead of the current struggle for them and attempts to legitimize that, using lies about the recent past. Mere compromise and social partnership have run their course.

As for how to relinquish the past and envision the future, no better idea has yet been found than that of a "renaissance," in the sense of a restoration of the past: the long ago deciphered phenomenon of an unconscious objective construction of the future, involving a conscious, subjective attempt to resurrect the distant past. The character of evolution is determined by its entire past, while its velocity is a function of stored-up mass and accumulated energy, but *irreversible* time demands that the future *be constructed* from *the recent past*. Sustainable development demands the exploration, in order to change it, of the nature of the *inequality* that comprises the tragedy of life, an inequality which has been justified on the grounds of an inevitable internal hierarchy, the "harmonically correct distribution of objects" (Tolstoy), in development and life, through *subordination*, or a *relative, subjective ordering of values*.

In a letter to I.I. Petrunkevich (held in the Bakhmetev Archive at Columbia University in the USA), Vernadsky wrote in the early 20th century: "There must be some kind of ordering of life, under which this inequality would be accepted as something that goes without saying, and would not be recognized as such." The example here is an organism.

Can we accomplish this? Is the answer connected with self-identification? That means the self-consciousness of all agents of vanguard and equifinal cycles of the evolutionary process, but especially of their wave front. Who will this be? One who leads a morally responsible vanguard of the intelligentsia into the future, or the smug and parasitical elite of the Golden Billion,[7] attempting to consolidate the past?

Translated from Russian by Rachel Douglas. Subheads were added and notes supplied by the translator and editors, except where otherwise indicated.

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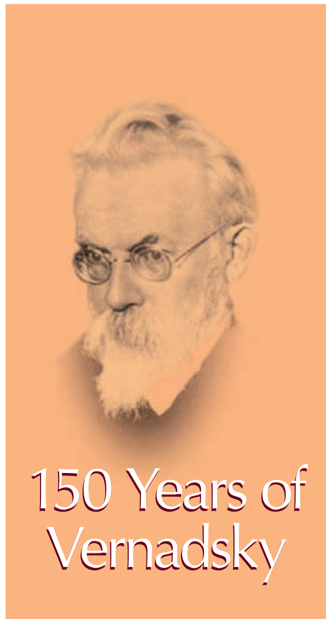
7. The term "golden billion" is used to denote the portion of the world's population, living primarily in so-called advanced-sector nations, who are better off than the remainder of people on the planet.

Biospheric Energy-Flux Density

by Benjamin Deniston



Tyrannosaurus Rex

In a February 5, 1928 speech given to the Society of Naturalists of Leningrad, Vernadsky made a series of concrete arguments that go directly against the core ideology of what is generally recognized as the modern environmentalist, or "green" movement. The specifics of the argument made there have crucial implications for today.

One year later, Vernadsky included this speech in the 1929 French publication of his seminal work, *The Biosphere*. According to Vernadsky, "I attach, as an appendix to the French translation [of the Biosphere], my speech, 'The Evolution of Species and Living Matter,' which seems to me to supplement the ideas established in *The Biosphere*".[1]

Here Vernadsky directly addresses the evolution of life on Earth from the standpoint of his concepts of the distinct, but interacting phase-spaces of the biosphere, lithosphere, and noösphere, concluding that evolution has a direction, and a specific, irreversible form of progress:

> 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…
>
> [This second biogeochemical principle] 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… 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

1. See Vernadsky's introduction to the French translation of *The Biosphere*. For an English translation of the introduction and the speech, see "The Evolution of Species And Living Matter," translated from French by Meghan Rouillard, *21st Century*, Spring-Summer 2012. All indented quotes below are from this translation of Vernadsky's speech on evolution.

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.

This concept runs in direct contradiction to the entire British reductionist school of thought which has increasingly dominated science over the course of the past century, and underlies the entirety of the founding of the modern environmentalist movement which has corrupted the morality of much of the population today. (See Box.)

This is not an academic debate: the governing beliefs in science and society have real-life consequences and effects. As Vernadsky clearly knew from his unique work on the concept of the noösphere, human progress can be studied in terms of the physical effects of scientific and cultural thoughts and discoveries. There are knowable benefits, or losses, resulting from either the successes, or failures, of humanity to progress scientifically and technologically.

For example, despite the depths of the immediate hyperinflationary crisis (the growing actual unemployment, the long-standing collapse of the productive capabilities of the trans-Atlantic region, unacceptable levels of global poverty and starvation, a looming collapse of food supplies for even developed nations, etc.), there is still a persisting delusion of investing in so-called "green jobs" and the "green economy," *activity inherently characterized by actually lowering the productive capabilities of the population per capita, necessarily resulting in mass death and suffering.*[2]

Understanding the principles underlying a scientifically definable nature of progress is of utmost importance for the immediate state of mankind. One path towards illustrating this principle is taking up Verandsky's challenge to identify the relationship between the overall progressive

2. Mass genocide is not simply a consequence of the policy, but the explicit intention, as stated and demonstrated repeatedly by the founders and orchestrators of the green movement. See, "Behind London's War Drive: A Policy To Kill Billions," by Nancy Spannaus, *Executive Intelligence Review* magazine, November 18, 2011.

British Reductionism: Evolution from The Standpoint of Imperialism

One year after Vernadsky gave his Feb. 5, 1928 speech, and the same year as its French publication, British imperial establishment figures H. G. Wells and Julian Huxley published a book, *The Science of Life*, in which they reiterated the British school's rabidly reductionist view of evolution. This view was also clearly expressed by Alexander Oparin, with whom Vernadsky was directly at odds over the fundamental nature and origin of life. Wells and Huxley write:

> Variation is at random, selection sifts and guides it, as nearly as possible into the direction prescribed by the particular conditions of the environment. Once we realize this, we must give up any idea that evolution is purposeful. It is full of apparent purpose; but this is apparent only; it is not real purpose. It is the result of purposeless and random variation sifted by purposeless and automatic selection. In brief, we are confronted with the gravest theological difficulties if we too light-heartedly set out to see purpose in Evolution. The wiser and saner course is to acknowledge our ignorance of ultimate causes and designs.

The concluding sentence of this quote is reminiscent of Adam Smith's famous quote from his *Theory of Moral Sentiments*:

> To man is allotted a much humbler department... Nature has directed us to the greater part of these by original and immediate instincts. Hunger, thirst, the passion which unites the two sexes, the love of pleasure, and the dread of pain, prompt us to apply those means for their own sakes, and without any consideration of their tendency to those beneficent ends which the great Director of nature intended to produce by them.
>
> —Adam Smith, *Theory of Moral Sentiments,* 1759

The view of Huxley and Wells sounds much closer to the stated social doctrine of the British Empire, imposed on populations for cultural and political effects, and less like valid scientific thought. This doctrine holds as a central axiom that there is no knowable purpose or inherent progress in the universe, and, if there were, mankind would have no business attempting to know the purpose, much less consciously intervene to determine his own fate. That is the doctrine the British Empire has fought to impose on the general population of the world in one form or another, be it in science, or in economics.

See Meghan Rouillard's article in this issue: "A.I. Oparin: Fraud, Fallacy, or Both?"

nature of the biosphere as a whole—as understood from his perspective of biogeochemistry and the role of living species—and the evolutionary change of living species within his understanding of the biosphere.

> 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… the agreement of evolution with [that 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.

In honor of 150 years of Vernadsky, these questions are now re-assessed from the perspective of the 85 years of scientific work accomplished since Vernadsky delivered this speech.

The Conceptual Groundwork

Addressing Vernadsky's challenge will require drawing upon both the body of his life's work, but also the related discoveries of Lyndon LaRouche. LaRouche's founding of the physical science underlying the growth and development of human societies, *physical economics*, uniquely converges upon the same subject of study as Vernadsky's noösphere in a very important way.

Specifically, LaRouche developed the concept of *energy-flux density*, initially as an indispensable metric of economic progress. Measuring energy throughput, per unit time, per unit area, energy flux density proved to be one of the factors most intimately correlated with economic growth and progress.[3] Compare, for example, the vastly superior energy densities of nuclear reactions, fission and fusion, with chemical combustion (and especially with the ridiculously low energy density of wind and solar power systems).

Since demonstrating that *increasing* the energy-flux density of an economic system is critical to progress, LaRouche indicated that this characteristic could be generalized, as a property of other developing (anti-entropic) systems as well, such as in the development of life on Earth, or perhaps even in certain astrophysical processes. The "energy" measured will obviously be of a different form, but the general property of increasing density of action and change should remain as an indicator of progress.

As to Vernadsky's discoveries, while rejecting the fraud of Alexander Oparin, he fully promoted and continued the work of Louis Pasteur on what he referred to as the principle of Francesco Redi: *life only comes from life*.[4] In Vernadsky's work, living organisms not only express a distinct universal principle, but their domain of action, the biosphere, operates at a quantitatively and qualitatively higher rate of activity compared with that of the surface of a planetary body unaffected by life (the lithosphere). Thus the biosphere is superior, and has transformed the face of the planet at speeds and in ways impossible in the domain of the lithosphere devoid of life. Furthermore, the biosphere, driven by the evolutionary advance of life, has done this at successively higher and higher rates, defining a true direction and measure of progress in the history of life on Earth.

Moving beyond the biosphere, Vernadsky also recognized that human creative thought is a force absolutely distinct from anything expressed by simply animal life as such. The domain of action of scientific discoveries, of creative of human thought, identified as the *noösphere*, expresses a rate of activity growing much faster than that of the biosphere, overtaking and transforming the biosphere, raising it to higher rates of activity than the untended biosphere could ever accomplish.[5]

Overall, Vernadsky's revolutionary approach to evolution did not come from a foundation built on the characteristics of individual organisms, but rather sprang from his unique concept of the biosphere, and its tiered interaction with the lithosphere and noösphere. Vernadsky saw an overly narrow focus on individual species, abstracted from the context of the biosphere, as artificially limiting the investigation and thus preventing a fuller understanding of the nature of life.

> 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

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3. For an introduction into LaRouche's science of physical economics see his *So, You Wish to Learn All About Economics?*, New York: New Benjamin Franklin Publishing House, 1984.

Based on LaRouche's method, from the late 1970s through 1987 the economic staff of *Executive Intelligence Review* magazine (founded by LaRouche), produced a series of regular economic reports and forecasts which far surpassed official government and other private economic analyses produced over the same time period: the *EIR Quarterly Economic Report*.

4. See Vernadsky's three essays on the material-energetic distinction between life and non-life, "On Some Fundamental Problems of Biogeochemistry," "Problems of Biogeochemistry II," and "On the States of Physical Space." Available in the *21st Century* Winter 2005 (http://bit.ly/AxeuMd), Winter 2000 (http://bit.ly/wrL86T), and Winter 2007 (http://bit.ly/zYLPZY) issues.

5. For Lyndon LaRouche's analysis of the principled importance of Vernadsky's work from the standpoint of the historical continuity of the development of extended-European science with the history of science itself understood from the standpoint of physical economic progress in terms of the fundamental cultural development of human society. See LaRouche, "Vernadsky and Dirichlet's Principle", *EIR*, May 18, 2005.

exist independently of the biosphere, nor to be divided from it as separated natural entities.

This connection is intimately expressed in what Vernadsky identified as the *biogenic migration of atoms*, the continuous consumption, respiration, and other forms of material-energetic exchange between living organisms and the surrounding environment.

According to this understanding, living organisms become special kinds of singularities in the biosphere, composed of continuous fluxes of atoms, coming from, and returning to, the surrounding environment, but also, *more crucially, they are the energetic drivers of the entire biosphere, constantly shaping it, maintaining it, and bringing it to a more energy-dense and more highly organized state by their activity*. If living organisms were to stop their activity, the surface of the Earth would rapidly, in a geological "moment" of time, approach that of a planetary body like Mars.

Vernadsky shows, on this basis, that the evolution of living organisms is inseparable from, and the driving force in the development of the biosphere as a whole, while at the same time, an integral component *of* the biosphere, completely dependent upon it. Therefore, instead of solely focusing on the visible morphological structure of the organism, as is the practice of the standard biologist or paleontologist, the study of the material and energetic interaction of the living organism with its surroundings, the study of *biogeochemistry*, becomes absolutely indispensable in understanding the nature of the direction and progress in evolution.

> 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 number, and species is considered from an *arithmetic* point of view.…
>
> 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.

The current, abstracted view of a species, defined solely by its visual appearance (or by its DNA), while not useless, is not sufficient to define the history of life on the planet. What is needed is a study of the totality of a species, and of various species, their interactions, and their ability to change and transform the surrounding environment. The action of the species in affecting the entire process of the biosphere becomes the primary point of reference, especially when that action is understood from its contribution towards creating a new, higher-order state of the biosphere.[6]

Vernadsky on Evolution

From this vantage point, Vernadsky converges on a measure of progress in evolution that falls under the concept of *energy-flux density* independently developed by LaRouche.

The ability of organisms or species to perform action in the biosphere Vernadsky called *geochemical energy*. In this way the displacement of chemical elements from one location to another, or from one form to another, by organisms can be measured. In his "Evolution of Species and Living Matter," Vernadsky focuses on three forms of this *biogenic migration of atoms.*[7]

1. **The basic biogenic migration created by living organisms:**
   The living organism during its life, is an incessant current, a whirlpool 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.
2. **The rate or intensity of the biogenic migration of atoms:**
   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 at-

6. This is similar to a physical economic pedagogy of LaRouche. Taking a standard auto mechanic in the economy, can we really define the value of his actions, his productivity, solely by the actions he performs as such? Say he makes the exact same repair on the exact same car of two different individuals. By standard monetary economic accounting, both repairs would supposedly have the same value, the same hours of labor, parts, etc. However, if the first individual is then able, by aid of the mechanic's actions, to continue his work asset-stripping industrial firms, while the second is then able to continue his work producing tractors for farming production, the *physical economic* value, defined by the contribution of the worker to the productive capabilities of the entire economy, is drastically different.

7 Vernadsky also cites a fourth kind, but does not elaborate on it in detail in that location.

oms encompassed by life is identical. That is the second form of biogenic migration, in relation to the intensity of the biogenic current of atoms.

3. The biogenic migration due to technological developments:
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.

These are three expressions of the geochemical energy of living organisms in the biosphere. The organism, or species, is understood, thus, not solely by its morphological structure, but by its power to effect change, specifically measured in terms of the growth and expansion of the biosphere over the lithosphere, as, for example, measured in these three forms of biogenic migration.

Focusing on evolution specifically from his understanding of the inseparable material-energetic interdependency between living organisms and the biosphere, Vernadsky formulates what he calls his *second principle of biogeochemistry* (different from his three types of biogenic migration).[8]

> 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.

Vernadsky argues that even if the total mass of living matter were to remain constant,[9] over evolutionary time there will still be an increase in the *rate* of the biogenic migration, that is, increase in the biogenic flux, per mass of living matter, per unit of time. Or, in LaRouche's terms, an increasing energy-flux density of the biosphere.

According to Vernadsky, this should be the key characteristic of the directional progress of evolution. Since Vernadsky's accomplishments, decades of new evidence have accumulated, providing a new basis to conclusively demonstrate his concept of the nature of irreversible progress governing the development of life on Earth.

The New Evidence

Various proxies provide indications of the conditions of the biosphere during past periods, and when viewed in light of Vernadsky's concept of the second biogeochemical principle, can provide excellent support for his views on evolution.[10]

First, evidence of the geochemical energy of species from previous periods is sought. This is not directly measured in absolute terms; rather, various proxies are investigated, either from the geological and biogeochemical records, or from descendants or holdover species from previous periods. An estimate of the geochemical energy of different taxonomic *classes*, for example, as opposed to species, often proves more insightful, because this taxo-

8. Vernadsky described his first biogeochemical principle as "the pressure of life," specifically: "*the biogenic migration of chemical elements in the biosphere tends towards its most complete manifestation.*" This is expressed, for example, in the tendency of life to expand into every location of the biosphere that it is technologically and energetically capable of occupying.

9. Although in this 1928 speech Vernadsky discusses a relatively fixed total mass of living matter over time, by 1938 he argues that the total mass has increased over evolutionary time. Given the fact that estimates of even the current living biomass vary, speculations on the total living biomass of previous geological periods will not be discussed here, and the evidence for changes in the rate of activity per unit mass will be investigated instead.

10. A significant amount of supporting evidence for Vernadsky's second biogeochemical principle is provided by a relative handful of studies from the past three decades. The work of the authors of these studies is of great significance for Vernadsky's concept, and, when understood from his science of biogeochemistry, provide additional support for a long-overdue fundamental revolution in the scientific understanding of the history of life. The fact that such a revolution has not already occurred, can only be attributed to the insistence on interpreting the evidence from within the accepted framework of ideological biases, typified by the continuing legacy of the British reductionist school, as expressed in, for example, Thomas Gould's unoriginal arguments attacking the concept of direction and progress in evolution. Science is often held back not by the quality of the evidence, but by the quality of the assumptions by which the evidence is interpreted. A revolution in the understanding of evolution will require the perspective of Vernadsky's biogeochemical analysis, and the independent work of both Vernadsky and LaRouche on the science of anti-entropic systems.

nomic level often specifies key characteristics which define the geochemical energy of an entire set of species.[11] Key proxies are found in indications of:

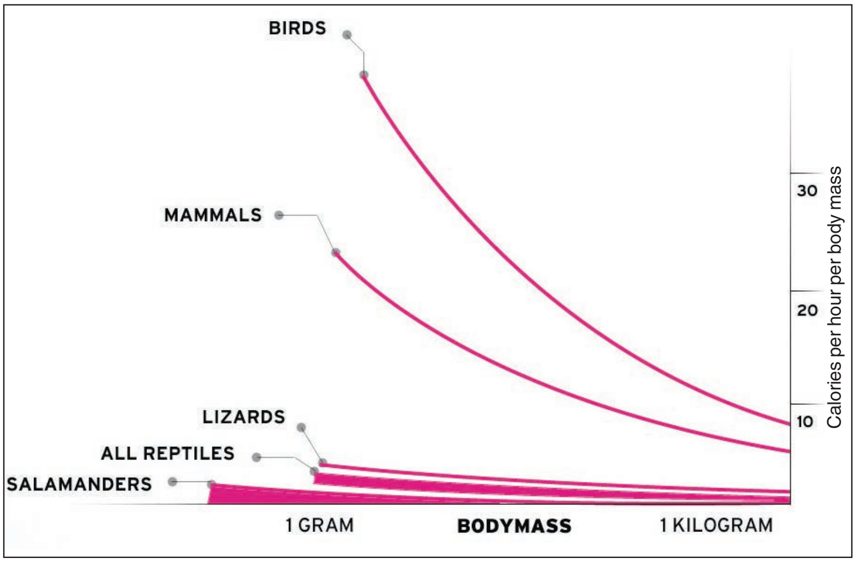
1. The metabolic rates of organisms.
2. The development of more energy intensive modes of life, such as actively pursuing and consuming other animals for food, predation.
3. The technological ability of organisms to freely move through the biosphere, expand their reach into new domains, and to alter the surrounding environment through their actions.

These are understood from their correspondence with Vernadsky's three forms of biogenic migration listed above.

Second, species tend to rise and fall in rough correspondence. This parallel turnover can be especially clear when examining the middle-level classifications (around the order/class taxonomic levels), pointing to the possibility that the correspondence indicates a characteristic geochemical energy associated with interacting and interdependent sets of species (or orders/classes, etc.). The progressive nature of the development of life is most clear from this perspective of sets of various interacting orders/classes defining large-scale orderings to the material-energetic structure of the biosphere across geological time (both in terms of the rate of biogenic migration, but also, possibly, in variations in the specific chemical elements in circulation, and in the biological and chemical structures formed by them). As will be seen below, there is remarkable evidence that specific biospheric sets define periods of relative stability across long periods of geological time, indicating a single level, or stage to the entire biospheric system.

Third, from one stage to the next, the geochemical energy of the biospheric system increases, specifically in terms of the biospheric energy-flux density, demonstrating Vernadsky's principle of progress in evolution.

Figure 1
Metabolic Rate



Adapted from "Amphibians and Reptiles as Low-Energy Systems," by F. Harvey Pough, in *Behavioral Energetics: The Cost of Survival in Vertebrates*, Ohio State University Press, 1983.

For any given species, or certain classes, the metabolic rate of an organism will scale with the size of the organism in a specific, fixed way. However, different species or classes of organisms will have different values of the entire class, such that comparing examples of the animals of the same weight from different classes yields different metabolic rates. Here metabolic rates are expressed per unit mass of various classes and species of vertebrate tetrapods.

Metabolic Rates and Biogenic Migration of the Second Type

To start, compare the metabolic rates of different classes of vertebrate animals: for example, today's birds, mammals, reptiles, and amphibians. Their average metabolic rates show a clear succession (see Figure 1). A lower metabolic rate translates into lower respiration and consumption, and thus a lower geochemical energy (a lower rate of displacement of the surrounding material of the biosphere).

The question then is: how have the metabolic rates (and thus the geochemical energy) changed over the course of evolution?

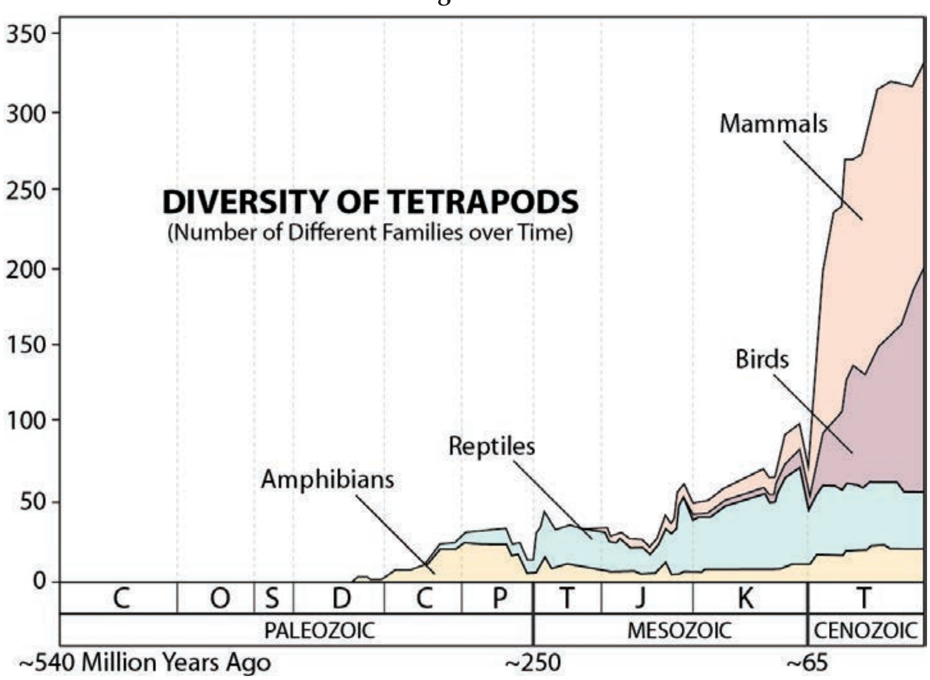
On a larger scale, it has been known that the past 400 million years have been characterized by the succession of the age of the amphibians (lasting until 250 million years ago), to the age of the reptiles (lasting until 65 million years ago), to the age of the mammals (see Figure 2). However there are many intricacies (such as the question of whether dinosaurs were warm- or cold-blooded) which prevent a *direct* application of the metabolic rates of living reptiles and amphibians to some of their more famous ancient forerunners, although there are likely certain characteristic similarities.

11. For example, the difference, especially in terms of geochemical energy, between two different species of mice is much less significant than the difference between a mouse (representing the mammalian class) and a lizard (representing the reptilian class). The standard taxonomic order, from low to high, is: species, genus (plural genera), family, order, class, phylum, kingdom.

The common amphibians of today are different from those dominant forms of seemingly amphibian-like vertebrates of 300 million years ago. The ones we find today did not exist then, and the skeletons of those we dig up from millions of years ago do not exist now... at least not most of them.

There are curious cases, however, often referred to as "*living fossils*," which help provide a critical glimpse into the ancient past. These are identified as species which emerged in the distant past, and have remained for a long period of time, having changed little for millions of years. There are only a very few such species of any given group, and they are often found in remote locations, either having been isolated from the main mode of the biospheric animal system, or having found new, minor roles in new biospheric stages.

Figure 2



Generalized succession of dominant forms of vertebrates illustrated by the comparative number of known families over geological time. Examining the number of genera or species, instead of families, yields slightly different curves, but the same series of successions.

Image adapted from Michael Benton, "The history of life: large databases in palaeontology" in D. A. T. Harper (ed.), *Numerical Palaeobiology*. Wiley, Chichester, 1999, pp. 249-283.

For example, a handful of strange egg-laying species of mammals still inhabit regions of Australia and the surrounding islands. These are mammals of the *monotreme* order, and only two forms exist, the echidnas, of which there are only four species, and the platypus, with only one species. As of recent studies,[12] it is thought that the echidna and platypus have existed for over 110 million years, and that the currently living species are representatives of this distant time. Thus they are often referred to as "living fossils."

Another strange grouping of mammals separates itself, *marsupials*, distinguished by their pouches, used to raise their young, instead of the placenta of the more common *placental mammals* of the biosphere today.

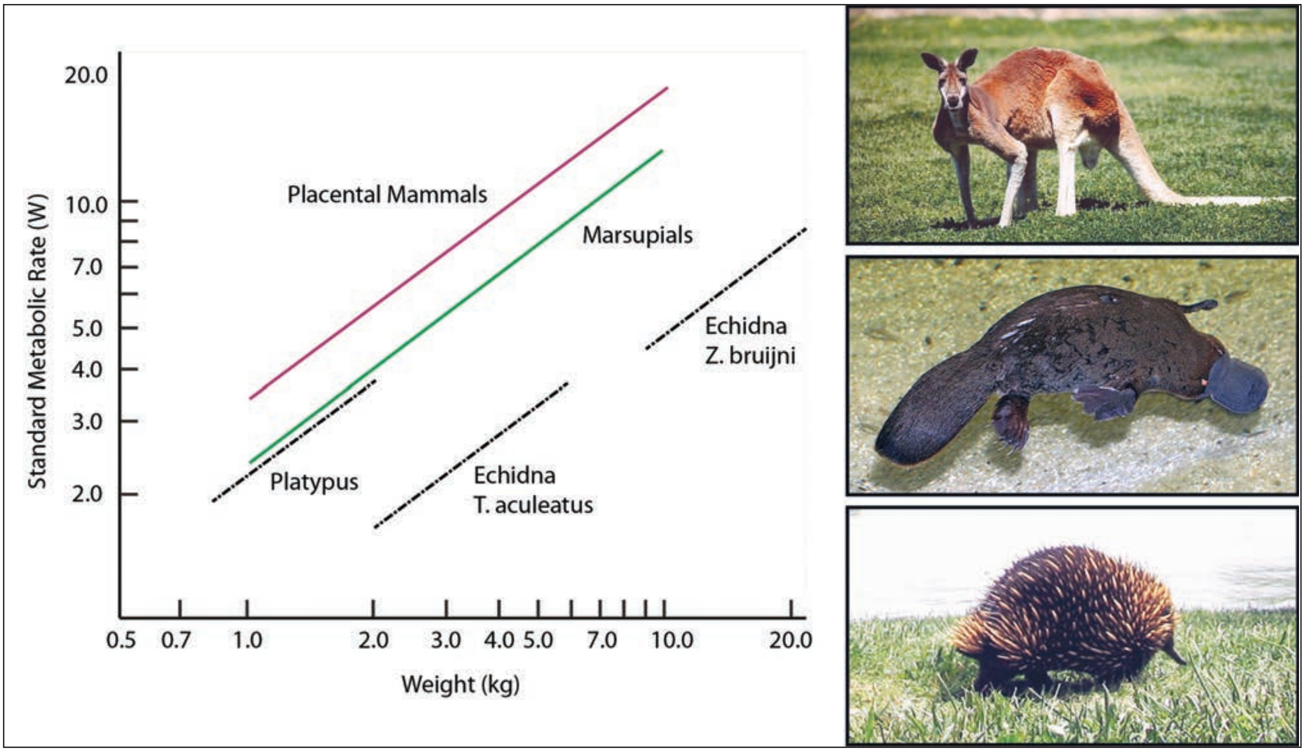
Monotremes, marsupials, and placental mammals comprise a set of three very distinct forms of mammals which show distinct energetic differences. All are warm-blooded, but some are more so than others. The monotremes have average body temperatures of only about 90°F. Marsupials maintain a higher average body temperature, around 95°F, which is still below the average body temperature of most placental mammals, about 99°F. These different body temperatures correspond to the same succession of different metabolic rates, as indicated in Figure 3.

This indicates that the placental mammals express a characteristically higher geochemical energy. Based on Vernadsky's concept of progress being expressed in increased biogenic migration of atoms, this may be viewed as a fundamental reason for the global dominance of placental mammals (with an estimated well over 5,000 species), the lower role of marsupials (with a little over 300 species), and the tucked-away handful of monotremes (5 species).

Currently the latter two groups are mostly found in and around Australia, largely isolated from the core placental mammal mode. But that was not always the case. For tens of millions of years, South America maintained a strong and diverse marsupial population, including many species appearing remarkably similar to certain placental mammal parallels (such as a marsupial version of the saber-toothed cat, for example). This diverse marsupial population of South America flourished, as long as it remained separated from North America, which was the case for

12. "Molecules, morphology, and ecology indicate a recent, amphibious ancestry for echidnas," Matthew J. Phillipsa, et. al., *PNAS*, October 6, 2009, vol. 106, no. 40.

Figure 3



A graph showing the average metabolic rates of placental mammals, marsupials, and three species of monotremes (a platypus and two echidna) compared on a logarithmic scale. Different from the metabolic comparison in Figure 1, this measures the total metabolic rate of the whole organism (as opposed to the metabolic rate per unit mass). Pictures (top to bottom) of a kangaroo (marsupial), a platypus (monotreme), and an echidna (monotreme).

Graph adapted from page 144 of *Comparative Physiology: Primitive Mammals*, by Knut Schmidt-Nielsen, Carla Liana Bolis, and Charles Richard Taylor; Cambridge University Press, 1980. Echidna picture from wikipedia user Skyring, platypus picture credit Stefan Kraft.

tens of millions of years. About three million years ago, a landbridge re-connected South and North America (the formation of the Isthmus of Panama) and for the first time, the placental species of the north moved into South America, largely overtaking and replacing the marsupial system with the higher-order placental mammal system, leading to the extinction of the vast majority of the South American marsupial system.[13] Although this also gave the southern marsupials a chance to migrate north, only a few species, such as the opossum, were able to integrate into the placental mammal system, but no extinction of placental mammals as a consequence of marsupial migration is recorded. The introduction of the placental mammals into a marsupial system had a completely different effect than the introduction of the marsupials into a mammalian system.

Today, the last small foothold of the marsupial system is on and around the isolated continent of Australia.

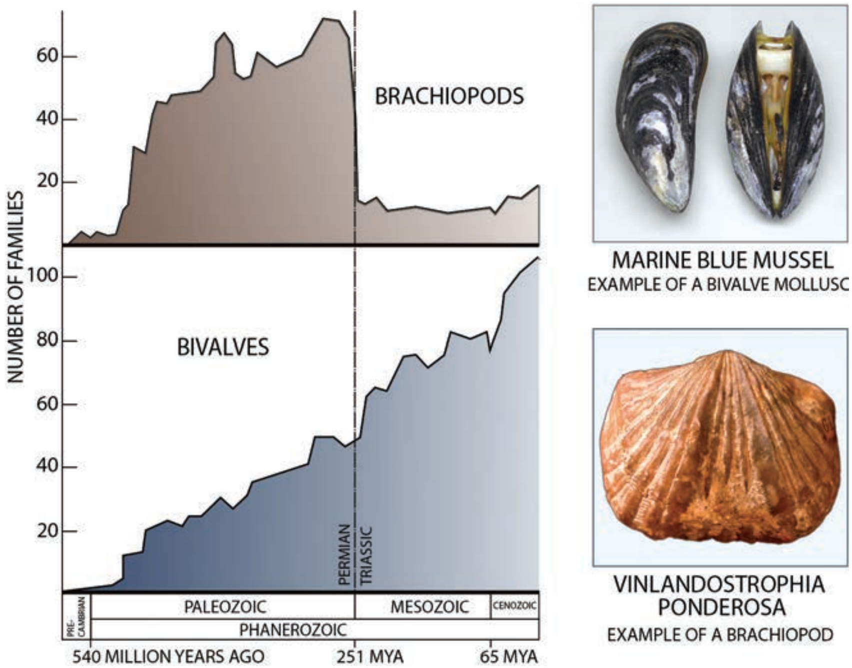
Marsupials aren't the only strange creatures tucked away in that corner of the planet. A second example is the creature known as the tuatara. Although looking like a lizard, the tuatara is actually a significantly different holdover from 200 million years ago (a time well before the modern lizards of today emerged). Currently there are only two living species, isolated to New Zealand and some surrounding islands. From the perspective of Vernadsky's geochemical energy, what stands out is the significantly lower metabolic rate, with average body temperatures half to a quarter that of comparable modern lizards. Keeping with the pattern of lower-energy systems being driven out by higher-energy systems, currently the tuatara species are being threatened because rats have be-

13. As one geologist who is an expert in the region stated quite frankly, "If the Isthmus of Panama [the landbridge] was not there, the world would be very different today. All the animals of South America would be unique marsupials, like in Australia, very different to today because they would never have been invaded and overtaken by all the species that colonized from North America." See "How the Isthmus of Panama Changed the World," April 13th, 2011, Smithsonian Journeys blog. (http://www.smithsonianjourneys.org/blog/2011/04/13/how-the-isthmus-of-panama-changed-the-world/)

gun to populate the islands, and are threatening to overtake the tuatara which had hidden in their lower-energy haven for tens of millions of years.[14]

One last specific example shifts the discussion from the Australian region of the planet to oceans all over the globe. For hundreds of millions of years, the ocean floors were populated with forms of two shelled creatures called brachiopods. They are actually the most common animal fossils found from the Paleozoic era,[15] due to both their abundance and the fact that they fossilize well. Despite the fact that they appear visually similar to clams, they are actually quite different, and separated by 600 million years of evolution.[16] Both these ancient brachiopods and our modern day clams (and their bivalve class) are filter feeders, constantly circulating volumes of water through their bodies and playing an important role in the biogeochemistry of ocean systems. The evolutionary transition from the domination of brachiopods to bivalves is a well-studied case in paleontology for a few reasons, but, specifically for the argument here, it expresses another example of increased geochemical energy of the biosphere. Tests on modern bivalves indicate nearly ten times the metabolic rate of modern brachiopods, translating to a higher rate of circulation of the ocean water, migration of chemical elements, transformation of material, etc., and they are more effective at filtering food from the water. In the paper, "Seafood Through Time," paleontologist Richard Bambach discusses how this is associated with bivalves having greater capabilities in the biosphere, and why the modern brachiopods are relegated to the outskirts of ocean floor communities where food supplies are low:

Figure 4



Comparison of brachiopods to bivalve molluscs over the past 540 million years in terms of the total number of families found at any one time.

"Clams and Brachiopods-Ships that Pass in the Night," *1980, by Stephen Jay Gould and C. Bradford Calloway; "Seafood through time: Changes in biomass, energetics, and productivity in the marine ecosystem," Richard Bambach; Paleobiology,* Vol. 19, No. 3, Summer 1993, pp. 372-397. Blue mussel photo from wikipedia user Rainer Zenz.

> For example, Thayer (1981) called the sedentary, passive, suspension feeding articulate brachiopods "minimal organisms" and pointed out the variety of ways in which [brachiopods] function with low energy expenditure. In contrast… bivalve mollusks are more active. Many move around, even if sluggishly, some burrow actively, and some scallops can swim. The contrast extends to metabolic rates. Peck et al. (1989) reported that, for individuals of equivalent biomass under similar physical conditions, the oxygen consumption rate for the articulate brachiopod *Terebratulina retusa* (L.) is only 12% of that of the byssate bivalve *Mytilus edulis*. Thayer (1992) argues that the low energy requirements of articulate brachiopods accounts for their continued abundance in low food supply (oligotrophic) environments while bivalves dominate in more food-rich habitats.[17]

As expressed in the case of brachiopods versus bi-

14. Just recently, a New Zealand financier and rabid environmentalist, Gareth Morgan, has drawn international attention for promoting a campaign to eliminate all cats from New Zealand, including calls for possible mass euthanization of stray cats, because they are posing a threat to the native bird population of the island. The threatened birds include more unique holdovers, such as the New Zealand wattlebirds, of which there are only two remaining species, and likely stem from a split from other birds over 80 million years ago. New Zealand's famous oddity, the Kiwi, is also threatened by the mammalian invasion.

15. The Paleozoic era lasted from roughly 540–250 million years ago.

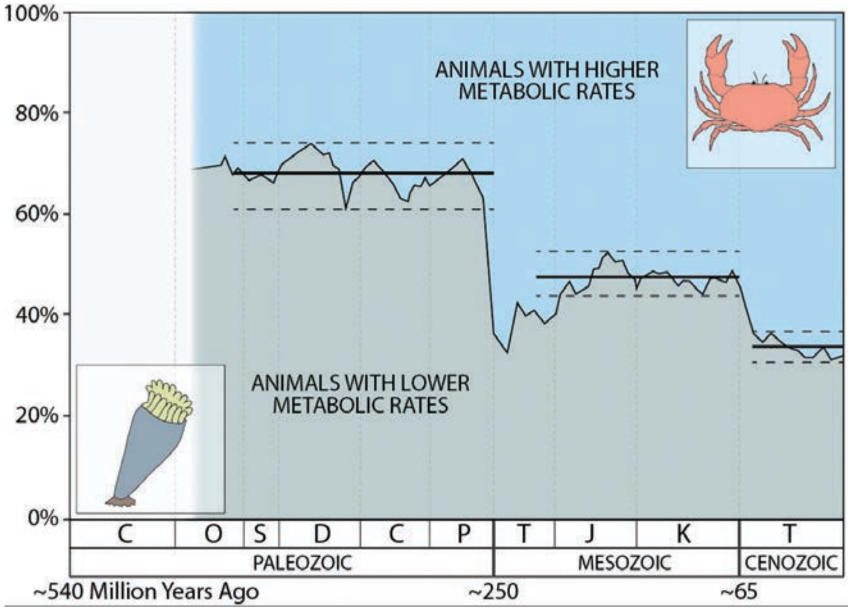
16. Clams (oysters, scallops, mussels, etc.) are part of the bivalve class of the mollusca phylum. Brachiopods makeup their own distinct phylum, based on fundamental structural differences.

17 Richard Bambach, "Seafood through time: Changes in biomass, energetics, and productivity in the marine ecosystem," *Paleobiology*, Vol. 19, No. 3, Summer 1993, pp. 372-397.

valves, and in other examples above, the general trend has been the displacement of less-energetic forms of life with more energetic ones. For example, in the oceans today, the only places that forms of life which used to dominate in Paleozoic era continue to reign, are in low-energy regions, with lower food supplies or on the fringes of the more productive regions of the biosphere.[18]

The examples above have only focused on comparing specific groups. An indication of the changes in the metabolic activity of the *entire ocean system* is provided by a 2002 study, examining tens of thousands of living and extinct genera over the past 500 million years.[19] This takes the investigation of geochemical energy out of specific examples, and begins to approach the entire biosphere.

Figure 5



The changing percentage of animal genera in the ocean with high versus low metabolic rates over time.

Image adapted from "Anatomical and ecological constraints on Phanerozoic animal diversity in the marine realm," by Richard Bambach, Andrew Knoll, and John Sepkoski, May 14, 2002; *PNAS*.

The study took a total number of 40,859 distinct ocean genera recorded in the geological record and divided them into two groups: those characterized by higher metabolic rates and those characterized by lower rates.[20] They then examined the changing ratio between these two groups over geologic time. The results would grab Vernadsky's attention at once.

Two remarkable characteristics immediately jump out (see Figure 5). First, the relative stability of the biospheric system for many tens or even hundreds of millions of years: from about 445 to 250 million years ago, the division hovered around 70% of animals having lower metabolic rate, 30% higher. When a dramatic change occurred, ending this stage, the system re-stabilized at a new division of about 50 / 50. Approximately 65 million years ago, the last major shift brought the proportion of animals with lower metabolism to only about 35% and those with higher metabolism to 65%, thus nearly inverting the ratio from earlier conditions. At each stage, the values fluctuate around levels that are characteristic of that stage, suggesting that these levels are not accidental, but rather indicate a larger evolutionary structure of life, intimately tied to this concept of geochemical energy.

This analysis alone, examining the proportional structure of animal life in the oceans over time, provides very strong evidence for Vernadsky's second biogeochemical principle, illustrating progressive shifts in the internal ordering of the biosphere over time.

> 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.

This is life's increasing power to *change* the environment, doing so at successively higher rates. With each advancement, the lower order systems, such as the marsupials, dinosaurs, etc., are either discarded and replaced, or subsumed and transformed by the progression of life to a

18 "Seafood Through Time," Bambach, op. cit.

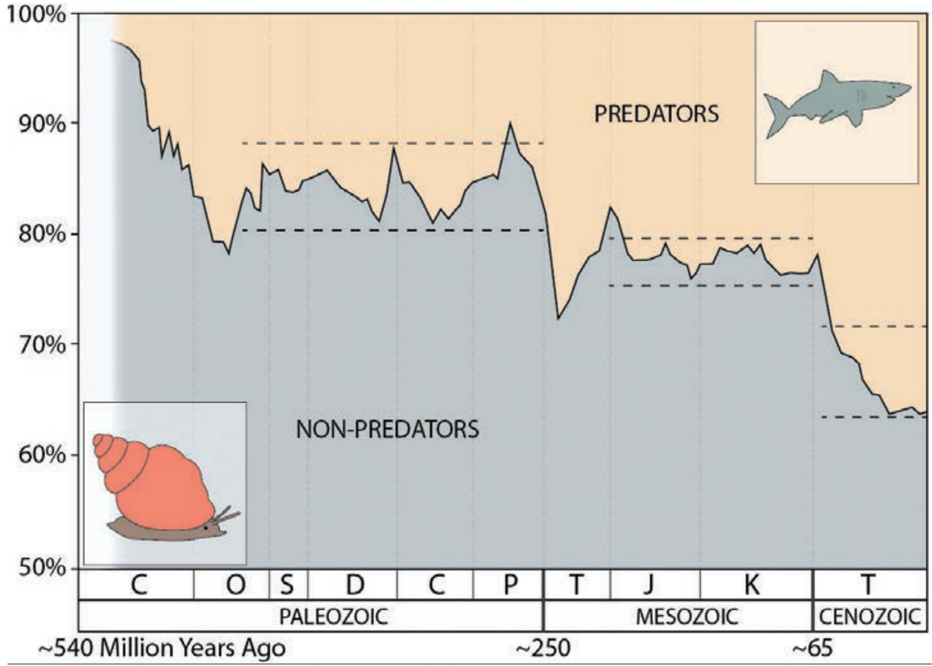
19 See Richard Bambach, Andrew Knoll, and John Sepkoski; "Anatomical and ecological constraints on Phanerozoic animal diversity in the marine realm," May 14, 2002; *PNAS*. Generally the fossil records from ocean life are more complete than comparable records of life on land, due to the better chances for organisms to be covered with sediment and preserved at the bottom of the ocean. This makes the marine fossil record a better subject for certain types of quantitative and qualitative analysis.

20 Their exact classification was slightly more complicated, but included the consideration of metabolic rates, which is being emphasized here. This was just one aspect of their study. See, Richard Bambach, Andrew Knoll, and John Sepkoski; "Anatomical and ecological constraints on Phanerozoic animal diversity in the marine realm," May 14, 2002; *PNAS*.

higher-order state.[21] Interestingly, a structure begins to emerge over the entire Phanerozoic eon, subsuming any one of the specific examples investigated so far. For example, the succession from the age of the amphibians, to the age of the reptiles, to the age of the mammals, defines the same three stages of activity as the changes in the percentage of ocean animals with higher metabolic rates.

This pattern continues to emerge when other examples of the increasing energy of the biosphere are examined.

Figure 6



The changing percentage of animal genera in the ocean which are predators.

Image adapted from, "Anatomical and ecological constraints on Phanerozoic animal diversity in the marine realm," by Richard Bambach, Andrew Knoll, and John Sepkoski; May 14, 2002; *PNAS*.

The Case of Predation

Broadening the investigation beyond metabolic rates alone, other proxies indicate the dominance of Vernadsky's second biogeochemical principle.

For example, certain modes of life simply require more energy to maintain, such as predation. Whereas many ocean animals, especially of more ancient times, could survive by simply consuming organic matter from the seafloor, or by filtering food out of the ocean water as it flowed by, the action of actively pursuing another animal requires a more energetic mode of life. This is associated with higher metabolic requirements, but also an expanding food supply, technological developments, and a more energy-dense food web (higher biospheric capital intensity) to support higher level predators.[22]

When the fossil record is examined, it is revealed that over evolutionary time, predation has increased. This can be seen most clearly by taking the percentage of predator genera versus non-predator genera of the total known fossil population at any given time. Remarkably, although slightly less well-defined, the same general stages emerge as in the comparison of metabolic rates above. While there is some less-regular change between 540 to 445 million years ago, a roughly 200 million year period of relative stability occurs, in which the ratio fluctuates above and below the level of about 15% predators, 85% non-predators. This period if followed by a dramatic shift approximately 250 million years ago, again followed by a period of recovery, stabilizing around the level of about 23% predators, 77% non-predators, with some fluctuation above and below. The last major shift, although not appearing quite as clearly as in the previous analysis of this type, begins at about 65 million years ago, taking a bit longer to settle, but arriving at a level of about 35% predators, 65% non-predators.

These three levels of predation again indicate three successive stages of energy-flux density in the biosphere. So far, this investigation has generally focused on Vernadsky's second type of biogenic migration of atoms, the rate or intensity *directly due to organisms' consumption, respiration, etc*. Vernadsky's third type, the biogenic migration *due to technological developments*, also clearly expresses this development.

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21 For example, numerous species of amphibians exist today, but the vast majority of the species are very different from those that existed 400 million years ago, and the role of today's amphibians in the mammalian stage is fundamentally different than their role in the amphibian stage.

22 See, for example, the 1993 paper by paleontologist Richard Bambach, "Seafood through time: Changes in biomass, energetics, and productivity in the marine ecosystem," *Paleobiology*, Vol. 19, No. 3, Summer 1993, pp 372-397. Bambach offers a series of arguments that are extremely valuable, and provide more conclusive evidence when viewed from the perspective of Vernadsky's concept of evolutionary progress. Examining an array of innovative proxies, Bambach presents a clear case for the increase of the total energy and energy density of life in the oceans over the past 500 million years. Predation is one example he focuses on. See "Seafood Through Time," Bambach, op. cit.

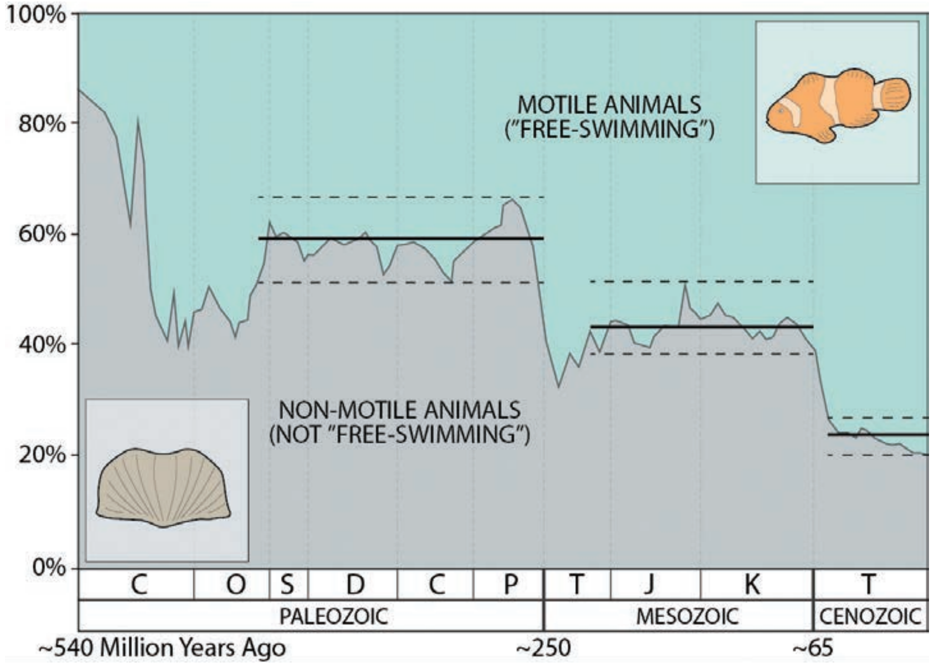
Biogenic Migration of the Third Type

A new series of proxies provide information about Vernadsky's third type of biogenic migration, which he defined as:

> 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.

This is expressed in a number of distinct ways. For instance, life has expanded into domains in which it did not exist prior, expanding the reach of the entire biogenic migration of atoms. Vernadsky gives the example of the development of birds, which now act as transporters of phosphorus and other chemical elements across the vast distances of their regular migrations. The movement of life onto land is another example, and perhaps the clearest: bringing the entire system of the biosphere to conquer and transform this new territory.[23] There are many useful examples within the ocean system as well.

Figure 7



The changing percentage of animal genera that can freely swim and move around the ocean, compared with the percentage that are either stuck in one place, or which simply float with the ocean currents.

Image adapted from, "Anatomical and ecological constraints on Phanerozoic animal diversity in the marine realm," by Richard Bambach, Andrew Knoll, and John Sepkoski; May 14, 2002; *PNAS.*

On the ocean floors, the continental shelf area is generally the most populated with animal life. This includes animals which dig and burrow into the sediment of these shelf regions. The degree to which digging and burrowing animals have actively displaced and churned up the sea floor has increased over time. Going back to 540 million years ago, the records show that the average depth of life's displacement of the shelf floor was about 2-3 cm, with some sediments showing deeper, and others showing no disturbance. By 400 million years ago, 5-6 cm became average (again with some locations deeper and other locations with little or no disturbance). By 200 million years ago it became nearly impossible to find *any* layers of sediment, even as thin as 3-4 cm, that had not been disrupted by the activity of life. Starting about 65 million years ago, the activity has increased so much that certain forms of species that used to live by anchoring themselves in the sediment in earlier periods, could no longer live on the modern seafloor because the sediment was churned up and displaced at such a high rate they would be rapidly overturned, or even buried.[24] As Bambach stated in "Seafood Through Time:"

> Sediment disturbance by "biological bulldozers" (Thayer 1979) is now so severe that LaBarbara (1981) concluded that some reclining free-living bivalves which were abundant in the later Mesozoic, such as *Gryphaea* and *Exogyra*, would not be able to survive on the modern sea floor.

Thus, even something as simple as the ability of ani-

23 For example, the LaRouche PAC video, *The Hypersea Platform* (2011) presents the theory of the Hypersea, as developed by scientists Dianna and Mark McMenamin. http://larouchepac.com/hypersea-2011

24 "Seafood Through Time," Bambach, op. cit.

mals to move around freely has significant effects on the biosphere, expressing Vernadsky's third type of biogenic migration. To look again at the internal division within the biosphere, a similar comparison can be made between motile ocean animals that have the ability to swim freely around the ocean, and thus have the potential to participate actively in Vernadsky's third form of biogenic migration, versus those non-motile animals that do not, and are either stuck to one location, or simply float with ocean currents. Once more, the same pattern emerges when comparing the percentage of genera in the two categories:

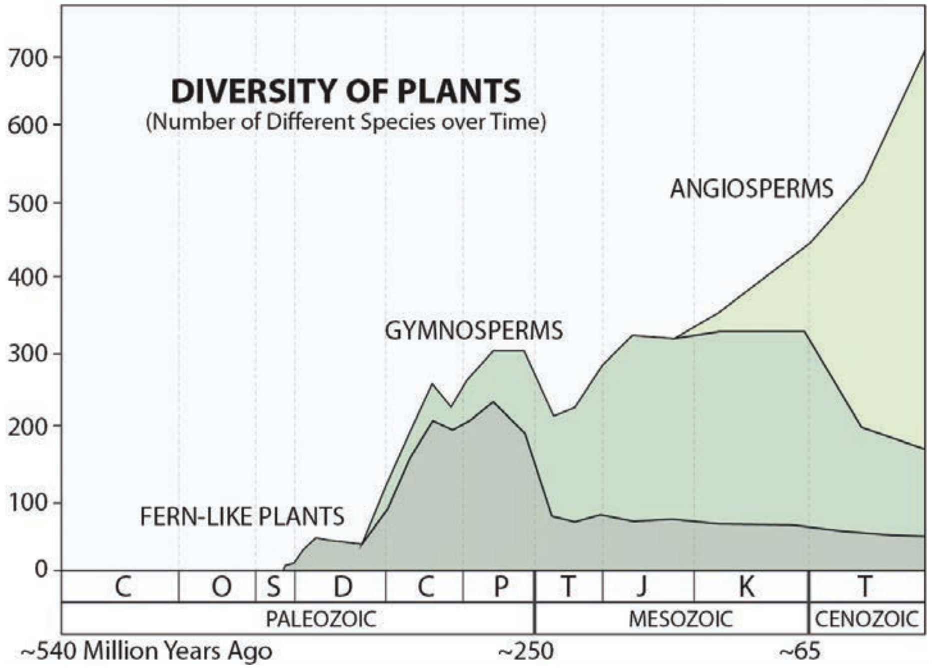
- Some irregularity from 540 to about 445 million years ago.
- Beginning at around 445 million years ago, there is a distinct 200 million year time period when the ratio of self-moving to passive life fluctuates slightly above and below the average level of about 40% to 60%.
- About 250 million years ago, this changes and recovers to a new stabilized level of about 55% to 45%, with fluctuation above and below this average.
- The last major shift beginning about 65 million years ago resulted in a new proportion of the ocean animal system, with almost 80% now being motile, and 20% not.

These proxies taken together—the increase in metabolic activity, increasing percentage of predator species, greater expansion of animal life into new regions of the biosphere, the greater displacement of material of the biosphere, etc.—all indicate the general increase in the biogenic migration of atoms through the biosphere over time. Vernadsky's second biogeochemical principle is confirmed in each of his three forms of biogenic migration.

These studies, however, have only treated *animal* life thus far.

Because animal life depends upon the action of photosynthetic life, as well as other key components of the biosphere, the increase of the biogenic migration of the animal system should parallel changes in the photosynthetic activity and other characteristics of the biosphere as well.

Figure 8



The biodiversity, counted in the number of different species, of three successive modes of plants, the pteridophytes (fern-like plants with spores instead of seeds), gymnosperms (with seeds but no flowers or fruit), and the angiosperms (flowering plants).

Adapted from, Niklas, Karl J. 1986. "Large-Scale Changes in Animal and Plant Terrestrial Communities." Pages 383-405 in D. M. Raup and D. Jablonski, eds., *Patterns and Processes in the History of Life*. New York: Springer-Verlag.

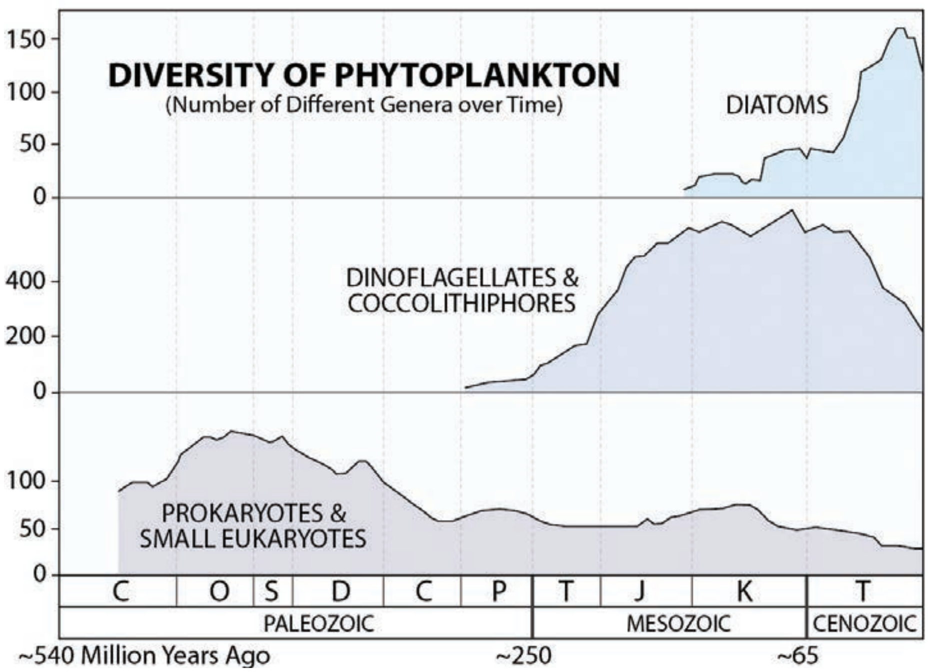
Kingdoms United

Much has already been written about the significance of the motion of plant life onto land: bringing the water cycle onto land in a completely new way, transforming weathering and related activity; plants driving the transformation of rocky lands to nutrient rich soils; all of this activity feeding back into the oceans, providing nutrients and helping upgrade the ocean system as well.[25] The full significance of this process from the standpoint of Vernadsky's three forms of biogenic migration of atoms requires an entire study in itself.

Once firmly rooted on land, clear shifts in the dominant forms of plant life are apparent. The first mode is characterized by the initial domination of fern-like plants, which have spores rather than seeds, requiring wet or moist environments in order to reproduce. Approximately 250 million years ago, the first seed-bearing plants, the gymnosperms, which had emerged earlier as a minority, began to dominate. The development of the seed, with its

25 *The Hypersea Platform*, LaRouche PAC video, 2011, http://larouchepac.com/hypersea-2011.

Figure 9



The changing biodiversity of the different modes of phytoplankton, measured in number of genera over time.

Adapted from "Evolutionary trajectories and biogeochemical impacts of marine eukaryotic phytoplankton," by Miriam Katz, et al., *Annual Review of Ecology, Evolution, and Systematics*, vol 35, 2004.

self-contained nutrient supply and internal fertilization, allowed plants to penetrate into drier regions of the land, forever changing the interiors of the continents. A third shift brought about a stage that is clearly associated with the shift in animal life around 65 million years ago, with the growing dominance of the flowering and nutrient-rich fruit-bearing plants, an increased energy density of sustenance which became crucial for the higher metabolic requirements of the mammalian system. Grasses (also flowering plants) emerged at this time as well, fast growing and providing the possibility for large grazing mammals.

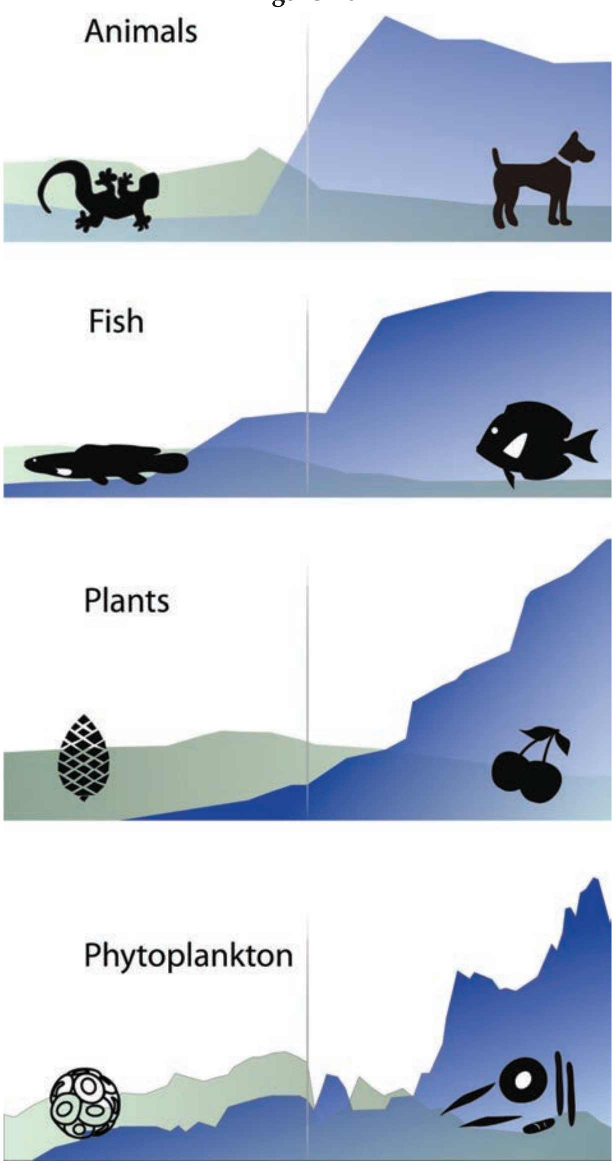
In the oceans, the majority of photosynthetic activity is provided not by multi-cellular plants, but rather by tiny single-celled creatures called *phytoplankton*. Even in this separate kingdom, there are parallel shifts around the same stages, with one set dominating from 500 to 250 million years ago, transitioning to new types which dominated from 250 to 65 million years ago, and a third type coming into dominance around the shift 65 million years ago.

Changes in the biochemistry of these sets of phytoplankton coincide with shifts in the broader food web they support. The phytoplankton of the first stage (including cyanobacteria and other prokaryotes) rely more on the trace metal nutrients iron, zinc, and copper, while the phytoplankton of the second and third stages require higher proportions of manganese, cobalt, and cadmium. Paralleling changes in capital-intensity in a growing human economy, the increased diversity seen in the phytoplankton realm was outstripped by the increasing development in the animal world they support. The first group (the prokaryotes) could support around five species per single species of phytoplankton, while the second (dinoflagellates and coccolithophores) supported around 10, and the third (the diatoms) supported 60.

The phytoplankton introduced with the third stage, the *diatoms*, also uniquely brought silicon into the biogeochemical cycles of the oceans in a completely new way. Even more interesting, this directly paralleled the development of grasses, which were the first land plants to require silicon in significant quantities, and played a crucial role in converting silicon into a soluble form, and helped to deliver it in a usable form into the oceans, much to the joy of the diatoms. Together, this brought the silicon cycle under the control of the biosphere to a degree never before achieved. Diatoms had other technological developments which helped them achieve a new space in the biosphere: they acquired a better control over their nitrogen and carbon usage by developing a urea cycle. They also developed a unique storage vacuole that could hold excess nutrients, allowing a diatom to go through several divisions without needing external supplies. There is little doubt about the significance of the change in the photosynthetic baseline in the oceans for the entire animal system which depends upon it. As one scientist put it, "the [expansion] of the diatoms in the Cenozoic era demarcates a large change in the food-web structure of the Phanerozoic oceans."[26] As is clear from

26 The Cenozoic Era spans from about 65 million years ago to the present day, and the Phanerozoic Eon spans from the Cambrian explosion of about 540 million years ago to today. See, "Evolutionary trajectories and biogeochemical impacts of marine eukaryotic phytoplankton," by Miriam Katz, et al., *Annual Review of Ecology, Evolution, and Systematics*, vol 35, 2004.

Figure 10



General biodiversity structure for different forms of life across the K-T extinction (marked here as the vertical line). Fish, tetrapods, land plants, and ocean phytoplankton (expressing the bounding top and bottom levels of the trophic system) all show the same character: the higher energy system starts in the second stage, grows in biodiversity, is less affected by the K-T extinction, and then comes into dominance. The lower order system is selectively more impacted by, or around, the K-T extinction, and declines thereafter, taking up a subsumed role within the new system.

Jablonski, eds., *Patterns and Processes in the History of Life.* New York: Springer-Verlag.

the above investigation, the change is towards higher rates of activity.

One last remark must be made about an often forgotten contributor to the biosphere, fungi. In Vernadsky's terms of the biogenic migration of atoms, fungi have played a consistent and important role, breaking down formerly living matter into forms that can be used by other living organisms.

Some biological structures decay more slowly than others. For example, lignin, a major structural component of plants, is one of the slowest plant structures to decay. It is also extremely hard to digest, and even animals that consume plant material do not consume lignin as a source of energy. If lignin is not consumed, or not broken down in some other way, it will just remain in that form for extended periods of time, being of little or no use to the biosphere, delaying the further useful biogenic migration of the chemical elements of which it is composed.

It was fungi that developed the capability to break down lignin, freeing carbon and oxygen, and increasing the rate of their cycling through the biosphere. Corresponding to the three stages of the biosphere discussed above, the development of this capability of fungi to break down lignin is part of the second stage, and associated with the overall increase of the biogenic migration of atoms associated with that stage.[27] Interestingly, fungi also go through an important shift associated with the third stage, the development of mushrooms, which are fruiting bodies with a higher density of consumable energy, allowing fungi to contribute to an increased food supply to the biosphere. All of this is well understood in terms of Vernadsky's second biogeochemical principle: the increase of the biogenic migration of atoms.[28]

Biospheric Energy Flux Density

From these examples from the plant and fungal kingdoms, the correspondence of developments within these kingdoms with development of the animal system is clear. Taken together, these become various proxies of a single metric, the general *biospheric energy-flux density* of successive geological periods.

The turnover from the popularized age of the amphibians, to the age of the reptiles, to the age of the mammals, defines the same biospheric shifts as the three stag-

27 "Seafood Through Time," Bambach, op. cit.

28 Interestingly, this development actually requires a net input of energy by the fungi. While fungi gain energy by consuming other plant material, for them to break down lignin they must lose energy to do so. It is as if they are working to contribute to accelerate the rate of biogenic migration of the whole biosphere, and not only acting in their own self-interest.

es of divisions of changes in the proportions of high versus low metabolic rates in the oceans. These shifts correspond with changes in other distinct sections of the biosphere: in photosynthetic life (both on land and in the oceans), in the percentage of species which are predators, in the ratio of animals which can freely move about the oceans, in the developments in fungal life, etc. These are all expressions of an overall increase in the

Toward A Physical Science of Anti-Entropic Evolution

For the large-scale development of the biosphere, the principle of progress is expressed clearly. From this understanding, the science of the anti-entropic system of the biosphere can be further refined, especially as mankind continues to dominate, manage, and increase the productivity of the biosphere, by applying the higher order creative power of mankind.

Addressing outstanding questions and challenges would further Vernadsky's hypothesis of the nature of the progress and development of the biosphere over time. This could provide a better understanding of the history of life, but also of how mankind can better manage and improve the biosphere (and also, eventually create a new biosphere on another planetary body). Such challenges include:

1. Refine possible metrics for biospheric energy-flux density. Something that can more specifically measured and/or estimated for both previous periods, and for current and future times.

2. Map the changes in the biogenic migration of atoms over the evolutionary development of the biosphere from the standpoint of the entire periodic table. How does the role of each chemical element evolve and change?[1] What about each isotope? How do the cycles and rates of key constituent elements of life, such as carbon or oxygen, change? What about trace metals and micronutrients, such as cadmium and copper, or the expansion of which elements and isotopes are used, such as the case of silicon? What can be learned about the changes and expansion of the different biological or biogenic structures formed in the biosphere? This could lead to an entire new periodic table, perhaps, and even provide for a better understanding of the distribution of natural resource deposits, or even the possibility of creating them biologically.

3. Investigate more specifically how the increasing biospheric energy-flux density corresponds to technological developments in the morphological structure of living organisms. For example, the development of wings, or a self-regulated body temperature. Many of these technological innovations made it possible for living organisms to expand into new regions which were simply out of prior reach.[2]

4. Develop a new taxonomic classification system from the standpoint of the process of the evolutionary development of the biosphere. As Vernadsky emphasized, solely defining the organism by its appearance is an abstraction. Instead, it must be investigated from the standpoint of its contribution to the entire process of the biosphere, and the evolutionary development of the biosphere over time.

5. Map out the times when living organisms fundamentally changed the material-energetic state of sections of the biosphere or lithosphere, making previously uninhabitable regions, habitable—the biospheric equivalent of infrastructure. Certain well-known case studies stand out, such as the motion of life onto land, or the oxygen revolution, but there may also be more subtle changes in the biogeochemistry or energetic conditions of the biosphere which have paved the way for new forms of life. For example, perhaps this could be seen in shifts in the utilization of the elements of the periodic table by the biosphere over time.

6. A study of the historical emergence and expansion of the noösphere in controlling and augmenting the biosphere. Recent studies have indicated that mankind's role is much stronger farther back in time than popular opinion has admitted thus far. Take, for example, the recent revelation that even the current nature of the Amazon rainforest is the product of mankind's activity going back thousands of years.[3] Plant and animal husbandry has gone back much farther. Irrigation systems have transformed deserts; fertilization has transformed soils. In terms of energy-flux density, productivity, and biogenic migration, what has this process looked like from the earliest times up to today, and how will we shape it into the future?

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1. In his speech on evolution, Vernadsky gives a few examples, such as the changing role of calcium, or phosphorus. Meghan Rouillard discussed the dramatic changes in the biogenic migration of silicon in her video production, *Single-Celled Creativity*, http://larouchepac.com/node/17850

2. For example, in 1985 Richard Bambach produced an excellent analysis of most of the phyla and classes of the ocean fossil record over the past 540 million years, identifying specific technological shifts in the morphology of various species which were directly associated with the expansion of the biodiversity of that group. See, "Classes and adaptive variety: The ecological diversification in marine faunas through the Phanerozoic," by Richard Bambach, published in the book, *Phanerozoic Diversity Patterns*, 1985, Princeton University Press, edited by James Valentine.

3. See "Virginity Lost" by Fred Pearce, in the January-March, 2007, issue of *Conservation*.

biospheric energy-flux density of the entire system of life on Earth.

Provocatively, these transitions from one stage to the next are demarcated by the largest mass extinctions of the entire Phanerozoic eon (the last 540 million years). The initiation of the first stage is marked by the Ordovician-Silurian mass extinction of 445 million years ago, the second largest mass extinction of the eon. The division between the first stage and the second (250 million years ago) is provided by the largest mass extinction of the eon, the Permian-Triassic mass extinction, and the shift from the second to the third stage is demarcated by the famous K-T mass extinction which eliminated the dinosaurs, and approximately 75% of all species on the planet, about 65 million years ago.

Even more interesting, each of these extinctions is selective with respect to the organisms associated with the respective stages of biospheric energy-flux density. The biodiversity of the diatoms was hardly affected by the K-T mass extinction, whereas the phytoplankton of the second stage were much more severely hit, and never regained the diversity they had prior. Although mammals were affected, the K-T extinction was much more devastating to the reptilian class. The case is similar for angiosperms compared with gymnosperms, etc. (see Figure 10). The same character of energy-flux density selective extinction is clear in the transition from the first stage to the second, as seen in the comparisons of bivalves and brachiopods, reptiles and amphibians, fern-like plants and gymnosperms, etc. This is also reflected in each of the three charts showing the increasing percentages of animals with higher metabolism, which are predators, and are freely-moving, with each shift occurring at these mass extinctions.

Understood in this context, the traditional view of the mass extinction needs to be inverted. Instead of a self-defined event, interrupting some balance of life, the mass extinctions become merely shadows or effects of a primary process of anti-entropic growth in the biosphere. While there may have been particular triggers, such as an asteroid impact, which might have helped to affect the exact timing, or kick-start a transition, they are of secondary importance, and not the *cause* of the anti-entropic development of the biosphere.

As Vernadsky said,

> 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.

These three stages of the development of life characterize the development of the biosphere in broad, but crucial strokes (see the table, *Three Stages of the Phanerozoic Biosphere*, in the appendix). Although much more work must be done to bring the investigation to greater resolution (see box), this should stand as undeniable proof of Vernadsky's great second principle of biogeochemistry, a principle of progress.

Willfully Acting on Principle

What does all of this mean for mankind today? Is mankind destined to be just another animal species, overtaken by the evolutionary process of the biosphere? Or perhaps by changes and developments in our Solar System, or even within our galaxy, which continue to have direct impact on the conditions of life here on Earth? This points to a more fundamental issue.

Progress is a principle of the universe in which we live. We certainly do not know the universe in its entirety, but we can know and understand this characteristic. Forms of existence that do not progress go extinct. Progress, per se, is not a vague, indefinable notion, but has a very specific character. For human society, this is expressed by a power that is completely absent from any form of animal life alone. It is the unique potential to act *willfully*, to creative new stages of nature, states which never before existed, and would be impossible for simply life, unaided by human creative action, to ever generate—in short, to willfully act in, and create our own future.

As Vernadsky recognized, this raises interesting questions. The action of human society can be seen in the unique quantitative and qualitative increase in the biogenic migration of atoms as a consequence of human activity.

> 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 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.*[29]

These changes in biogenic migration, while completely unique to only human action, can be measured in terms of certain material and energetic effects—the migration and transformation of chemical elements as a function of human activity. However, the actual source of these changes can not be measured in terms of matter or energy. The power of human creativity, is not, itself, measured in material or energy terms, or even in simply biological terms. The changes mankind induces in the material-energetic state of the biosphere or lithosphere exist as a shadow, as a mere expression of a capability, a power, which uniquely lies with the human mind.

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 dis-

29 Emphasis added.

Figure 11

The North American Water and Power Alliance, NAWAPA, would save massive amounts of freshwater from otherwise wastefully running off into the northern Pacific and Arctic oceans, by directing it down through a series of natural trenches, rivers, tunnels, canals, and reservoirs, into the western United States and northern Mexico.

For more see, http://larouchepac.com/nawapaxxi tinguish itself in any of the other manifestations of biogenic migration, which are connected to other vital functions.

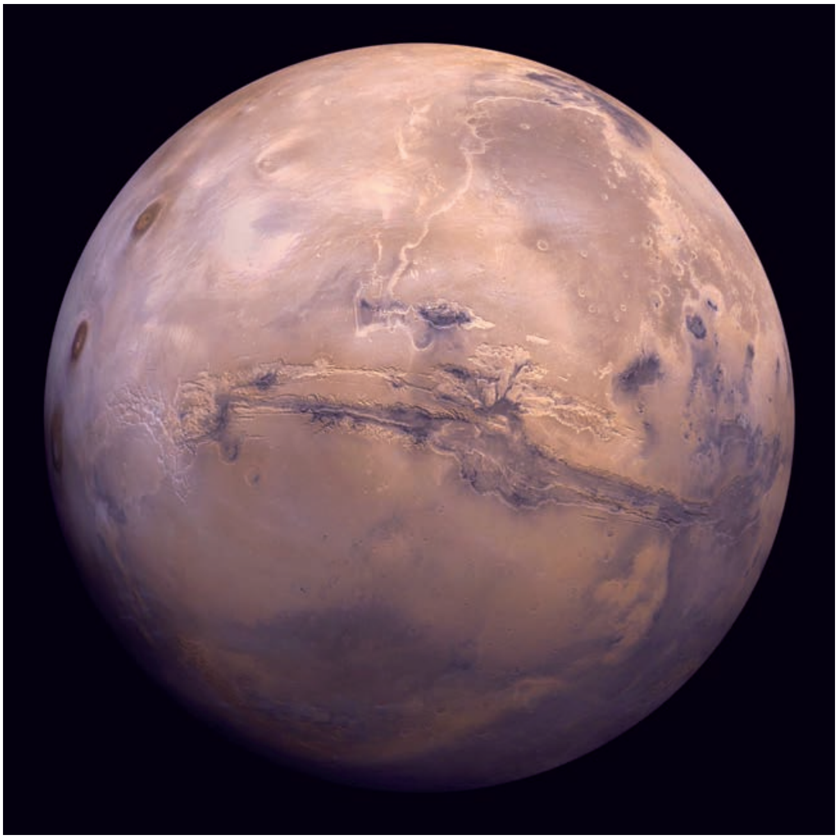
We can, at the same time, establish in a precise way, that human thought changes in a sharp and radical way the course of natural processes, and modifies that which we call the laws of nature.

Consciousness, and thought, despite the efforts of generations of thinkers and wise men, 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?

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.

Figure 12



Mars represents, for mankind, a challenge even more important than Columbus' crossing of the Atlantic Ocean.

Credit: U.S. Geological Survey

Thus, the continual demand for progress for mankind takes a fundamentally different form. It is the continual expansion of the creative powers of society, measured in terms of the power of scientific and cultural thought to act upon and transform our planet at higher and higher rates. Society must always move in the direction of higher levels of energy-flux density in terms of physical economics, as measured in the forms of "fire" that can be wielded under the control of scientific thought: the general succession of burning biomass, to coal, petroleum, nuclear fission, thermonuclear fusion, and the prospect of matter-antimatter reactions, is exemplary.

This is coupled with the expansion of human management of more and more of the territory of the Earth. Programs such as the North American Water and Power Alliance (NAWAPA) are exemplary, designed to provide an integrated controlled water management system for much of the North American continent, shifting excess water to where it is needed, and dramatically transforming the biospheric productivity of much of the total land area. Water that is brought inland and participates in plant life is much more likely to evaporate and fall back down as rainfall multiple times before returning to the ocean. On average, plants increase this water usage 2.7 times, and more in heavily forested areas.

Despite the great lie of the environmentalist movement—which is an affront to the principle of life itself—continuous, never-ending progress is the only measure by which mankind can justifiably view his actions.

These challenges must be met with the goal of mastering the entire principle of the evolutionary development of the biosphere, and consciously wielding and applying that understanding for the betterment of the Earth itself, and eventually, other planetary bodies as well. Viewed from the perspective of an awaiting barren Mars, such discoveries are crucial, and there is too much progress demanded to waste time with stagnation.

This defines the necessary mission for the progress of mankind, one which would please Vernadsky in celebration of his 150th birthday.

Three Stages of the Phanerozoic Biosphere

	Stage 1: 445 to 250 MYA	Stage 2: 250 to 65 MYA	Stage 3: 65 MYA to Present
Photosynthesis: Ocean	Metabolic Rates / Energy Flux Density (EFD):	Metabolic Rates / EFD:	Metabolic Rates / EFD:
	Technology and Expansion:	**Technology and Expansion:** Cocolythophores and Dinoflagellates emerged as the first forms of eukaryotic phytoplankton to play a dominant role in the oceans.	**Technology and Expansion:** Diatoms developed a urea cycle, increasing more efficient utilization of nitrogen and carbon. They developed a storage vacuole, for storing nutrients.
	Biogenic Migration of Atoms: Cyanobacteria and other prokaryotic phytoplankton are of the green plastid lineage, requiring more iron, zinc, and copper.	**Biogenic Migration of Atoms:** Cocolythophores and dinoflagellates (and diatoms) are of the red plastid lineage, requiring more manganese, cobalt, and cadmium.	**Biogenic Migration of Atoms:** Diatoms made better use of nitrogen, and require silicon, bringing it under a tighter control by ocean life than ever before.
Photosynthesis: Land	**Metabolic Rates / EFD:**	**Metabolic Rates / EFD:**	**Metabolic Rates / EFD:** The energy densities of the fruits of angiosperms are better suited for the higher requirements of mammals, for example. Quick-growing grasses fed the development of grazing mammals.
	Technology and Expansion: Reproduction through spores. Vascular structures to bring water up for vertical growth. Roots to anchor into the ground.	**Technology and Expansion:** The seeds of gymnosperms allows for the penetration into dryer environments, no longer being dependent upon wet environments to reproduce.	**Technology and Expansion:** Angiosperm reproduction makes greater use of other animals as carriers of either fruit or pollen.
	Biogenic Migration of Atoms: …	**Biogenic Migration of Atoms: …**	**Biogenic Migration of Atoms:** Grasses require silicon, and have brought the silicon cycle under greater control on land than ever before.
Fungi	**Metabolic Rates / EFD:** Lignin-degrading fungi were rare or absent, leaving biological matter that resists decay for longer in the soils.	**Metabolic Rates / EFD:** The development of fungi with the ability to break down lignin significantly sped up the cycling of carbon and oxygen.	**Metabolic Rates / EFD:** Mushrooms make nutrients accessible to animals, and allow for more specialized spore-production.
Animals: Land	**Metabolic Rates / EFD:** Age of the amphibians.	**Metabolic Rates / EFD:** Age of the reptiles.	**Metabolic Rates / EFD:** Age of the mammals and birds.
	Technology and Expansion of Tetrapods: Moist skin and water-requiring reproductive strategies left amphibians tied to environments near the water.	**Technology and Expansion of Tetrapods:** Dry skin and eggs allowed for the expansion of reptiles into dryer environments.	**Technology and Expansion:** The warmblooded capabilities of birds and mammals allows for their expansion into colder environments.
Animals: Ocean	**Metabolic Rates / EFD:** Stage 1 division of high to low metabolic rates was ~30 / 70. Stage 1 division of predation was ~15 / 85. Shelf bioturbation increased, averaging 2-6 cm, with some regions untouched. "In general terms the Paleozoic dominants were low in individual biomass, their living tissue often arrayed as a thin two-dimensional film coating the skeleton..." (Bambach, 1993)	**Metabolic Rates / EFD:** Stage 2 division of high to low metabolic rates was ~50 / 50. Stage 2 division of predation was ~23 / 77, also associated with Vermij's "Mesozoic marine revolution". Shelf bioturbation increased to the degree that untouched sediments became very rare. "[the] replacement groups in the Mesozoic and Cenozoic and those added into the ecosystem are generally high biomass organisms, often with three dimensional masses of fleshy tissue" (Bambach, 1993)	**Metabolic Rates / EFD:** Stage 3 division of high to low metabolic rates was ~65 / 35. Stage 3 division of predation was ~35 / 65. Shelf bioturbation became so intense that immobile organisms living loosely planted in the sediments could not longer survive . "The energetics of many groups that dominate Cenozoic and modern faunas is greater that that characteristic of Paleozoic dominant groups" (Bambach, 1993)
	Technology and Expansion: Stage 1 percentage of free-swimming species was ~40%.	**Technology and Expansion:** Stage 2 percentage of free-swimming species was ~55%.	**Technology and Expansion:** Stage 3 percentage of free-swimming species was ~80%.

A.I. Oparin:

150 Years of Vernadsky

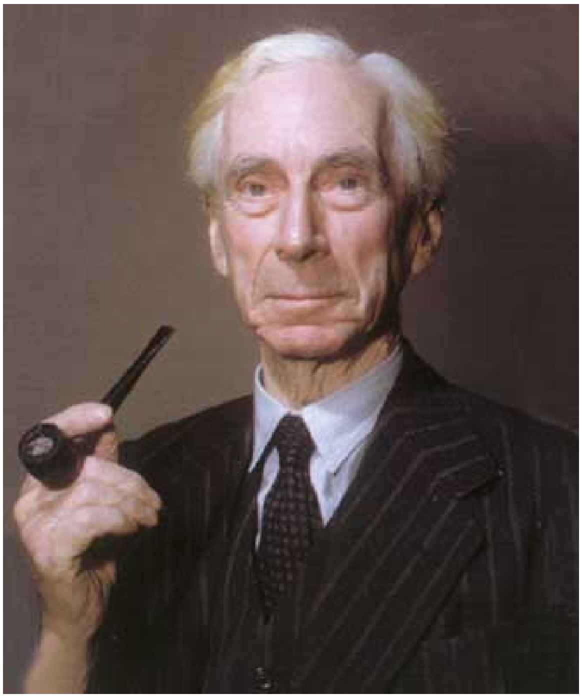
Fraud, Fallacy, or Both?

by Meghan Rouillard

The 150th anniversary of V. I. Vernadsky's birth serves as an appropriate occasion to vindicate him and the crucial contributions which he made to modern science, in geology, biology, chemistry, or as he would call it, "biogeochemistry," from the fraudulent and fallacious formulations of a contemporary and conceptual adversary of his, A. I. Oparin. Vladimir Vernadsky and Alexander Oparin, both 20th century Russian scientists, had fundamentally different approaches to biological and evolutionary processes. Vernadsky's conception of the domains of cognition, life, and nonlife as clearly distinct, and treated by him as different physical space-times, is in opposition to Oparin's view that all of these processes can be built up from non-living components, and hence, defined solely in terms of those abiotic building blocks. Oparin's view is an example of reductionism which is the much more common approach to the sciences more broadly today than is Vernadsky's unique outlook. Unfortunately, the revolutionary import of Vernadsky's ideas has not been taken advantage of, his ideas supplanted by those of Oparin which have taken center stage. This is apparent in the field of astrobiology, where Oparin is held up on a pedestal as its veritable father.

To a student of Vernadsky, this seems almost as outrageous as it does to a student of Kepler to be told that Newton is the father of the theory of gravitation. Vernadsky's work is highly relevant to this area of study, but to the minds of many scientists (especially Americans), he remains simply forgotten or unknown. The same also applies to the biological sciences more generally, where increasingly, a reductionist approach to the study of living processes is dominant. Vernadsky had a powerful argument indicating that the only way a real breakthrough in the study of life would be made, would be through its treatment as literally representing a unique physical space-time, something that Oparin rejected.

Here we will review the case of Alexander Oparin, and compare his fallacious scientific arguments with respect to the origin of life with Vernadsky's. Many of the profound questions raised by Vernadsky were never dealt with by Oparin, who simply tried to brush them aside by asserting his own theory. Examining the roots of this fallacy of Oparin, causes it to appear, perhaps more appropriately, as a fraud. His arguments were not original, and they were highly political. The reductionist approach to science in general during the early 20th century was something which was heavily promoted and supported by a highly dubious cast of characters. Realizing this, in addition to exploring the scientific arguments per se, is an important part of understanding what is wrong with Oparin's ideas. Unfortunately, it is an oft-told story in the history of mankind, of being subject to the ideas and policies of empire, through its changing names and locations, which desires to suppress human creativity, and does so using the various means of politics, war, economics, culture, and also, shaping scientific thought. Submitting to this subjugation, while it may save one temporarily from incurring the wrath of that empire, leaves mankind incapable of making the fundamental breakthroughs in science and technology which are needed to progress, in the most rigorous sense of that term, as laid out in the economic writings of Lyndon LaRouche over the past several decades.



Bertrand Russell sought to make logical positivism, or reductionism, the fundamental scientific method in the 20th century.

Many, out of ignorance or, perhaps, cowardice, have failed to call attention to these facts. This is a story of not only the political fight which created these circumstances, but the important methodological fight with which it is one and the same. Before getting into the specific fraud and fallacy of A. I. Oparin, and the concepts of Vernadsky, examine the political and scientific landscape of the early 20th century, which was not an easy time for truly revolutionary scientists anywhere in the world.

A Century Turned Bad

The major breakthroughs made in physical chemistry by such scientists as Dmitri Mendeleev, Max Planck, Albert Einstein and a host of others, as well as prospects for economic development not unrelated to that scientific work, seemed to come to a screeching halt with the turn of the 20th century. The environment shifted politically and scientifically all at once, as leaders such as Otto von Bismarck in Germany, Sergei Witte in Russia, and William McKinley in the United States were overthrown or assassinated. The economic development perspective which they offered, consistent with the intentions of the slain Abraham Lincoln, seemed to disappear with them, and the political mood in Europe shifted into what eventually became the terror of World War I.[1]

The fundamental discoveries made by Planck and Einstein were subverted and made subject to a doctrine of irrationalism, which attempted to interpret the significance of the questions posed by the discovery of the quantum as pointing towards the fact that the laws of the universe were fundamentally, ontologically, not able to be known precisely by man, as Niels Bohr and Werner Heisenberg attempted to argue. The forays by such men as Bohr into outright mysticism not only call into question the intention behind this work, but also point to another Cambridge-educated figure engaged in similar activity at the time, Bertrand Russell, who advocated, on the one hand, for the reign of logical positivism in science, and at the same time, praised any ideology which pointed towards a fundamentally unknowable universe. This is evidenced by Russell's comments on the "implications" of Einstein's theory of relativity in 1925:

> Causation, in the old sense, no longer has a place in theoretical physics... The collapse of the notion of one all-embracing time, in which all events can be dated, must, in the long run, affect our views as to cause and effect, evolution, and many other matters. For instance, the question whether, on the whole, there is progress in the universe, may depend upon our choice of a measuring of time. If we choose one out of a number of equally good clocks, we may find that the universe is progressing as fast as the most optimistic American thinks it is; if we choose another, equally good clock, we may find that the universe is going from bad to worse as fast as the most melancholy Slav

1. This period also marked the death of the last classical composer, Johannes Brahms, and the ushering in of so-called "modern music."

could imagine. This optimism and pessimism are neither true nor false, but depend upon the choice of clocks.[2]

Do not be misled—his comments on relativity, for example, are not made as an impartial scientist, or even a cynical scientist. Lord Russell's comments serve to point us toward the leading oligarchical circles in Great Britain which were determined to introduce fundamental changes into scientific thought at the same time as they intended to fundamentally shape man's self-conception as a way of changing his activity to better suit the purposes of the British Empire.[3]

Science as Control

Julian Huxley's 1953 book, *Evolution in Action*, begins with the following assertion: "Science has two functions: control and comprehension."

Most scientists might not make the same formulation as Mr. Huxley, but, then again, Huxley is not rightfully called a "scientist" per se—Huxley, like Russell, actively wrote and lectured on scientific topics at the same time that he played an instrumental role in the world policy-shaping of the British Empire of the time. Huxley was the first director of UNESCO (the United Nations Educational, Scientific and Cultural Organization) as well as a founding member of the World Wildlife Fund, and a leading proponent of eugenics, a perverted application of science for purposes of population control. Huxley was a prominent member of the British Eugenics Society and its president from 1959–1962.

For individuals like Huxley and Russell, a primary definition of science is a means of control.

While Russell focused more explicitly on mathematical physics, Huxley took care of biology and evolution.

Huxley, the recipient of a UNESCO award in 1953 for the "popularisation of science," intended to popularize concepts which were well-suited to the shift in scientific thinking occurring more broadly at the time. This included arguing against the knowability of scientific processes, and accepting and encouraging related cultural ideologies. The conclusions of Huxley and Russell[4] in their scientific writings inevitably converge on the idea that man and his economic activity are harmful, as do the Greens today. They maintain that the destructive (in their view) concept of *purpose* in evolution has led man to believe than he is somehow superior to other species. Their "scientific writings" frequently refer to the need for reducing the human population, as Thomas Malthus had called for earlier, and as Huxley concludes his *Evolution in Action*:

H.G. Wells, author of The Open Conspiracy *and* The Science of Life.

> Most educated people now know that the total number of human beings has increased more or less steadily from early prehistoric times to the present, and that each year more people are being added to the population than were added the year before (the present figure is about twenty-two millions). But very few, I believe, realize that the rate of increase itself has been steadily increasing... And there is no sign of its decrease in the near future. The result is that population is pressing increasingly hard on resources; and the further result is that, during the past few centuries, at least, world population as a whole has come to contain vast numbers of

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2. Russell himself appeared to prefer the time of the melancholy Slav, having exclaimed after a meeting with Lenin in 1920 that the Russians were unfortunately being turned into pro-industrial Yankees. In early 1920, Russell had tried to discourage Lenin from pursuing an electrification program. Of the Russian people, Russell had once said, "Human beings they undoubtedly were, yet it would have been far easier for me to grow intimate with a dog or cat or a horse than with one of them."

3. See Mike Billington's "The Taoist Perversion of 20th Century Science."

4. From Russell's 1935 *Science and Religion*: "Is there not something a trifle absurd in the spectacle of human beings holding a mirror before themselves, and thinking what they behold so beautiful that a Cosmic Purpose must have been aiming at it all along? Why, in any case, this glorification of Man? How about lions and tigers? They destroy fewer animals or human lives than we do, and they are much more beautiful than we are. How about ants? They manage the Corporate State much better than any fascist..."

undernourished and therefore subnormally developed individuals. Human fertility is now the greatest long-term threat to human standards, spiritual as well as material.[5]

The introduction to Huxley's book features a defense of the Second Law of Thermodynamics, the so-called tendency of processes to become increasingly disorganized. Huxley claimed that the Second Law held for intergalactic space:

> Nowhere in all its vast extent is there any trace of purpose, or even of prospective significance. It is impelled from behind by blind physical forces, a gigantic jazz dance of particles and radiations, in which the only over-all tendency we have so far been able to detect is that summarized in the Second Law of Thermodynamics—the tendency to run down.[6]

Julian Huxley and his grandfather, Thomas Henry Huxley, "Darwin's bulldog."

In dealing with life, Huxley found it sufficient for his purposes to emphasize the fundamentally random nature of evolution, and to encourage a fundamentally reductionist approach to the study of living processes.

From Huxley's 1953 book:

> At first sight the biological sector seems full of purpose. Organisms are built as if purposely designed, and work as if in puroposeful pursuit of a conscious aim. But the truth lies in those two words "as if." As the genius Darwin showed, the purpose is only an apparent one.

Huxley also asserted that, "that living substance evolved out of nonliving, is the only hypothesis consistent with scientific continuity," later admitting, however, that the actual process by which such "abiogenesis" occurred "is still conjectural." Huxley tried to minimize the difference between animal and machine by declaring that the only difference lies in the ability of a living organism to construct itself. [7]

The attack on purpose or directionality in evolution, as well as the promotion of a reductionist approach to biology was also laid out in an earlier Huxley project. In 1926, the year before the release in Russian of Vladimir Vernadsky's *The Biosphere*,[8] Julian Huxley teamed up with another infamous family within the British establishment of the time, H. G. Wells, already a best-selling author, and his son, G. P. Wells to write a book called *The Science of Life*. While the elder Wells participated in the writing of *The Science of Life*, he also produced, in 1928, another work that was to become much more world-famous, *The Open Conspiracy*, in which he promoted a fascist world government that would have sole possession of atomic weapons, and be served by an elite with esoteric scientific knowledge.

But there was a clear reason for Wells to join in writing *The Science of Life*. This was not a simple science textbook, just as Bertrand Russell's *ABC of Relativity* was not an innocent textbook intended to make clear the discoveries of Einstein.

The Science of Life, completed in 1929, repeated the attacks on purpose in evolution, and introduced the concept of "ecologism" while attacking man's economic activity, going so far as to propose renaming "Homo sapiens" as "*Homo stullus*"—man the fool.

The trio also went out of their way to applaud the work of J. B. S. Haldane, a British geneticist and Darwinian evo-

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5. Lyndon LaRouche's economic writings have clearly outlined the fraud of this argument: that human population must be curbed so that a decreasing amount of resources can be more easily shared. With fundamental technological progress, this is unnecessary, a fact obviously known to someone like Huxley. The modern environmentalist movement has attempted to claim Vernadsky as one of their own, something which seems clearly ridiculous after reading Vernadsky's works. For more on this see Ben Deniston, this issue of *21st Century*.

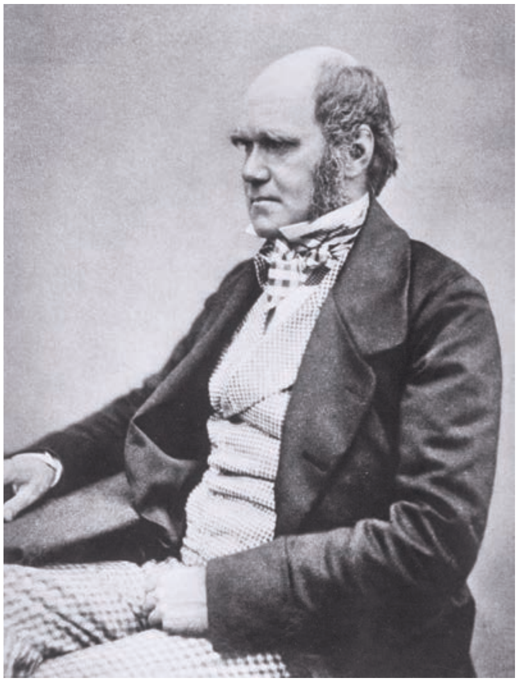
6. In his "The Problem of Time in Contemporary Science," Vladimir Vernadsky had written: "Thirty years later, Rudolph Julius Clausius, then a professor at Zurich, in the principle of entropy, generalized this unidirectional process, which is expressed in space-time by a polar vector of time, to all of reality, as defining the 'end of the world.' In this form, that was an extrapolation of a logical thought, but it is not a phenomenon of reality."

7. Norbert Weiner, the father of "cybernetics," and a student of Bertrand Russell, later made a similar, modified argument with respect to man and machine.

8. Vernadsky had already stunned scientists in the West with the presentation of his ideas in a lecture series on geochemistry delivered at the Paris Sorbonne in 1922-1923.

lutionary biologist. Haldane, a Marxist who later would join the Communist party of Great Britain, had written his own tract in 1929, the same year as the Wells, Huxley, and Wells book, and called it *The Origin of Life*. This was five years after Alexander Oparin's own *Origin of Life* was published in Russian, presenting his totally hypothetical argument for how life could have arisen from non-life out of a "prebiotic soup."

While admitting that it did appear to be the case that all life which exists today has sprung from pre-existing life, Haldane made an identical argument to that of Oparin: that given virtually endless amounts of time, this condition could be proved false, or at least it could be imagined to be proved false. Wells, Huxley, and Wells summarized Haldane's theory in their book:



Charles Darwin had argued for abiogenesis in the 1870s, about 10 years after the experiments of Pasteur refuting spontaneous generation.

> But of course, this apparent impossibility of spontaneous generation applies only to the world as we know it today. At some point in the remote past, when the earth was hotter and its air and crust differed, physically and chemically, from their present state, it seems reasonable to believe that life must have originated in a simple form from lifeless matter. It was presumably a fairly gradual change, a slow progressive synthesis, rather than a sudden leaping into being of organisms from formless slime...
>
> Light, even without chlorophyll to act as a transformer, can effect various chemical syntheses. Under the influence of light, small quantities of sugars and other organic substances, some of them nitrogen-containing, are generated from a mixture of such simple substances as water, carbon dioxide, and ammonia...
>
> Such substances are presumably being manufactured today in sea-water, but in much smaller quantities. For it is the ultra-violet waves of light which are active in this chemical transformation, and most of them are stopped in our present day atmosphere by the oxygen in it. In those primeval times, the oxygen-content of the atmosphere was certainly lower, perhaps almost absent, and so the light could get to work to some purpose. But today any of these substances that may be formed are quickly absorbed by the multitudes of living things that everywhere exist, or got rid of by decay... But before there were any living things to absorb them or break them down, they must have accumulated until, as J. B. S. Haldane puts it, "the primeval oceans reached the consistency of hot dilute soup."[9]

photo by Yousuf Karsh

J.B.S. Haldane wrote his own Origin of Life*, which featured an argument identical to Oparin's.*

It has always been asserted that the tracts of Haldane and Oparin, possessing exactly the same name, were produced and published "completely independently." Whether or not this is the case, it was clear that at this time, there was an intention coming from those who promoted these ideas to create a broad shift in scientific thinking, especially in Europe, and emphatically in Russia, which was still in post-revolution turmoil, to roll back the breakthroughs in physical chemistry which had been taking place during the last quarter of the 19th and into the new, 20th century.

In 1920, H.G. and G.P. Wells traveled to Russia, with G.P. Wells acting as a translator for his father. There, he took advantage of the opportunity to "exchange ideas" with Russian zoology students.

It has been said that devising a reductionist theory of life itself, rather than simply evolution, was an issue which Darwin personally avoided. But, in fact, he did *not* avoid making the argument himself, and indeed proposed an abiogenic origin of life in almost the exact same manner as Alexander Oparin would later. In a letter to Joseph Dalton Hooker written on February 1, 1871, Darwin suggested that the original spark of life might have begun in a "warm little pond, with all sorts of ammonia and phosphoric salts, lights, heat, electricity, etc. present, so that a protein compound was chemically formed ready to undergo still more complex changes... at the present day such matter would be instantly devoured or absorbed,

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9. Wells, H.G., Wells G.P., Huxley, Julian, *The Science of Life*, The Literary Guild, NY, 1929, pp. 438, 651.

which would not have been the case before living creatures were formed."

"Darwin's bulldog," otherwise known as Thomas Henry Huxley, the grandfather of Julian Huxley, had also outlined that very argument years earlier in a lecture he gave on November 8, 1868, called "The Physical Basis of Life." In the lecture, Huxley asserted that vital action is nothing more than "the result of molecular forces of the protoplasm which displays it." The audience was reportedly shocked at the assertion, and the editor of the *Fortnightly Review*, which published the lecture in 1869, said, "No article that had appeared in any periodical for a generation had caused such a sensation."


Alexander Oparin

Such has been the nature of the British oligarchy. Viewing science as a means of control, they devise theories which may be shocking at first, but which they intend to make popular. In this sense, popularizing a fundamentally reductionist theory of life killed two birds with one stone. Such a theory could, and would later, be applied to man and beast alike, in an attempt to erase any concept of a fundamental distinction between them. Such a belief, as the British Empire knew very well, could also prove useful in winning a population over to policies such as slavery, colonialism, and free trade, which prevents man from developing economically and living otherwise as the beasts.

The political and scientific fight in Russia during the 20th century, is not a separate matter from these global battles in politics and science of that time.

The Fraud of Oparin

Soviet Russia of the 1920s found itself divided between two contrary impulses. This was not unlike the situation in Europe, as manifested at the 1927 Solvay conference, birthplace of the "Copenhagen interpretation" of quantum mechanics, which threw causality out the window, and against which Einstein fought tirelessly. During this time, Russia was divided by, on the one hand, an impulse to promote scientific and economic advancement and real, creative scientific work, and on the other, a culture of peasantry and backwardness, supported by Bertrand Russell and his ilk. A handful of creative, independent thinkers were determined to make scientific breakthroughs as they fought against the very difficult circumstances in which they lived. In Russia, this was typified by the personality and activity of V.I. Vernadsky. Vernadsky, who emigrated from Russia to Ukraine in 1917, decided to return to Russia in 1926, to uphold and fight for this tradition.[10] Alexander Oparin represented the contrary view.

The early background of Oparin can be best understood by looking at the role of Kliment A. Timiryazev, one of his earliest inspirations. Timiryazev was known as "Darwin's Russian bulldog," echoing Thomas Huxley's nickname. After the publication of *The Origin of Species*, he was so enthusiastic about Darwin's ideas, that he made a pilgrimage to Darwin's home. Timiryazev was an early Marxist, from the 1860s on, and a plant physiologist at the University of Moscow[11]. Oparin attended Timiryazev's lectures in 1916,[12] which inspired him to enroll there.[13]

Oparin had been a student of Alexei Nicolaevich Bakh, a bio-chemist and member of the Academy of Sciences, at the Karpov Physicochemical Institute, where research was largely focused on identifying the molecular components of life. Oparin and Bakh founded the Bakh Institute of Biochemistry, of which Oparin became the director in 1946. It largely served the function of supporting scientific work which fit well with the ideology of the Soviet regime, such as the work of Trofim Lysenko, whose theory of the inheritance of acquired characteristics represented an extreme and ineffective reaction against the theory of genetics as applied to agriculture. Ultimately, Lysenko was largely discredited, but many were killed for opposing his work.

The extent to which Oparin's own ideological bent dictated his "scientific work" is made clear in the following

10. This is not unlike the case of conductor Wilhelm Furtwängler, who decided to remain in Germany during the Nazi period, to insist upon upholding the classical musical tradition—the best of Germany.

11. This example illustrates how Darwinism began to infiltrate Soviet science, but also politics and culture, through these Marxist circles. Darwinism, "the survival of the fittest," is not merely accidentally analogous to the doctrine of imperialism. It is notable that Friedrich Engels, who spent some of his most important formative years in Great Britain, dominated the Marxist movement and claimed to be its principal "scientific" leader.

12. See Berkowitz, Jacob, *The Stardust Revolution*, Prometheus Books, 2012.

13. The later receipt of Oparin's own lectures was not so stellar, as one student later commented: "Despite his impressive and pretentious appearance (always wearing a bow tie), the lectures were quite dull. It is very difficult to say why, but after the second lecture, students refused to attend them. There was something false in Oparin's manner that students did not like. This refusal created a serious scandal: Such a famous and highly paid scientist found an hour per week to come to the university, but ungrateful students did not want to listen to his lectures!" From Birstein, Vadim, *The Perversion of Knowledge: The True Story of Soviet Science*, Westview Press, 2001, p. 262.

quote from a joint meeting of the Academy Biological Division, Medical Academy, and representatives of the Agricultural Academy. It was initiated by a protege of Oparin's, Olga Lepeshinskaya. The meeting took place in 1950, and Oparin presided over the commission which organized it.

> The attempts to create living systems are possible... only in the Soviet Union. Such attempts are not possible anywhere in capitalist countries because of the ideological position.[14]

From 1927, Bakh headed the VARNITSO (All-Union Association of Workers of Science and Technique to Assist the Socialist Construction) which played a key role in controlling Russian science and the work of the Academy. Oparin later served Bakh as one of its main organizers.[15]

Oparin working in the laboratory.

A new Academy Statute of 1929 stated that "a member of the Academy could be deprived his Academic title for acts of sabotage against the USSR." In response to this, Vernadsky wrote in a letter to his son George:

> The Communist party is a world of intrigues and arbitrariness. And on the Party's orders a decent person acts indecently, justified by the Party discipline... Every appointment of a Communist means that a Communist group and a Communist outside organ become extremely influential... A greedy and hungry Communist crowd finds a new way to make a profit: to take positions in science. Secret information on political and ideological disloyalty are sent to the supervisors... and a cleansing process starts... Until now the Academy of Sciences was not touched by this process. Now it comes...[16]

In diary excerpts, Vernadsky referred to the wasteful efforts of Bakh (whom he once referred to simply as an "evil old man") and expressed his discontent at the nomination and appointment of Oparin to the Academy of Sciences in 1939.[17] Vernadsky criticized the project of the Academy to support research of the theory of "abiogenesis," calling it a "wild and ignorant, sometimes crazy" project, promoted by Bakh, and ardently by Oparin.[18]

Oparin personally supported the work of Olga Lepeshinskaya, who attacked the work of her supervisor, Alexander Gurvich, on mitogenetic radiation—a potentially revolutionary theory, largely abandoned as a result of these attacks, but backed by experimental work done by Gurwitsch himself—showing that low-level emissions of UV light are emitted by living cells and possibly aid in directing the growth process of an organism. She also promoted the theory of abiogenesis.

Lepeshinkaya's husband, Panteleimon Lepechinsky, was quoted as saying that his wife knew nothing and should not be listened to: "Don't you listen to her. She's totally ignorant about science and everything she's been saying is a lot of rubbish."[19]

Oparin's own *Origin of Life* appeared not as a book, but as a political pamphlet in 1923, circulating on the streets of Moscow.

Vernadsky, a member of the Academy of Sciences since 1912, did not cower in the face of the scientific tyranny, led by such individuals as Oparin. Perhaps it was the scientific and also economic merit of Vernadsky's own work which spared him the fate of other scientists at the time. For example, Vernadsky had played a leading role in the creation of the Commission for the Study of the Natural Productive Forces of Russia in 1915, known by its acronym KEPS, a body which sought to assess and develop the strategic raw materials of the nation.[20]

Vernadsky's ideas directly challenged the Soviet doctrine of Dialectical Materialism, itself just a breed of reductionism or mechanics. In fact, after 1917, there was a debate on whether Mechanism or Dialectical Materialism would be the official philosophy of the new regime. It was such a tough call, that Josef Stalin had to personally intervene to decide the outcome, in which Dialectical Materi-

14. Ibid., p. 261.

15. Before the Bolsheviks took power, Bakh was known to have been associated with a group called Narodnaya Volya, a terrorist group which assassinated Abraham Lincoln's ally Alexander II in 1881. He then spent 30 years abroad before returning to Russia.

16. Ibid., p. 42.

17. Vernadsky, V.I., Dnevniki (Diaries) 1935-1941. Vol 1. Diary entry on March 29, 1937. p.128. Nauka. Moscow. 2008.

18. Vernadsky, V.I., Dnevniki (Diaries) 1935-1941. Vol 1. Diary entry on March 29, 1937. p.128. Nauka. Moscow. 2008.

19. Birstein, op cit, p. 261.

20. From Bailes, Kendall E., *Science and Russian Culture in an Age of Revolutions*, (Indiana University Press, 1990).

alism won. But Vernadsky also challenged the concepts, of the mother of this doctrine: the British reductionist movement which was actively moving in on the scientific territory of biology and physics. This faction, represented by Russell, Wells, Huxley, et al., explicitly attacked the concept of purpose or progress, especially pertaining to man. Those within the Soviet Union, like Oparin, who were making their career as guardians of the Marxist version of British reductionism, were equally hostile.

Vernadsky explicitly defended and proved the idea of purpose in evolution,[21] a concept attacked outright by the Huxleys and Wellses, in addition to Bertrand Russell. In Russia, his writings and speeches on this idea, such as his "The Problem of Time in Contemporary Science," provoked a significant debate, something which he had intended.[22]

High-level Soviet official and Academician Abram Deborin wrote two attacks on this writing, the second in response to Vernadsky's defense of the idea of time irreversibility, and the fundamental progress invariably manifested by especially living and cognitive processes. Vernadsky's writings on the noösphere were attacked and suppressed at the time, and what has survived of them remains largely twisted to fit the views of environmentalists, clearly not his intention.

It is possible to explore the substance of the methodological fight between Vernadsky and Oparin, which neither discussed much at all publicly, but which is clear from the writings of both, without losing sight of the political nature of the arguments foisted upon science by Oparin, arguments of which his co-thinkers Russell, Wells, and Huxley would be proud.

Louis Pasteur did experiments refuting abiogenesis beginning in the 1850s and pioneered the study of the unique symmetry of life.

The Fallacy of Oparin

The main technical argument of Oparin's *Origin of Life* can be summed up by the following short excerpt from that book:

> The carbon atom in the Sun's atmosphere does not represent organic matter, but the exceptional capacity of this element to form long atomic chains and to unite with other elements, such as hydrogen, oxygen, and nitrogen, is the hidden spring which under proper conditions of existence has furnished the impetus for the formation of organic compounds.

Oparin's thesis ended up being virtually identical to the later thesis of J. B. S. Haldane in Great Britain, summed up by Wells, Huxley, and Wells in their 1929 book, the same year Haldane's piece was published. "The primordial soup," the supposed ancient, hydrogen-rich ocean of Earth, was the ideal location for this supposed formation of organic compounds, with the aid of a little bit of radiation. Oparin described the "evolution" of the Solar System, for the purpose of determining which elements could have been present on Earth and in what state, based on a simple kinematic unfolding.

Oparin acknowledged that the work of his predecessors, most notably Louis Pasteur, did disprove abiogenesis.[23] He reviewed some of the more ridiculous theories of abiogenesis which date back to Aristotle,[24] but said that his own theory added something critical which was not disproved by Pasteur or others. In a sense, he tried to capitalize on a loophole in their experiments which dealt only with relatively short time scales.

Oparin conceded that it was normal to imagine highly organized states as the result of a creative act, be it a factory, or a living thing, and this was overwhelmingly proved to be the case: a factory doesn't appear overnight unless there was an intention to build it. But he then suggested that one could also imagine these things "evolving" from certain random interactions of building-blocks over time. Any product which appears to be the work of a creative act could also be produced by a non-creative process which has millions of years of chances for the building blocks to interact in the right way to produce the more

21. See Vernadsky's "Evolution of Species and Living Matter," in the Spring-Summer 2012 issue of *21st Century*.

22. To appear in the Summer 2013 issue of *21st Century*.

23. Article by Denise and Roger Ham to appear in a future issue of *21st Century*.

24. From chapter 11 of book 3 of Aristotle's *On the Generation of Animals*: "Animals and plants come into being in earth and in liquid because there is water in earth, and air in water, and in all air is vital heat so that in a sense all things are full of soul. Therefore living things form quickly whenever this air and vital heat are enclosed in anything. When they are so enclosed, the corporeal liquids being heated, there arises as it were a frothy bubble." While acknowledging the failure of this kind of early theory, Oparin did cite Aristotle as one of his predecessors.

highly organized structure, he absurdly proposed.

For random interactions of elements, etc. to produce something as highly organized as life would have required a very long time and the right hypothetical building blocks. This is Oparin's conception of evolution as presented in his *Origin of Life*.

Vernadsky's view is altogether different: for him, evolution is not just an expanse of time over which random in-

Vernadsky's States of Space

Russian-Ukrainian biogeochemist Vladimir Vernadsky used the experimental work of Louis Pasteur to draw the conclusion that the space-time characteristics of life are fundamentally distinct from the space and time of the mathematician or geometer. Such a concept of a malleable space and time is probably best known from the work of Albert Einstein, but Vernadsky's application of such an idea to the field of life is instructive for the investigation of unique physical spacetimes of other processes, even at the cosmic level.

Immanuel Kant wrote on the problem of handedness, and concluded that left and right were fundamentally the same, except only for an arbitrary choice in choosing their names. Outside of that choice in naming, there would be no way to distinguish a priori, with geometry and without referring to other objects of reference, a left from a right hand. However, living processes disagree with the world of Immanuel Kant.

Louis Pasteur showed the unique preference which a living organism has for either the left or right hand, or enantiomer, of a given chemical compound when the compound exists in such a handed form. The rotation of the plane of polarization in polarized light either to the left or right by an organic solution prompted Pasteur to investigate at what level this handedness existed.

For the organic compounds, it could not have been at the level of the larger crystal structure, since quartz crystals (a non-organic compound) will rotate the plane of polarization in their crystal form, but will not do so when dissolved, whereas the organic compounds do rotate the polarization in their *dissolved* form. This led Pasteur to hypothesize a unique molecular asymmetry of living matter, such as the right-handed character of naturally occurring tartaric acid. It is now known that with few exceptions, sugars used by living organisms are right-handed and amino acids are left-handed.

Any variation has shown the opposite handedness to have a completely different physiological effect, such as the case of rare left-handed sugars (the ratio of right to left-handed glucose is at least 10^{15} to 1!) and right-handed amino acids.

There are also notable cases of medications which show the effect of a change in handedness, such as dextromethorphan (Robotussin), the well-known cough suppressant, whose mirror-image levomethorphan, an opiate painkiller, will have no effect on your cough. The separation of racemic mixtures is a difficult but often necessary process for this reason, done either with the use of enzymes, or using modern variations of the technique originally used by Pasteur, a mechanical separating of handed crystals.

The sense of smell also registers the difference between two enantiomers, caraway and spearmint being two among many examples, chemically identical except for their effect on our noses.

Pierre Curie, partly informed and prompted by the work of Pasteur, made discoveries in physics, such as the pizoelectric effect, based on recognizing the ontological significance of symmetry.

However, Kant's original question remains: If, in Euclidean space, it is impossible to privilege left over right, what metric do organisms use to make such a radical distinction? If this a priori distinction does not in fact exist in Euclidean space, might it exist for some other geometry?

This problem coincides with yet another, which might at first seem distinct. Just as Euclidean space is incapable of distinguishing a priori between left and right, simple linear time is incapable of distinguishing between progress and regress. Life, however, seems to encounter no such problem in making this distinction. Space and time measurements, as we now know well from Einstein, are also fundamentally linked to one another. If the space of life has fundamentally unique properties, the temporal characteristics should also require the same.

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2. Pierre Curie, *Œuvres*, and *Pierre Curie*, by Marie Curie.
3. Kant, "Concerning the ultimate ground of the differentiation of direction in space," 1768.
4. Uwe Meierhenric, "Minority Report: Life's Chiral Molecules of Opposite Handedness", *Amino Acids and the Asymmetry of Life*, Springer, 2008.
5. Leffingwell, John. "On Chirality and Odour Perception" at http://www.leffingwell.com/chirality/cyclic_terpenoid.htm
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teractions occur. Rather, his study of the history of evolution showed him that there appears to be a kind of intention causing specific kinds of changes to occur as they do. For example, the biogenic migration of atoms increases throughout evolutionary history, and Vernadsky insisted that a randomly created species could not exist unless it kept up with the requirements of the new system, such as an increased rate of biogenic migration, a requirement, always fulfilled, and not determined by or dependent on random interactions.[25]

Oparin bent over backwards in his 1924 book, *The Origin of Life*, to attack creative intention, even specifically human creative intention. But to discard human creativity and life, and their distinct "fossils," Oparin employed a kind of lazy reason, suggesting that a factor of an exceedingly long amount of time, which he calls "evolution," could somehow give comparable results. Oparin did not, because he could not, actually prove anything—he simply used the "power of suggestion."

It is notable that Oparin felt the need to bring the products of human activity into his arguments about life, as something which should, by analogy, also be subject to reductionism:

> If the reader were asked to consider the probability that in the midst of inorganic matter a large factory with smoke stacks, pipes, boilers, machines, ventilators, etc. suddenly sprang into existence by some natural process, let us say a volcanic eruption, this would be taken at best for a silly joke. Yet even the simplest microorganism has a more complex structure than any factory, and therefore its fortuitous creation is very much less probable...
>
> All these difficulties, however, disappear, if we take the standpoint that the simplest living organisms originated gradually by a long evolutionary process of organic substance and that they represent merely definite mileposts along the general historic road of evolution of matter.

Here, Oparin acknowledged that he still cannot create such a "preconceived plan" as a factory by this means, and admitted that the same challenge exists for something as complex as protoplasmic structure. In both of these cases we seem to have something which "fulfills definite and foreseen aims". But he then counterposed this notion of intention to his idea of evolution—the higher-order processes which are produced are not generative, but "become superimposed" after they come into existence:

> It is inconceivable that such a preconceived plan of protoplasmic structure could exist unless one assumes a creative divine will and plan of creation. But a definite protoplasmic organization and fitness of its inner structure to carry out definite functions could easily be formed in the course of evolution of organic matter just as highly organized animals and plants have come from the simplest things by a process of evolution. Later we shall attempt to trace this evolution and to picture the gradual formation of living things from non-living matter. In this evolution more and more complex phenomena of a higher order became superimposed upon the simplest physical and chemical processes...

In a paper written in 1938,[26] Vernadsky, without explicitly attacking the work of Oparin, laid out a much more rigorous argument, in the form of a table, outlining the fundamental material-energetic distinctions of living and inert natural bodies.

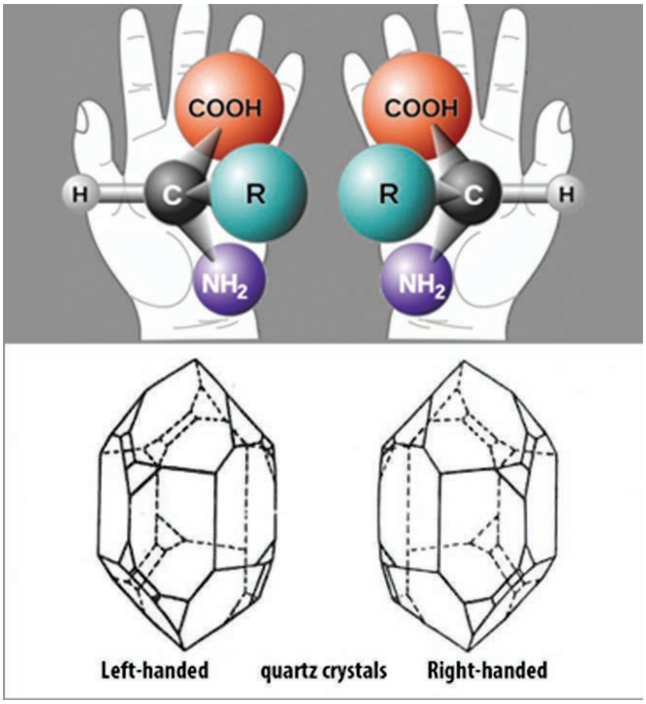
In direct opposition to the assertions of Oparin, Vernadsky wrote:

> The artificial synthesis of a living natural body has never been accomplished. This indicates that some fundamental condition, required for such a synthesis, is absent in the laboratory. L. Pasteur identifies dissymmetry—a special state of space—as the missing condition.

Pasteur himself tried and failed to generate the dissymmetry of living matter using physical forces, such as magnetic fields and a heliostat, for example. He had discovered that there was a special symmetry present in solutions of organic origin which did not only exist at the crystalline level. Louis Pasteur had isolated handed tartaric acid crystals from wine; left and right handed inorganic quartz crystals were also known to exist. The difference was that when the crystalline structure of both of these kinds of crystals was dissolved, that is, when a solution was made, the tartaric acid solution still displayed some evidence of handedness—being able to rotate polarized light to the left or right depending on its overall compositioon. While the quartz crystals were handed, when dissolved in a solution, any trace of this handedness disappeared; the solution could not rotate plane polarized light as the organic solution could. Pasteur himself never asserted at what level this symmetry existed, but insisted that it indicated something fundamentally distinct about living matter. Pierre Curie and Vernadsky both took their cue from the work of Pas-

25. From Vernadsky's 1925 speech, "The Evolution of Species and Living Matter," in the Spring-Summer 2012 issue of *21st Century* and referenced in an accompanying article in this issue: "...a species which was accidentally created would, however, not have been able to survive...only the species which were sufficiently stable, and susceptible of augmenting the biogenic migration of the biosphere, would have survived." See article by Ben Deniston.

26. See Vernadsky's "Problems of Biogeochemistry II" in the Winter 2000-2001 issue of *21st Century*.



Top: Generic structure of an amino acid. The left-handed form is predominant in life. Bottom: Left and right quartz crystals.

teur, concurring that the dissymmetry of living matter and its products, compared to the symmetry of non-living matter, was of fundamental significance. Vernadsky tasked mathematicians and experimentalists to work to find a geometry which exhibits some of these characteristics of life, which standard Euclidean geometry is incapable of doing.

Just as Vernadsky thought that the space of living matter had a chiral quality, so should its time—Einstein had shown that these two are intrinsically linked. For Vernadsky, this is expressed in an increase of free-energy, biogenic migration, and cephalization—a general phenomenon of time irreversibility which can be measured on evolutionary time-scales.

Vernadsky comments that the Redi Principle, "all life comes from life," could be reformulated as the Curie Principle—that the dissymmetry of an effect must be present in its cause. Hence, if the unique dissymmetry of living matter could only be generated in the presence of life, life possibly existed for eternity.

Vernadsky's assertion that "there are no special biogenic chemical elements," was in direct opposition to Oparin's definition of life, which asserts that life exists merely due to the presence of three types of chemical bonds among four specific elements, carbon being the most fundamental building block of life. Vernadsky virtually dismissed this as a fundamental criterion. In fact, it is Oparin's view which has become the driving force of astrobiological research—a search for life premised on the search for the right kinds of molecular constellations, disregarding some of the other clues posed by Vernadsky's work.

Vernadsky also refers to the unique isotope fractionation found in living matter—for example, the unique ratio of Carbon-12 to Carbon-13 which is a by-product of photosynthesis. While some kinds of isotope fractionation have "physical" explanations, there remains a whole category which do not, called mass-independent isotope fractionation.[27]

Ironically, though more significance is usually given to the unique handedness of life, it appears that Oparin saw Vernadsky's hypothesis regarding isotope fractionation in life, having a greater significance than a simple physics problem, as a bigger thorn in the side of his theory. In a work assembled by him, based on the Symposium on the Origin of Life on Earth which he organized in 1957, Oparin discusses Vernadsky in the chapter called, "The Eternity of Life."

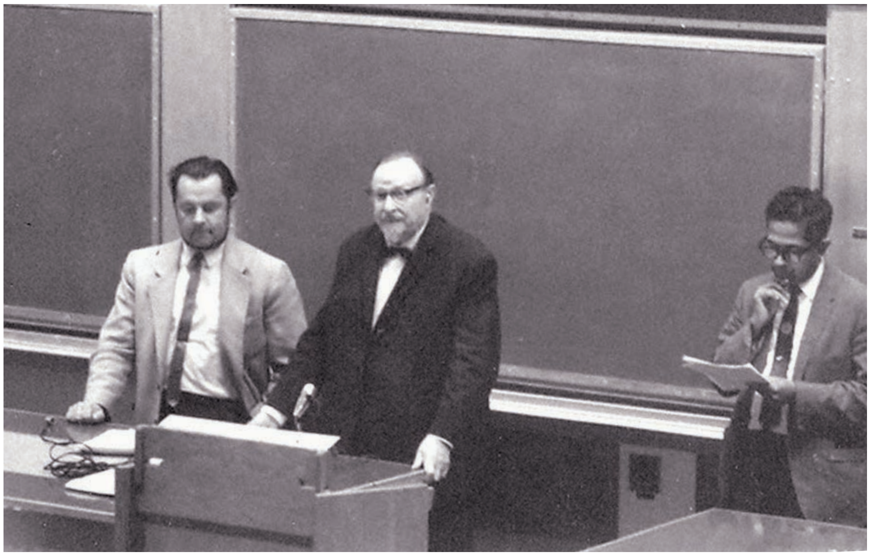
Here, we have perhaps the most direct attack by Oparin on Vernadsky, twelve years after the latter's death. Oparin correctly characterized Vernadsky's argument with respect to his own: "...our lack of success in bringing about the synthesis of a living thing is due to the fact that the special asymmetric spatial conditions required for the purpose are absent from our laboratories." He also correctly said that Vernadsky placed tremendous importance upon the work of Pasteur, but included as his only evidence that Vernadsky "gave up on this" the fact that in 1944 Vernadsky wrote a paper which did not mention the distinction between right and left, but rather focused on the unique isotopic composition of living matter. Oparin offers no explanation of his own as to why there is a distinction between left and right handedness in living processes. Here, Oparin did give the reader a little insight into how this isotope problem bothered him, acknowledging the problem of needing to explain the origination of this biological isotope fractionation:

> As early as 1926 Vernadsky demonstrated that the isotopic composition of the elements present in living organisms differs considerably from that of the elements derived from rocks and minerals... The direct transition from materials which have not arisen biogenically to living things would seem to be excluded on account of the profound differences in isotopic composition.[28]

27. See Rouillard, Meghan, "Isotopes and Life: Considerations for Space Colonization," in the Summer 2010 issue of *21st Century*.

28. Oparin, A.I., *The Origin of Life on Earth*, Academy Press, 1957, p. 49.

Oparin's only defense ended up being an outright twisting of Vernadsky's own words, claiming that Vernadsky had once admitted that processes at high temperatures and pressures could display unique isotopic fractionation, virtually asserting that this proves that Vernadsky ultimately gave up on the idea of a fundamental distinction between living and non-living matter.



Esther M. Zimmer Lederberg Memorial Website

Oparin lecturing at NASA Ames in 1969.

Vernadsky *did* admit this in his 1938 table—under characteristics of inert natural bodies which are distinct from living. Living processes generally have a unique isotopic fractionation. Vernadsky acknowledges that in non-living processes, there can be isotope fractionation (not of the same type or amount as occurs in life), but a varying of standard ratios at high temperatures and pressures, but it is clear that that cause is different than what causes fractionation in life. The unique isotopic composition of living matter does not occur due to high pressures and temperatures, and it is unique in terms of the kind of fractionation it produces. Oparin claims that if life and non-life, even if in totally different circumstances and to different degrees, can cause variation from the standard isotopic ratio at all, fractionation should not be considered something unique to life. Typical of Oparin's reasoning, he insisted that since high temperatures and pressures existed at the time of his hypothetical non-living earth, he could dismiss Vernadsky's insistence on the fundamental distinction of living and non-living matter. But Vernadsky never said fractionation per se was only something life could do. He noted that it occurred in a unique way, and much more generally than in non-life—that in life, it is "characteristic:"

Regarding isotope fractionation in non-life, Vernadsky says:

> With the exception of radioactive decay, isotopic composition (for the terrestrial chemical elements) does not change in inert natural bodies of the biosphere.
>
> Evidently, there exist natural processes outside the limits of the biosphere—for example, the movement of gases under high pressures and at high temperature in the Earth's crust—which can shift the isotopic ratios.
>
> These shifts do not violate the basic constancy, in first approximation, of atomic weights, since those meteorites (galactic matter) which have been studied give the same atomic weights, with accuracy to the second decimal place.
>
> One of the most important tasks of geochemistry at the moment is to obtain a more precise definition of the atomic weight of chemical elements in inert bodies, than is possible through chemistry.

> Note that Vernadsky makes the explicit distinction that isotopic fractionation is characteristic of living matter: Evidently, a shift (within certain ranges) in the isotopic composition (atomic weights) inside living organisms is a characteristic property of living matter. This has been proven for hydrogen, carbon, and potassium, and is probable for oxygen and nitrogen. This phenomenon calls for precise investigation.
>
> It is becoming more than probable, that a chemical element, upon entering a living organism, changes its isotopic composition.

The same year as the Origin of Life Symposium, American scientist Stanley Miller gave a presentation before the Soviet Academy of Sciences on work which was supposed to have practically confirmed Oparin's thesis. Oparin had learned of the results in 1953, and had personally invited Miller to attend the symposium.

Miller had teamed up with, not so surprisingly, a student of Niels Bohr, Harold Urey.[29] These two experimentalists intended to prove Oparin right by attempting to synthesize the veritable primordial soup. In 1951 Urey had suggested, "that experimentation on the production of organic compounds from water and methane... and the possible effects of electric discharges on the reaction [simulating] electric storms... would be most profitable."

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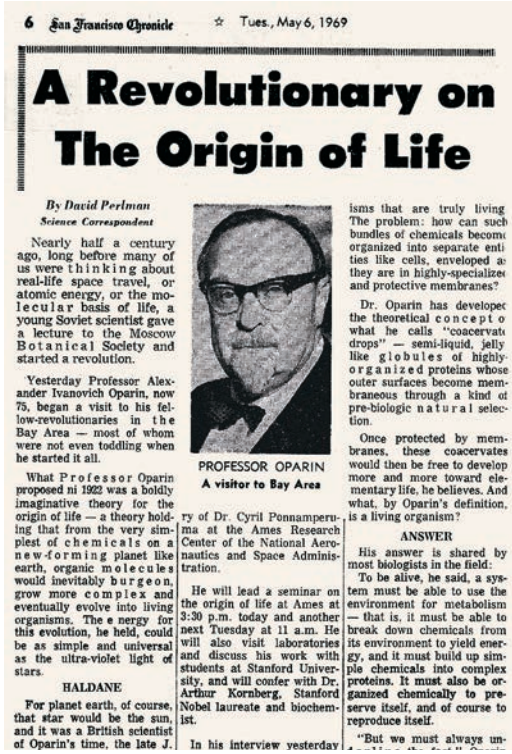
29. Berkowitz, op cit., p. 125.

This was exactly what Urey and Miller set out to do. Their experiment was a simple setup involving two globe-shaped flasks, one containing the contents of the supposed primordial atmosphere (a mixture of methane, ammonia, and hydrogen), and the other containing the primordial sea (water) which when heated, fed water vapor into the other flask. With the flip of an electricity switch sparks flew between the electrodes in the gas mixture. Within a week, the "sea" had turned brown, and the higher chamber, which had contained the "atmosphere" was coated in an oily sludge. They had created life!

Not quite... really, not at all. Five amino acids were able to be separated out, three of them known to be found in most living things, composing their proteins: glycine, aspartic acid, and alanine. More modern versions of the experiment claim to have isolated more than these original five.



6 San Francisco Chronicle ☆ Tues., May 6, 1969

A Revolutionary on The Origin of Life

By David Perlman
Science Correspondent

Nearly half a century ago, long before many of us were thinking about real-life space travel, or atomic energy, or the molecular basis of life, a young Soviet scientist gave a lecture to the Moscow Botanical Society and started a revolution.

Yesterday Professor Alexander Ivanovich Oparin, now 75, began a visit to his fellow-revolutionaries in the Bay Area — most of whom were not even toddling when he started it all.

What Professor Oparin proposed ni 1922 was a boldly imaginative theory for the origin of life — a theory holding that from the very simplest of chemicals on a new-forming planet like earth, organic molecules would inevitably burgeon, grow more complex and eventually evolve into living organisms. The e nergy for this evolution, he held, could be as simple and universal as the ultra-violet light of stars.

HALDANE

For planet earth, of course, that star would be the sun, and it was a British scientist of Oparin's time, the late J.

PROFESSOR OPARIN
A visitor to Bay Area

ry of Dr. Cyril Ponnamperuma at the Ames Research Center of the National Aeronautics and Space Administration.

He will lead a seminar on the origin of life at Ames at 3:30 p.m. today and another next Tuesday at 11 a.m. He will also visit laboratories and discuss his work with students at Stanford University, and will confer with Dr. Arthur Kornberg, Stanford Nobel laureate and biochemist.

In his interview yesterday

isms that are truly living. The problem: how can such bundles of chemicals become organized into separate entities like cells, enveloped as they are in highly-specialized and protective membranes?

Dr. Oparin has developed the theoretical concept of what he calls "coacervate drops" — semi-liquid, jelly like globules of highly-organized proteins whose outer surfaces become membraneous through a kind of pre-biologic natural selection.

Once protected by membranes, these coacervates would then be free to develop more and more toward elementary life, he believes. And what, by Oparin's definition, is a living organism?

ANSWER

His answer is shared by most biologists in the field:

To be alive, he said, a system must be able to use the environment for metabolism — that is, it must be able to break down chemicals from its environment to yield energy, and it must build up simple chemicals into complex proteins. It must also be organized chemically to preserve itself, and of course to reproduce itself.

"But we must always un-

Esther M. Zimmer Lederberg Memorial Website

San Francisco Chronicle article detailing Oparin's trip to NASA Ames in 1969.

astrobiology, as it has come to be called.

Oparin's influence

Astrobiologists represent probably the only community of scientists for whom Alexander Oparin is practically a household name. At the Astrobiology Science Conference 2012, held in Altanta, Georgia, this author had the opportunity to present a poster on the views of Vernadsky and Oparin with respect to the recent Kepler spacecraft's missions searching for habitable planets. Almost all of the dozens of scientists spoken with were quite familiar with Oparin's work, and only one really knew much of anything about Vernadsky, correctly exclaiming, "That towering figure of science!"

The reason for this discrepancy becomes clearer when Oparin's 1969 trip to NASA Ames is taken into account.

On the one hand, no one has ever demonstrated that a living organism can emerge from a pile of amino acids.

On the other hand, the lack of success of these experiments is more interestingly shown by the fact that the amino acids produced in the original Miller-Urey experiments, as well as all subsequent similar experiments, have failed to produce amino acids which posses the unique left-handedness which they exhibit in living organisms, but rather produce racemic mixtures, which consist of both left and and right enantiomers.

Also interesting is recent work and discussion regarding the problematic nature of Oparin's "coacervates," the colloidal gels which he claimed would "develop" in his theoretical primordial soup, formed of polypeptides and polysaccharides. To this day, despite the efforts of the many scientists who seek to prove his thesis, polysaccharides have not been created abiogenically.[30]

This more modern history surrounding Oparin's work and legacy leads to the next chapter in this story: Oparin's trip to the NASA Ames Research Center in 1969. This trip may begin to explain how it is that Oparin has come to be viewed as the virtual father of exobiology, or

From an article in the *San Francisco Chronicle*:

Nearly half a century ago, long before many of us were thinking about real-life space travel, or atomic energy, or the molecular basis of life, a young Soviet scientist gave a lecture to the Moscow Botanical Society and started a revolution.

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What professor Oparin proposed in 1922 was a boldly imaginative theory for the origin of life—a theory holding that from the very simplest of chemicals on a new-forming planet like earth, organic molecules would inevitably burgeon, grow more complex and eventually evolve into living organisms The energy for this evolution, he held, could be as simple and universal as the ultra-violet light of stars...[31]

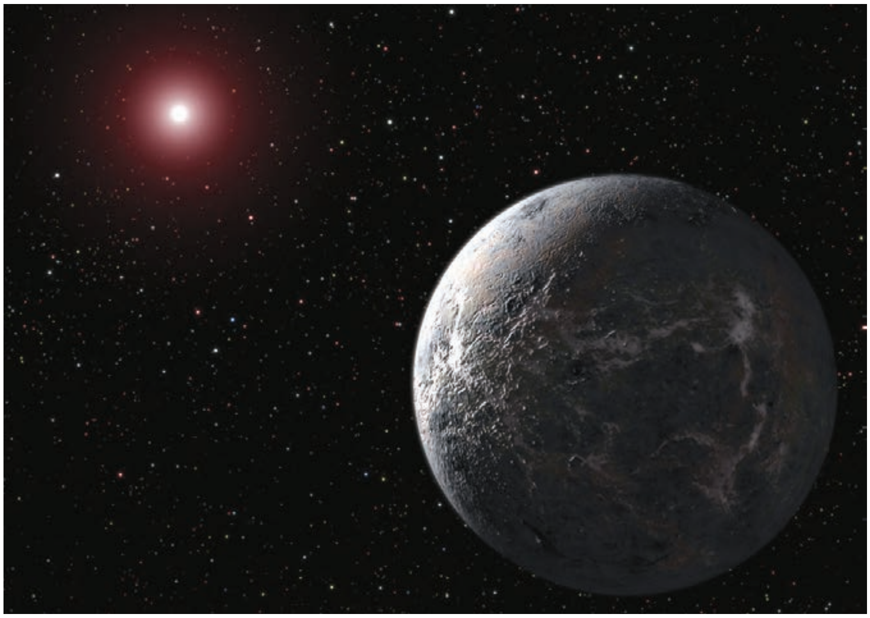
The article then reviewed the work of Haldane and discussed the two seminars which Oparin would host, in addition to meetings at Stanford University. It included commentary from Oparin, who admitted that his concepts

30. See abstract of Vera Kolb submitted to 2012 NASA Astrobiology Conference: "On the Applicability of Oparin's coacervates to modern prebiotic chemistry" at: http://abscicon2012.arc.nasa.gov/abstracts/

31. Perlman, David, "A Revolutionary on the Origin of Life," *San Francisco Chronicle*, May 6, 1969.

were not entirely original, and that many of them were inspired by the ideas and tradition of Aristotle.[32]

More investigation into the circumstances surrounding this trip would certainly be of interest, but it is indicative of the promotion of the reductionist ideas of Oparin, known at his time, and by his own words, to be more of a political tool than a scientist.



NASA

The field of astrobiology has been greatly influenced by Oparin's work.

Deeper Implications

Oparin's ideas and their impact have surely spread outside of the more limited field of astrobiology. Reductionist thinking has become all-pervasive: from economic policy-making governed by the doctrine of free trade, which virtually bans any guiding future orientation, to other work in the sciences and music. Oparin's theory of the parts organizing themselves is not unlike the theories of modern musical composition.

Oparin appears to have assumed that the domain of chemistry is safe from attacks against reductionism. His own Russian predeccesors knew better than this. Below is a quote from Dmitri Mendeleev, the renowned chemist and also one of the most famous economists of his day. Mendeleev, who discovered the organization of chemical elements which we know as the Periodic Table, was no reductionist. His scientific work was apparently restricted to the material, chemical domain, but he stated that the study of so-called matter must be done with a view towards the real (not simply "emergent") higher processes in which it is able to participate, contrary to the approach of Alexander Oparin.

> Thought, which has no resting place in the history of knowledge, is free to wander in these unlimited regions whither and how it pleases, and may therefore return to the point from which it started in the dawn of science. I do not in the least censure such thought in any respect, but when my thoughts turn to this region they always rest steadfastly on the fact that we are unable to comprehend matter, force, and the soul in their substance or reality, but are only able to study them in their manifestations in which they are invariably united together, and that beyond their inherent indestructibility they also have their tangible, common, peculiar signs or properties which should be studied in every possible aspect.[33]

Vernadsky's work on the three domains which he called the lithosphere, biosphere, and noösphere, was also governed by a top-down conception of their ordering. His work focused on the distinction of non-living and living matter; the unique dissymmetry of living matter is indicative of the unique potentials of living matter more broadly which cannot be generated "from below." Pierre Curie had formulated this in a similar way—stating that the dissymmetry of an effect must be present in its cause, and also adding that an effect could not have a greater dissymmetry than its cause. Vernadsky's work also focused on the unique power of the noösphere—of human cognition.

In a 1931 presentation to the Leningrad Society of Naturalists, "On the Conditions of the Appearance of Life on Earth," Vernadsky, while not naming Oparin, provided an interesting, playful yet devastating hypothesis (from Oparin's standpoint) of the only way a synthesis of life could occur: it could only occur as a synthesis from the top-down—as a synthesis generated by the noösphere, with a unique understanding of the fundamental distinction of life from non-life, such as the unique dissymmetry it displays and requires:

> Man can create in laboratories environments of enantiomorphic structure, possessing some properties of dissymmetric enantiomorphic structure, characteristic of life. However, he has not succeeded up until now in creating a dissymmetrical environment analogous to that which we find in the interior of organisms.

32. See the Esther M. Zimmer Lederberg archive at: http://www.estherlederberg.com/Oparin/Opar2Z.html#IMAGE

33. Mendeleev, Dmitri, *Principles of Chemistry*, Kraus Reprint Co., 1969, Vol. 2, p. 30.

The study of the action upon living phenomena by environments formed by left or right handed circularly polarized light opens a field of great interest, but it is not a dissymmetrical environment similar to that of organisms. It is necessary still, always, to have in view, according to the principle of Curie, that the activity of man would be itself a dissymmetrical cause and the creation by him of a dissymmetrical environment, responding to life, would be a normal event, from the point of view of dissymmetry.[34]

Oparin's intention to reduce living matter to its non-living constituents was a major assumption, and something which he could not prove, but only suggest. But it is no coincidence that by means of such a theory, the notion of directionality and intention which we see in human and non-human life could also possibly be reduced to simple parts which interact only mechanically, and by chance produce "life," "creativity," and their products as a kind of epiphenomenon. It is likely that for this reason Oparin's work has been "popularized," since it fit the agenda of an oligarchical faction largely based in Great Britain who explicitly viewed science as a means of control, and sought to prevent man's economic progress. Making popular a doctrine of reductionism, blurring the lines between living and non-living matter, and by analogy, man and beast, aids in encouraging man to abandon anything which he should demand as a unique, creative species.

34. Vernadsky, V.I., "Sur les conditions de l'apparition de la vie sur la Terre," speech to the Leningrad Society of Naturalists, 1931. French translation reviewed by Vernadsky.

Vindicate Vernadsky: End Oparin's Scientific Tyranny

To properly honor Vladimir Vernadsky's 150th birthday, we should have a goal to restore in the minds of many, especially within the scientific community, the image of Vernadsky as that one attendee at the 2012 NASA astrobiology conference said to the author—as the "towering figure of science" which he is. With this comes the necessity to abandon the politically motivated and unrigorous conceptions of Alexander Oparin, and the more general doctrine of reductionism which infects our culture, our science, and our policy-making. With respect to investigations in biology, we should, as Lyndon LaRouche once commented, seek a definition of life "which is of the ontological character of metaphor." Vladimir Vernadsky would surely approve.

The author is indebted to the work of Allen Douglas, Rachel Douglas, William C. Jones, and Craig Isherwood.

Getting the Dose-Response Wrong:

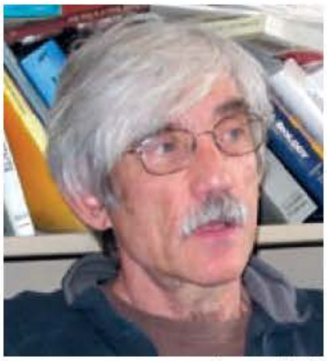
Although there were no adverse health effects from the 1979 accident, Three Mile Island became a symbol of fear for irrational environmentalists.

A Costly Environmental Problem

by Edward J. Calabrese, Ph.D.

The dose-response, the amount of a substance that causes a particular reaction, is the central pillar of toxicology, pharmacology, therapeutic medicine, and risk assessment. Getting the dose right is critical for patient health but also for public health, as reflected in community and occupational health standards. This might seem to be an easy task, but this hasn't been the case. The problem is that toxicological testing and the government version of it, called risk assessment, has been built upon the idea that all one needs to know can be derived from the testing of very few doses (for example, two or three) at very high levels of exposure; that is, the maximum amount that can be tolerated by mice or rats without obvious illness. This is the testing strategy by which chemicals are regulated by U.S. agencies like EPA (Environmental Protection Agency) and OSHA (Occupational Safety and Health Administration) and from which community and occupational health standards are derived.

The current method for risk and safety assessment for environmental substances is seriously flawed, because it does not consider effects at low-dose exposure.



Laurence Hecht

Dr. Edward Calabrese is Professor in the Environmental Health Sciences Division at the University of Massachusetts at Amherst. He is a toxicology specialist, who has written extensively on the non-linearity of dose-response, including the benefits of low-dose radiation, called hormesis. He is founder and chairman of the advisory committee of BELLE, the Biological Effects of Low Level Exposure, a group founded in 1990, which includes scientists from several disciplines and aims to encourage assessment of the biological effects of low level exposures to chemical agents and radioactivity. Dr. Calabrese explained in an interview with 21st Century Science & Technology, *published in the Fall 2011 issue, that today's environmental policies are based upon the lie that there is no safe dose of radiation. This has led to an irrational fear of radiation and of nuclear power, depriving millions of both nuclear energy, and the health benefits of hormesis.*

The problem with the above hazard assessment scenario is that the vast majority of people live in a world of very low exposures. The challenge is to ensure that regulatory agencies can accurately extrapolate their findings at very high doses to those at very low levels. The magnitude of such extrapolations can be highly variable, ranging from "only" several thousand-fold to well over a million-fold, depending on the chemical tested and the animal model used. It is similar to long-range weather forecasting: The longer out the forecast period goes, the greater the uncertainty. Thus, the decision of what is the so-called "right dose" becomes model-based. That is, a biostatistical model, rather than experimental results, is used to estimate responses in the low-dose zone, which suggests the further question of what is the "right model."

During the early to middle decades of the 20th century, the combined fields of medicine, pharmacology, and toxicology determined that the most fundamental dose-response model was the **threshold model**—below a certain threshold, there are no discernible effects; above it, biological effects occur. The threshold model resonated consistently well with personal experience, and there was also a fair amount of experimental data that appeared consistent with it. These factors helped shape the interdisciplinary consensus that made the threshold dose-response the standard basis for hazard assessment protocols for testing all drugs, chemicals, and commercial products and for the derivation of occupational and community health standards.

The threshold model was simple to understand, easy to accept, and easy to implement: "Threshold" indicated that biological changes can be induced only once a certain level of exposure was exceeded. Below that level, or threshold, no significant biological changes take place, only background noise. Exposure above that threshold would initiate a process of pharmacological activity in the case of drugs, or toxicity for chemicals. On the pharmacological side, it was thought that many drugs would act only after a certain number of receptors on or in a cell had been activated. In the case of toxicity, the threshold would be passed when the repair processes were exceeded.

The Biphasic Dose Model

Although this simple explanation provided the theoretical and empirical basis to support the threshold dose-response model, its acceptance became complicated by two troubling facts: It failed to be validated experimentally, and it was in an ongoing competition with the **biphasic dose model**. In this model, the biological effects below a certain threshold were often seen to be beneficial, while those above the threshold were detrimental. Historically, the biphasic dose-response model was nest-

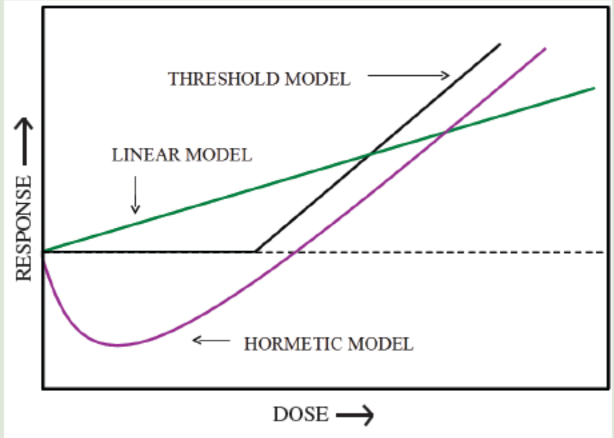


Figure 1
Comparison of the Three Most Dominant Dose-Response Relationships in Toxicology and Pharmacology

Threshold dose-response model—This dose-response describes a relationship when a drug or toxic substance shows a response only after a certain dosage has been exceeded. Below that transitional dose (i.e., threshold) no biological response occurs due to exposure to the agent under study. The only changes observed in the below threshold dosage zone (i.e., low dose zone) would be due to normal background variability.

Linear dose-response model—This dose-response describes a relationship in which the response is directly related to the dosage. In this case, there would be no safe exposure to a toxicant or carcinogen. Taken to its extreme, it suggests that even a single molecule (or ionization, in the case of radiation), could initiate the disease process, including cancer. This is an assumption that is used by regulatory agencies in the United States for genotoxic chemical carcinogens and ionizing radiation.

Hormesis dose-response model—This dose-response describes a specific type of *biphasic dose-response*. A biphasic dose-response occurs when both a stimulation and an inhibition are represented. The hormetic-biphasic dose-response is one which has a unique quantitative description. That is, its amplitude and width of the stimulatory response are constrained to be within specific limits. In addition, the stimulatory response has a specific quantitative relationship to the threshold value. These features result in making the hormetic dose-response a specific type of biphasic dose-response. It is a more precise descriptor of the biphasic dose-response and therefore is extremely useful.

ed within the conflict between traditional medicine and homeopathy. By the early 1900s, the biphasic dose-response model was called the Arndt-Schulz Law and also Hueppe's Rule, after its discoverers. However, in 1943, it received the description "hormesis" from the Greek word "to excite" by two University of Idaho mycology researchers, as will be discussed below (Calabrese 2011a).

Among the different investigators, the primacy of the discovery of the hormesis concept, and its long-standing articulation and defense, go to Hugo Schulz, a Professor of Pharmacology and Toxicology at the University of Greifswald in Northern Germany (Calabrese 2009a). The moment of discovery, as recaptured in an autobiographical statement by Schulz in 1923, occurred during a series of experiments performed more than four decades earlier. The seminal experiment involved the observation that low doses of chemical disinfectants enhanced the metabolism of yeasts while higher doses inhibited metabolism. Schulz said that the low-dose stimulation surprised him. In fact, initially he thought it was an experimental artifact and not a real, reproducible phenomenon. However, after numerous replications of the experiment, he became convinced that the phenomenon was real. He first presented these findings at a meeting about a year later for the local Medical Society.

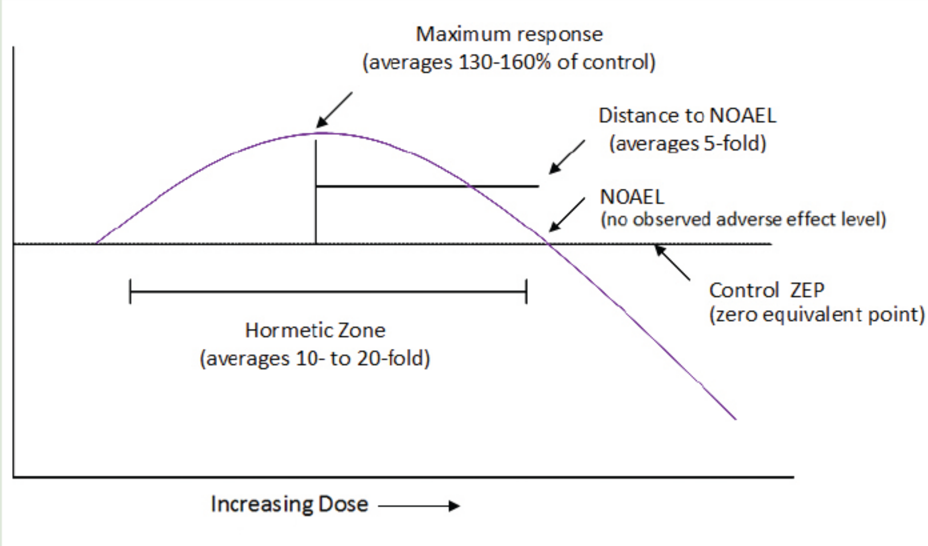


Figure 2
The Hormesis Dose-Response Model
The hormetic dose-response is biphasic in nature with a low-dose stimulation and a high-dose inhibition. The stimulatory response is typically modest in nature, being less than twice the control value in most incidences. The strong majority of the maximum stimulatory responses are only 30-60% greater than the control value. The width of the stimulatory response is typically in the 10 to 20-fold range. For approximately 5-10% of the hormetic dose-responses, the width of the stimulatory response is greater than 100-fold, sometimes exceeding 1,000-fold. The low-dose stimulation can display either desirable responses (i.e., increases in longevity, memory) or undesirable responses, such as enhanced growth of tumor cells in response to low doses of chemotherapeutic agents. In general, the hormetic stimulation should be seen as a highly conserved evolutionary trait that enhances the adaptive capacity to a broad range of toxic substances and stressor agents in the environment.

During the four decades preceding his 1923 report, four events occurred which were to give a new meaning to Schulz's observation and change the course of dose-response history—but not for the good.

Event (1): A clinical study in 1884 indicated that the homeopathic preparation veratrine was effective in the treatment of gastroenteritis.

Event (2): Research at Robert Koch's famous lab in Leipzig, Germany, discovered a bacterial cause of gastroenteritis and a method to culture it.

Event (3): Schulz conducted experiments to assess whether veratrine could kill the bacterial causative agent, and reported that veratrine was unable to kill the bacterium in *in vitro* culture studies, regardless of the dose.

Event (4): During discussions with his colleague Rudolph Arndt in 1885, Schulz connected his biphasic dose-response, discovered with yeast experiments, to the homeopathic study with veratrine and his own experiments which failed to find toxicity with this agent.

Schulz pieced the puzzle together this way: He claimed that the veratrine was effective in the treatment of the gastroenteritis despite its failure to kill the harmful bacteria. It worked, he said, by enhancing the adaptive capacity of the patient at low doses to resist the infection. He then linked this interpretation to his biphasic dose-response, concluding that homeopathic drugs act via the induction of adaptive processes at low doses, rather than any direct killing effect on the causative organism.

The Homeopathy Battle

Schulz generalized this explanation to the fields of therapeutics and toxicology, by providing what he believed to be the explanatory principle of homeopathy. Because traditional medicine was engaged in a highly acrimonious conflict with homeopathy during the 1880s and 1890s, Schulz literally gave homeopathy a major trophy: the biphasic dose-response.

These acts by Schulz led to his immediate rejection from the traditional medicine "club" and the label of traitor for the remainder of his life. It also created a new "context" in which traditional medicine could not view the biphasic dose-response concept objectively. Instead, the biphasic dose-response was marginalized and rejected, and traditional medicine replaced it with a model of its own making. Hence, the threshold dose-response concept was not only born out of personal experience and experimental findings, but also out of necessity; traditional medicine needed a dose-response model of its own.

The conflict between homeopathy and traditional medicine was complex, having philosophical, scientific, social, economic, and personalized elements, and so deep-seated that it has persisted for multiple generations. The hostilities enveloped and victimized Schulz and the dose-response concept, because Schulz had made the significant error of proclaiming that he had discovered the explanatory principle of homeopathy, basing it on his biphasic dose-response observations. By associating the biphasic dose-response model with homeopathy, Schulz never gave his new model the opportunity to be fairly considered by the proponents of traditional medicine. He placed it within a complex, long-standing, and bitter conflict.

Although the medical establishment and its scientific elite took aim at Schulz and his dose-response, this did not prevent other researchers from independently observing the same type of dose-response phenomenon. In fact, the occurrence of biphasic dose-response relationships, especially in the areas of plant biology, microbiology, and entomology, were common in the early decades of the 20th century, based on studies with chemicals and ionizing radiation (Calabrese and Baldwin 2000a-e). Despite such developments in the scientific domain, these findings were ignored or marginalized by the leaders of the medical and scientific establishment, who were interested in the destruction of homeopathy and its dose-response concept.

Eventually the medical establishment gained control of the funding, scientific literature, university curricula, and government regulatory programs—that is, the real power. By the mid-1930s, homeopathy was no longer a serious competitor and its biphasic dose-response was suffering a similar fate. Instead, the threshold model took center stage in the regulatory and academic toxicology arenas. Despite this major victory for traditional medicine, the establishment overlooked a very important feature of its new and successful dose-response model, which would eventually come back to challenge its scientific legitimacy: They neglected to validate the capacity of their model to make accurate predictions in the low-dose zone, that is, where people live. The medical/toxicological establishment never provided the proof that its model worked. The threshold model simply made untested predictions of responses based on studies with too few excessively high doses. This is what the fields of toxicology and risk assessment were—and still are—based on!

Why didn't the leadership of traditional medicine and their subsequent toxicological and risk assessment offspring ever validate the threshold dose-response model for low-dose zone responses? It would not have been a hard thing to do.

There is no definitive answer to this question in the scientific/medical literature. Perhaps no one in the "field" ever thought to do so; but could it have been simply overlooked and continued to be overlooked by so many practitioners for the entire 20th century? On the other hand, could it have been deliberately shunned over concerns of what to do if the threshold model did not perform as well as the biphasic dose-response model in head-to-head competition? The bottom line is that

Homeopathy and Hormesis

Hormesis is a dose-response relationship that is biphasic in nature. The low-dose stimulation occurs immediately below the toxic and pharmacological dose-response thresholds. In contrast, high-dilutional homeopathic practices as advocated by the founder of homeopathy, Samuel Hanneman, typically deal with exposures to therapeutic agents that are so diluted that there may not even be a single molecule within a treatment preparation. Thus, *there is no relationship between high-dilutional homeopathy and the concept of hormesis.* The two conceps became historically engaged when Hugo Schulz, the discoverer of the biphasic dose-response relationship today called hormesis, claimed that this dose-response could account for the therapeutic success seen in homeopathic preparations that were not highly diluted (i.e., those that had molecules in their treatment). Schulz was *not* a supporter of high-dilutional homeopathy. Hormesis is therefore a traditional pharmacological and toxicological concept and is not related in any way to high-dilutional homeopathy.

the issue of the experimental validation of the threshold model was not addressed until early into the new millennium.

Finally, Some Experimental Validation

In the first decade of the 21st century, our research group at the University of Massachusetts assessed the capacity of the threshold, linear, and hormetic (biphasic) dose-response models to make accurate predictions in the low-dose zone, using three separate and substantial data sets. In each case, the threshold and linear models performed very poorly, whereas the hormetic dose-response performed with a high level of accuracy. Thus, while it took nearly 70 years to vet out the dose-response model adopted by the regulatory communities, an answer finally emerged. It revealed that the models used by all regulatory agencies in the U.S. and elsewhere failed to make accurate predictions in the low-dose zone (Calabrese and Baldwin 2001, 2003; Calabrese et al., 2006, 2007, 2008, 2010).

Along a somewhat parallel track, but occurring in the 1950s, the threshold dose-response was challenged by the radiation genetics community, which argued that the effects of ionizing radiation on the genome were proportional to dose and that the nature of the dose-response was *linear*—not a threshold (Calabrese 2009b). This perspective was led by the Nobel Prize winner Hermann J. Muller who discovered that X-rays caused mutations in the germ cells of fruit flies. Muller apparently so feared the effects of radiation, that in his Nobel Prize acceptance speech, he deliberately deceived the audience.

In his Nobel Prize lecture, Muller stated that the dose-response for radiation-induced germ cell mutations was linear. He further emphasized that there was "no escape from the conclusion… there is no threshold." The problem for Muller is that only one month prior to his Nobel Prize lecture he acknowledged the results of a major new dose study from the University of Rochester supporting a threshold. In fact, Muller heaped praise for the quality of the study, noted its implications, recommended that it be repeated, all in a letter to the professor directing the study, Dr. Curt Stern. Such comments were contained and repeated in letters between Stern and Muller only five weeks before and after Stockholm.

Linear Overturns Threshold

After a prolonged effort that at times employed deliberately deceptive tactics by Muller and several colleagues (Calabrese 2011b,c; 2012a), the radiation geneticist community became a dominant influence, which took on major practical significance through the Biological Effects of Atomic Radiation (BEAR I) committee of the National Academy of Sciences. In 1956, this committee issued recommendations to the federal government that changed the course of risk assessment history. BEAR I argued that the assessment of mutation in germ cells by ionizing radiation should be considered as linear at low-dose. This judgment overturned the threshold model, at least in this one area. However, only one year later, the U.S. National Committee for Radiation Protection and Measurement (NCRPM) generalized this recommendation to somatic cells, thus including cancer. Many other governmental advisory groups across the globe joined in, and before long, linearity ruled the risk assessment world for cancer induced by ionizing radiation and chemical carcinogens (Calabrese 2009a), under the concept called Linear No-Threshold or LNT.

Throughout the first half of the 20th century there was little effort by those researching hormesis to summarize their collective findings and to offer a counter-position to the opponents of Schulz's biphasic dose-response. This is seen in a memorial article about the life of Schulz in the year after he died (Wels 1933). It was a reflection on how unfairly he was treated by his medical colleagues through techniques of professional isolation, marginalization, and intimidation. Such actions were not lost on Schulz's peers and were an effective means of keeping other potential dissenters obedient to the "company" line. One towed the line, or would face the same fate that Schulz long endured.

There was one major attempt to test the hormetic concept by a U.S. governmental agency in 1948. The U.S. Department of Agriculture (USDA), acting on numerous published articles reporting that low doses of radionuclides could enhance plant growth, put this concept to the test. In a large-scale but very poorly designed study, the USDA arranged for a 13-site assessment of 20 plant species (Alexander 1950). The subsequent failure of this study to support the hormetic dose-response hypothesis stymied a major opportunity for expansive testing, evaluation, and application of this concept. In retrospect, the USDA study was about as inadequate as could be imagined. There was no preliminary testing of the multiple plant species to estimate the threshold dose, all species were assumed to have the same hormetic zone, and most experiments used only a single dose. Any one of these deficiencies would have been catastrophic to the testing, let alone implementing the study with all three fundamental mistakes at the same time. In any case, this failure had profound implications for the hormesis concept to the USDA and agriculture, essentially killing it for the remainder of the century.

It is hard to understand how such poor study design decisions could have been made. It suggests either a profound ignorance of the hormesis phenomenon or perhaps a well-orchestrated attempt to see the concept fail the test.

Hormesis Emerges

The 1940s witnessed two important, but at the time, somewhat obscure developments, that would come to have important effects on the hormesis field. The first was that investigators at the University of Idaho observed the biphasic dose-response in experiments assessing the effect of extracts of the Red Cedar tree on fungal metabolism. These investigators, who were studying how fungi decay wood, called this phenomenon hormesis, for the Greek word meaning "to excite." These two researchers, John Erhlich and his graduate student Chester Southam, would go on to highly visible careers in the biomedical domain, leaving the concept of hormesis behind. Nonetheless, their terminology would stick, eventually replacing the Arndt-Schulz Law and Hueppe's Rule.

The second development was that a U.S. biochemist, Thomas Luckey, observed that low doses of antibiotics, in the absence of gut microflora, enhanced the growth of poultry. This unexpected finding eventually brought Luckey into the world of hormesis research. And 35 years later, Luckey wrote the first book on the subject, a major summary of ionizing radiation and hormesis (Luckey, 1980). Luckey had planned to develop a companion book on chemical hormesis, but that never happened. He did write an updated version of the ionizing radiation book a decade later (Luckey, 1990). However, it was his first book that had the most impact.

When Luckey's first book reached Dr. Sadao Hattori of the Japan Electric Power Research Institute (EPRI), Hattori became intrigued with the possibility that low doses of radiation could bring about positive health outcomes, perhaps even lowering cancer incidence, and he contacted the medical department of the U.S. EPRI. This connection set in motion a process that led to the first "Conference on Radiation Hormesis," held in Oakland, California, in August 14-16, 1985 (http://bit.ly/W935fs).[1] As a result of this conference, a series of activities was initiated that led to the current resurgence in hormesis by our group at the University of Massachusetts and others.

In parallel with the publication of Luckey's first book, there were independent developments by researchers in other fields who were starting to study the hormesis concept more systematically. For example, at the University of Edinburgh, Szabadi (1977) summarized the pharmacological literature concerning biphasic dose-responses and offered a mechanistic model to account for such responses. Likewise, epidemiological researchers started to publish findings on the occurrence of **U**-shaped dose-responses. Similarly, the neuroscience area reported a plethora of **U**-shaped dose-responses on numerous endpoints such as memory, anxiety, and pain (Calabrese 2008). And in the area of stress biology, the biphasic concepts of Robert Yerkes were transformed into a "Law" in 1957—the Yerkes-Dodson Law—which saw the biphasic dose-response as the basic feature of stress responses (Calabrese 2008).

These developments would be given an unexpected methodological boost from the debate over the desire to reduce the number of whole animals in toxicity testing and the desire to make greater use of cell lines. This transformation was a product of the 1980s, and it ushered in the testing of large numbers of agents over a far broader range of concentrations much more quickly, via high-throughput testing methods now so commonly employed. In fact, as a result of the transition to *in vitro* testing, the majority of published examples of hormesis over the past decade involve cellular systems.

That considerable growth has occurred with respect to hormesis is evident in the increased number of articles published on the topic, and citations of the articles within the leading professional scientific and biomedical indexes. For example, in the Web of Knowledge/Science database there were only 10 to 15 citations of hormesis per

Testing Which Model Gives the Most Correct Answers

The "big" model test experiments occurred using very large data sets that had thousands of different chemicals, tested over a large number of dose-responses in different biological organisms (i.e., bacteria, yeast, invertebrates, vertebrates, and plants). The data sets were subjected to *a priori* criteria so that they could be useful in assessing which dose-response model gave the most accurate predictions in the low dose zone, that is, the rules of evaluation were created before the assessments were conducted in order to prevent potential bias. The *a priori* entry criteria (i.e., which dose-responses were acceptable for evaluation) were such that each dose-response model would be treated equally and fairly so that no advantage was given to any dose-response model. In a similar fashion to the *a priori* entry criteria, separate evaluative criteria were also used for the evaluation of responses in the low dose zone. Based on the application of the evaluative criteria to all dose-responses satisfying the entry criteria, statistical judgments were made as to which dose-response model did best. In the three databases that our group studied, the hormetic model performed far better than the threshold and linear dose-response models, both of which performed poorly.

1. http://www.dose-response.org/low-dose/hormesis/pdf/Radiation_Hormesis_Conference_%28CA%29_April%201985.pdf

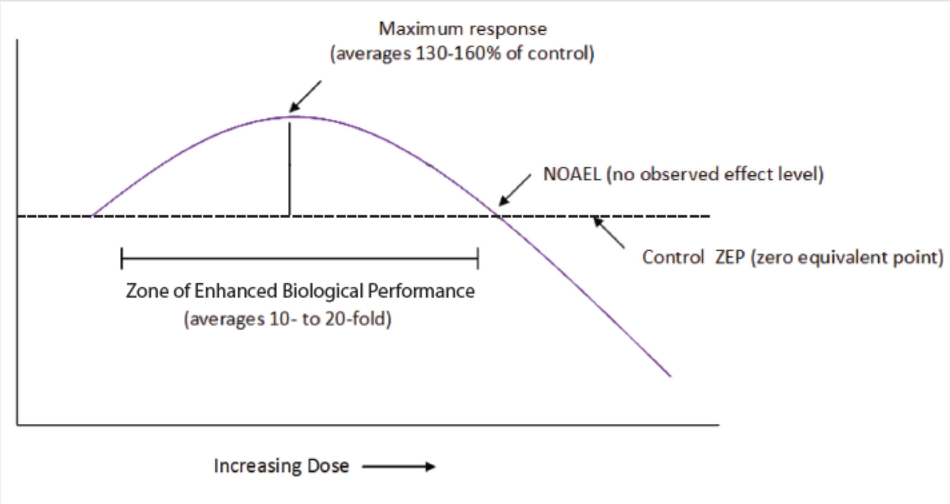


Figure 3
Dose-Response Curve Depicting the Quantitative Features of Hormesis and Its Application to the Concept of Enhanced Biological Performance

year in the decade of the 1980s. But in recent years, this number has exceeded 4,000 per year. Furthermore, it is possible that the number of authors and citations of the hormesis concept (rather than the term hormesis) is a substantial underestimate of the actual occurrence of hormetic dose-responses, because this phenomenon is often described by many other terms.

The Benefits of Hormesis

What emerged from these studies is the general and well-supported conclusion that hormesis is a real, reproducible biological dose-response phenomenon that is highly generalizable; that is, hormesis is independent of the biological model, endpoint measured, and chemical class or physical agent. It has very specific quantitative features, the most significant being that the magnitude of the stimulation is modest, usually less than twice that of the control group. In the majority of cases, the maximum stimulatory response is in the 130-160% range as compared to the control group response (i.e., 100%) (Calabrese and Blain 2005, 2009, 2011). The width of the stimulatory response zone is also generally modest, ranging 5- to 20-fold below the estimated threshold (Figure 3). However, about 5 to 10 percent of the examples of hormetic dose-responses displayed a stimulatory range greater than 100-fold, with some greater than 1,000-fold. These observations have important implications for the design of experimental studies, affecting the selection of the number of doses and sample size.

These quantitative features of the dose-response occur regardless of whether the stimulation is a result of a direct stimulus or an overcompensation stimulus. This suggests that the magnitude of the stimulatory response in this low-dose zone is not only independent of mechanism, but may represent a quantitative estimate of plasticity in biological systems. If this were the case, then it would indicate that the maximum pharmacological stimulatory response would likely be limited by the magnitude of the hormetic stimulation, having major implications for the pharmaceutical industry. In other words, increasing the dose of drug may not help the patient, if the maximum benefit is reached at a lower dose.

The low-dose stimulation represents a manifestation of biological performance within the constraints of plasticity, the limits of the organism's adaptability (Calabrese and Mattson 2011). It is therefore a highly regulated response, an integration of complex signaling pathway network mechanisms. These features of the low-dose stimulation are highly conserved, occurring from plants to microorganisms to man, and consistently seen across all affected endpoints (cancer and other diseases, for example) and at different levels of biological organization (cell, organ, organism).

The hormetic biphasic dose-response is now employed as the basis for numerous drugs. For example, pre-clinical data consistently show hormetic dose-response for anti-anxiety drugs, anti-seizure medications, osteoporosis prevention agents, Alzheimer's disease treatments, skin care products, and numerous other applications.

The Regulatory Challenge

Since the hormetic dose-response provides superior performance in low-dose predictions over that of the threshold and linear dose-response models, it challenges the use of those models by regulatory agencies. The failure of both threshold and linear models to pass multiple experimental validation tests, in contrast to the hormetic model, is an important finding. But despite the many reports of such findings in leading toxicological journals, regulatory agencies seem to show little institutional self-reflection or concern for the fact that the models they use for risk assessment and setting standards fail to accurately predict responses in the low-dose zone. It is difficult to imagine organizations that would continue to employ models that lack validation, and that fail experimental validation when tested. This is especially the case when dealing with community exposure standards which have significant public health and economic implications. To take just one example: Many countries are spending billions of dollars to protect people from exposures to low radiation doses by setting extremely stringent standards, while creating profound fear of extremely low doses of radiation for which there is no demonstrable harm but in fact likely health benefits due to hormesis.

The hormesis concept addresses responses across the entire dose-response continuum. It has the capacity to detail both harm and benefit in the low-dose zone and it addresses the limitations of the threshold and linear models in risk assessment. By their strict adherence to the threshold and linear dose-response models, regulatory agencies can miss the possibility of either benefit or harm that occurs in the low dose zone. The use of the hormetic dose-response in risk assessment addresses these limitations of the threshold and linear models.

The EPA has further affected the public health by formally excluding the potential for benefit within the definition of a risk assessment. Denying a benefit is the equivalent of reducing the health status of the population (Calabrese 2011a). Congress created legislation that requires the EPA to protect the public from environmentally induced harm. In so doing, it is doubtful that Congress ever intended for their legislation to result in the denial of health benefits (Calabrese 2012b). By denying the possibility of health benefits from the definition of a risk assessment, the current EPA policy results in a higher incidence of environmental disease, higher medical costs, as well as higher regulatory costs for industry that are passed on to the consumer. This definition of risk assessment by EPA is incorrect scientifically and carries serious societal costs.

These failed environmental policies raise even more concern as they affect the risk communication message through the media and distort the education and research agenda. The EPA risk assessment process was wrong from the start. It was the product of an historical battle between homeopathy and medicine and the corrupted manipulation of the actions of leaders of the radiation genetics community, such as the Nobel Laureate Hermann J. Muller and his colleague Curt Stern.

It is time for society to be led by science, not ideology, in the matter of risk assessment. Society has suffered untold illness and incurred unnecessary costs in the process. It is time to reverse this process and choose low-dose exposure models based on experimental validation, rather than ideology.

Potential Benefits of Hormesis for Toxicology and Clinical Practices

Toxicology/Risk Assessment

Changes strategy for hazard assessment:
- Affects animal model and endpoint selection
- Changes the study design by altering the number of doses used, the range of doses studied, and the number of subject evaluated per dose

Changes biostatistical modeling:
- Predicts responses below background disease incidence, i.e., benefits

Improves risk assessment process:
- Refines and better targets uncertainty factor applications
- Differentiates benefits from harm below the toxicological threshold

Clinical Practices

Drug performance is constrained by the quantitative features of the hormetic dose-response.

High dose acting drugs may have different effect at low doses (i.e., anti-tumor drugs kill tumor cells at high doses but can stimulate proliferation at lower doses).

Clinical trial implications:
- Need to recognize interindividual variation in the hormetic dose-response
- Need to recognize the quantitative features of the hormetic dose-response
- Drugs can have multiple hormetic effects on different organs, creating a broad spectrum of beneficial and harmful effects.

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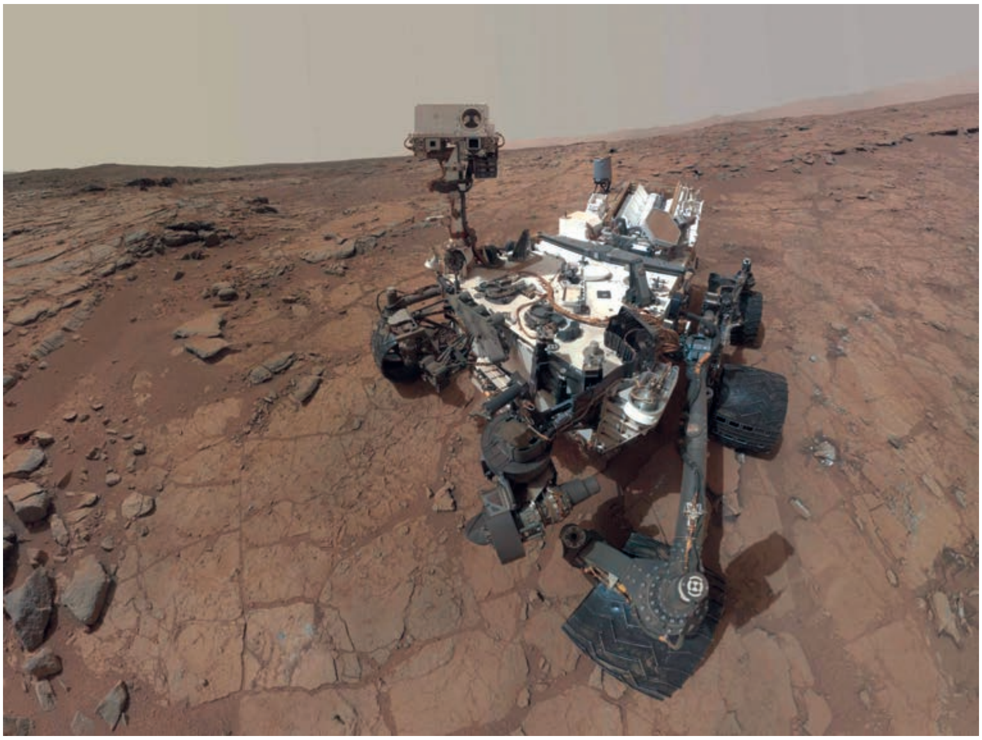


NASA/JPL-Caltech/MSSS

The Curiosity rover took this self-portrait during its 177th day on Mars, on Feb. 3. The rover is near the John Klein outcrop, where the rover carried out the first rock-drilling experiment on another planet.

Curiosity Discovers Mars Could Have Supported Life

by Marsha Freeman

Scientists have taken a major step toward answering the question: did life exist anywhere in the Solar System, besides the Earth?

The most recent data sent to Earth from the Curiosity rover indicate that at least at some time in its past, Mars could have been a habitable planet. Curiosity is only in the seventh month of its minimally two-year mission, and still months away from its arrival at Mount Sharp—its ultimate destination—but it has already uncovered evidence of what scientists surmise is a region of Mars that could have supported microbial life.

At a March 12 press briefing at NASA headquarters, Michael Meyer, lead scientist for NASA's Mars Exploration Program said: "A fundamental question for this mission is whether Mars could have supported a habitable environment. From what we know now, the answer is 'yes.' "

Two key suites of scientific instruments on Curiosity provided the new data—Sample Analysis at Mars (SAM), and Chemistry and Mineralogy (CheMin). The new data come from the first-ever examination of material from inside a rock on another planet. Last month, Curiosity drilled a 2.5 inch hole into a rock outcrop called "John Klein," which resides in a region not far from where Curiosity landed on Aug. 7, 2012, dubbed Yellowknife Bay. An aspirin-sized sample of the powdered rock was delivered to SAM and CheMin for analysis, and the results have been very rewarding.

New Discoveries

Two new ground-breaking results were announced by scientists during the March 12 briefing.

First, on Earth, it is the case that, although life can be found in very extreme environments, such as inside nuclear power plants and in bone-dry deserts, some amount of water, even if very small, must be available for life to exist. Numerous Mars missions have observed from orbit the footprints of past water on Mars, in the form of dry river beds, deep-cut canyons carved from the landscape by flowing water, and signatures of chemicals, that, on Earth, form in watery environments. Opportunity has provided scientists with *in situ* confirmation that Mars had a wet past, adding ground truth to the orbital observations. But the evidence provided by Opportunity's investigations of the chemistry of the minerals it examined indicate that the past water in Meridiani Planum was acidic and salty.

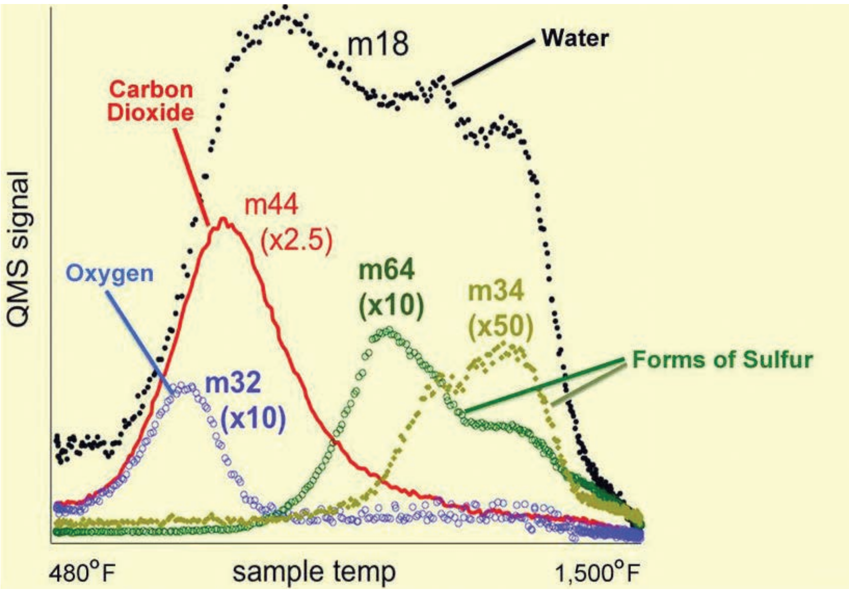
However, Curiosity confirmed the presence of clays, first seen from orbit, with a chemical composition that indicated that they were formed in a neutral, or mildly alkaline, water environment. Asked at the briefing how he would characterize this finding in layman's terms, Curiosity chief scientist John Grotzinger said, "If this water were around, and you had been on the planet, you would have been able to drink it."

At least 20% of the rock sample, according to CheMin principal investigator David Blake, was made up of clay. He described the clay as produced through the reaction of relatively fresh water with igneous material. The presence of calcium sulfate also indicates a non-acidic watery environment.

Second, in addition to water, any life on Mars would have had to find an available source of the key chemical ingredients for life. Curiosity's CheMin and SAM instruments identified some of these in the rock sample, including sulfur, nitrogen, hydrogen, oxygen, phosphorus, and carbon (**Figure 1**). Paul Mahaffy, SAM principal investigator, reported that "the range of chemical ingredients we have identified in the sample is impressive, and it suggests pairings such as sulfates and sulfides that indicate a possible chemical energy source for micro-organisms." Dr. Grotzinger said these minerals are "effectively like batteries," that can be a source of energy for life.

In addition, scientists unexpectedly found a mixture of chemicals that were oxidized, less-oxidized, and even non-oxidized, inside the rock. (Iron on the surface that has been oxidized, or chemically combined with oxygen, is what gives Mars its red coloration). Photographs of the drill cuttings, before samples were delivered for chemical analysis, showed them to be gray, indicating the material had not been fully oxidized. These different levels of oxidation indicate a range of energy that microbes on Earth make use of.

FIGURE 1
Major Gases Released from the Bedrock Called 'John Klein' and Analyzed by the SAM Instruments



NASA/JPL-Caltech/GSFC

As the temperature of the rock powder was increased, different gases were released, and then analyzed by the rover's Sample Analysis at Mars (SAM) instrument.

The Road Ahead

The SAM instrument is also able to detect organic chemicals, which on Earth are created by life, but are also produced inorganically, through chemical reactions. These complex compounds, containing carbon and hydrogen, have long been assumed to be prerequites for life.

In the past, methane has been detected from orbit in the Martian atmosphere. This is intriguing because methane in the atmosphere would not be long-lived, since it is destroyed when exposed to radiation. If there is methane in the atmosphere of Mars today, it could mean that it is currently being produced there, either chemically or organically. But the orbital observations were spotty and the methane signature seemed temporary, so scientists are anxious for ground truth.

So far, the scientists reported, Curiosity's instruments have not detected any complex organic compounds. The search will continue. "What we can do now," Grotziner

NASA/JPL-Caltech/MSSS

This mosaic was assembled from dozens of images of Mt. Sharp, taken on Sept. 20, 2012.

stated, "with the issue of habitability in the bag, we can undertake a more systematic search for a brighter carbon signal."

But the scientists also cautioned that, even if no organics are found, it does not mean that life was never resident on Mars. Complicated compounds, such as organics, degrade over time, it was pointed out, especially under the constant bombardment of radiation on the Martian surface. It is possible that life, and organics, were present in Mars' past, but have been erased, at least from the surface, over time.

Grotzinger also stated that even if organic compounds are not found during this mission because they were not there in the past, the Gale Crater site could still have supported life, because inorganic carbon can be used as food by a microbe. "What we have learned in the last 20 years of modern microbiology," Grotziner said, "is that very primitive organisms . . . can derive energy just by feeding on rocks."

Following a month of conjunction throughout April, where the relative position of the Sun between the Earth and Mars prevents robust communications between the two planets, Curiosity is slated to start its multi-month trek to Mount Sharp. The 3-mile-high mountain was created when a meteorite struck the planet, excavating Gale Crater and throwing subsurface material up in to the center.

From orbit, and now, from stunning photos taken by Curiosity, it is clear that Mount Sharp has a story to tell. The base of the mountain will contain the oldest excavated material in the crater, and its sedementary layers, laid down through successive periods of flowing water, should reveal more of the chemical, geologic, hydrologic, and atmospheric history there. If Curiosity is able to climb up the side of Mount Sharp, eons of time of Mars' history will be revealed.

The meteor strike at Chelyabinsk, Feb 15, 2013.

The Strategic Defense of Earth: Unanswered Questions

The following is an open letter to the US Congress, prepared in response to the two Congressional Hearings on planetary defense held in March:

- *"Threats from Space: A Review of U.S. Government Efforts to Track and Mitigate Asteroids and Meteors, Part 1"—March 19, House of Representatives Committee on Science, Space, and Technology*
- *"Assessing the Risks, Impacts, and Solutions for Space Threats"—March 20, Senate Committee on Commerce, Science and Transportation—Subcommittee on Science and Space*

This letter was prepared by:

- *Kesha Rogers, 2010 and 2012 Democratic nominee for the House of Representatives in the 22nd District of Texas. Ms. Rogers ran her campaigns on a platform of full funding for NASA and the impeachment of President Obama, achieving solid victories in the primaries.*
- *Jason Ross, 21st Century Science and Technology Editor in Chief.*
- *Benjamin Deniston, 21st Century Science and Technology Staff Writer, specializing in planetary defense.*

March 29, 2013

Distinguished Members of the United States Congress,

In March, the House of Representatives and the Senate held independent hearings inspired by the February 15, 2013 surprise impact of the Chelyabinsk meteor and the close flyby of asteroid 2012 DA14, featuring relevant witnesses from the government, military, academia, and industry. It was good to see that this issue is being addressed by the federal government. However, while some useful discussion was generated, clarifying what the United States has done on this issue and what has yet to be done, we were shocked by what was missing from the discussion.

The subject at hand is the continued existence of human civilization. Can we honestly say that the United States is measuring up to this challenge? The decisions now being made, or not made, will affect all humanity, future and past. The Chelyabinsk meteor impact delivered a clear warning: *we can no longer delay and stall our expansion into space, as we have increasingly done over the past decades*. Defending the Earth from threats from space will not be accomplished with a few specific telescopes or missions, but raises more fundamental questions. What type of future are we going to create over the next two decades? Over the next two generations? And what are we doing right now, *today*, to make that future a reality? The simple fact is that we are already far behind where we could have been, and where we must be. Currently mankind sits blind, unprotected, and vulnerable to extinction, a situation we must do everything in our power to change as rapidly as possible.

The following six critical points were either completely missed or misrepresented during the March 19 and 20 hearings, and must be addressed to ensure a comprehensive defense of Earth.

Courtesy of Kesha Rogers

Kesha Rogers outside the Johnson Space Center, launching her 2010 campaign for Congress. Campaigning on a platform of full funding for NASA and impeachment of President Obama, she won the Democratic nomination for the House of Representatives in the 22nd District of Texas in 2010 and 2012.

1.) Cooperation with Russia on a Strategic Defense of Earth

At the March congressional hearings, there was no mention of the Russian offers for strategic cooperation with the United States on planetary defense. This is very strange. These offers have been repeated since the fall of 2011, starting with Dmitry Rogozin, who is currently the Russian Deputy Prime Minister in charge of defense and space industry, and is heading up the creation of the Russian Foundation for Advanced Research Projects in the Defense Industry (Russia's equivalent of DARPA). In 2011, Rogozin proposed that the United States and Russia openly cooperate on both missile defense systems and planetary defense systems. Calling this the "Strategic Defense of Earth," he said this is an important opportunity to collaborate in addressing challenges that are larger than any one nation. It was reported at the time that then-president Dmitry Medvedev showed interest in the proposal.

In 2012 the Russian Security Council Secretary, Nikolai Patrushev, placed asteroid defense on the agenda of the June 2012 Global Security Summit in St. Petersburg, and since the Chelyabinsk meteor impact on February 15, 2013, Rogozin, Patrushev, and an array of other top Russian officials have repeated this offer, including the head of the Russian Parliament's Foreign Affairs Committee, Alexei Pushkov, who said, "Instead of fighting on Earth, people should be creating a joint system of asteroid defense… Instead of creating a [military] European space defense system, the United States should join us and China in creating the AADS—the Anti-Asteroid Defense System."

With the Cold War long over, and the United States facing extreme financial and economic crises, which prevent us from addressing this challenge alone, it is perplexing that this offer is not being discussed or pursued by the U.S. Congress. We should also note that this concept of U.S.-Russian strategic cooperation on planetary defense goes back to the work of Dr. Edward Teller, who in the 1990s worked with other veterans of the LaRouche-Teller-Reagan SDI in promoting open strategic cooperation with Russia on planetary defense.

The most recent calls from Russia came on March 12, when the upper house of the Russian parliament (the Federation Council) held a high-level round table discussion on the subject of planetary defense, featuring top Russian representatives from Roscosmos, the Russian Academy of Sciences, the Ministry of Emergency Situations, the Ministry of Foreign Affairs, the Ministry of Defense, Rosatom, Energia, the Center for Planetary Defense, and more. A repeated theme of the Russian parliamentary discussion was the need for close collaboration with the United States and other nations. Strangely, there has been no coverage of this extremely important discussion in the western media, and it was not even mentioned at the March 19 and 20 U.S. congressional hearings.

2.) The Constitutional Implications of Planetary Defense

The supreme law of the United States government, our Constitution, opens with a simple and clear declaration of purpose:

> We the People of the United States, in Order to form a more perfect Union, establish Justice, insure domestic Tranquility, provide for the common defense, promote the general Welfare, and secure the Blessings of Liberty to ourselves and our Posterity, do ordain and establish this Constitution for the United States of America.

Protecting the territory and interests of the our nation from asteroids, comets, and meteoroids falls under the federal government's obligation to "provide for the common defense," and the failure to pursue the adequate means to do so would mean the government is neglecting its primary responsibility. NASA Administrator Bolden's statement during the House hearing, that currently our only response to certain scenarios of a threatening asteroid impact, would be to "pray," is not encouraging. It must be emphasized that the scenario he was responding to is among the most likely scenarios for the next asteroid impact.

Presently NASA is not being provided the means to meet its 2005 mandate to find 90% of near-Earth objects down to 140 meters in diameter by 2020. The 2010 National Research Council report, *Defending Planet Earth: Near-Earth Object Surveys and Hazard Mitigation Strategies*, stated:

> Finding: Congress has mandated that NASA discover 90 percent of all near-Earth objects 140 meters in diameter or greater by 2020. The administration has not requested and Congress has not appropriated new funds to meet this objective. Only limited facilities are currently involved in this survey/discovery effort, funded by NASA's existing budget.

While we are failing to support even this modest effort, presently there is *no* government-directed mission to find asteroids down to the size of 30 meters in diameter and provide enough warning time to prevent the impact from occurring. According to NASA's most recent estimates, we presently know of less than 1% of the total expected population of the asteroids ranging from 30 to 100 meters in diameter, a size large enough to destroy an entire metropolitan area and kill millions of people, if one were to strike a major city.

The efforts of certain private initiatives and foundations, such as the B612 Foundation's Sentinel Mission, are certainly commendable. However, even these efforts will not find all the potentially threatening asteroids that could do serious damage to the Earth, and, *more importantly, such efforts do not alleviate the obligation of the federal government to lead this effort*. Again, it is the government's job to provide for the common defense.

Is the present policy of the United States government to leave the defense of Earth to philanthropists?

3.) Long-Period Comets

Neither of the March hearings addressed the challenge of long-period comets (those with periods longer than 200 years). While it is clear that long-period comets strike less frequently than near-Earth asteroids, they are harder to see and deflect, and must be discussed. Because of their long periods, they spend the vast majority of their time in the outer depths of the Solar System, where they are undetectable by our current observation systems. By the time we do detect them, they are generally only a few months to a few years away, providing a very short warning time. This short warning time, coupled with the fact that they are generally significantly larger than near-Earth asteroids and can travel much faster, make deflection missions to stop a long-period comet impact extremely difficult, if not impossible with current capabilities.

For more information, see the 2010 National Research Council report, *Defending Planet Earth: Near-Earth Object Surveys and Hazard Mitigation Strategies*, pages 22, 80-83; and the 2009 IAA report, *Dealing with the Threat to the Earth from Asteroids and Comets*, pages 45-47, 111-113, 119.

4.) Statistics vs Knowledge

Unfortunately, much of the discussion of planetary defense quickly falls to statistics. Statements claiming that we don't have to worry about future impacts because the "chances are so low," are irresponsible at best.

We can all recall the havoc that Hurricane Katrina created in New Orleans in 2005, and the tragic results of not preparing for the "100-year storm" because it was believed that it was unlikely to hit any time soon. With the threats from even smaller asteroids, down to 30 meters in diameter (of which we have discovered less than 1%), the consequences could be much worse than a Category 5 hurricane, and we could lose an entire city. A single long-period comet could eliminate all human civilization. It would be negligence to replace or delay a much-need policy of serious space expansion and planetary defense with statistical arguments.

It must be emphasized that statistics do not represent real knowledge. Specifically, statistics do not provide an understanding of the underlying dynamic nature of the Solar System. For example, from 1840 to 1880 there was an anomalous increase in the number of large meteor sitings around the world, as recorded independently in both China and Europe (see *Meteorite Falls in China and Some Related Human Casualty Events*, by Kevin Yau, et al., Meteoritical Society, 1994). While these particular meteors were not large enough to cause severe damage, the periodic global increase indicates that asteroid impacts do not necessarily follow a random statistical distribution, and we must look for a larger dynamic we don't yet understand.

The only truly competent basis for policy is real knowledge. Until we have an adequate understanding of the entire asteroid population, and a comprehensive means to defend the Earth from these asteroids and comets, downplaying the danger by use of statistical estimations borders on potential criminality.

5.) Reverse Obama's Impeachable Takedown of NASA

Operating under the governing principle of the Preamble to the Federal Constitution, to "provide for the common defense" and to "promote the general Welfare," the systematic takedown of NASA's capabilities by President Obama amounts to an impeachable offense. Following his attacks on the manned space program, the recent sequestration cuts and the just announced additional cuts on top of sequestration, threaten NASA's in-depth capabilities, which in turn, threatens all mankind.

To defend all human civilization, past and future, from the threats of asteroids and comets, the best chance we have is to unleash NASA, providing all the funding necessary for NASA to again excel in its role in leading the United States into space and increase cooperation with other leading nations, especially Russia and China.

The challenge of defending the Earth requires mankind have dominion over the entire inner Solar System as a territory. This means expanding our knowledge of the inner Solar System and expanding our ability to act quickly and efficiently throughout this entire territory. In addition to specific efforts, including those discussed in the hearing, this requires the general expansion of NASA and our space-faring capabilities. This includes the accelerated development of the broad-based space infrastructure required to provide mankind quick and efficient access to the Solar System, most emphatically the development of industrialized basing operations on the Moon, the development of outposts on Mars, and the development of advanced propulsion systems utilizing the high energy-flux densities of thermonuclear fusion reactions (while working towards breakthroughs in harnessing the power of matter-antimatter reactions). These are medium- to long-term missions, but are fundamental for mankind's future survival in the Solar System. They have already been delayed for decades, and absolutely require our immediate attention now.

6.) The Financial Reforms to Make All of This Possible

The supreme principle of the preamble of the Constitution, including providing for defense and promoting the general welfare, overrides any speculative financial obligations. If we are told we cannot afford to invest in these needed space efforts, but we can continue to pour money into a program to "bail out" (or "bail in") bankrupt investment banks, then something is fundamentally wrong, or potentially treasonous, with our national policy decisions. For example, the looting of the population of Cyprus is only the latest scheme in the past five years of bailouts, and, unless this process is stopped, such schemes will come here to United States. We can no longer place the speculative debt of the trans-Atlantic financial system above the interests of our population and our posterity.

The reinstatement of the Glass-Steagall financial regulations of Franklin Roosevelt is absolutely necessary to stabilize the finances of the United States. Only by freeing the economy and the government from the obligation to maintain the value of hyperinflationary speculative assets, can we issue new credit, under the auspices of a Hamiltonian national bank, for real investment to improve the conditions of the nation.

The role of NASA, in both exploration and defense, as part of an international Strategic Defense of Earth effort, is among the most important investments we can make as a nation.

In conclusion, we must rise to the challenges placed before all mankind by the events of February 15, 2013, and respond with what some might call "outside the box thinking." However, "outside the box" in this case is simply outside the Earth, and this is nothing more than meeting the basic challenges facing mankind. The entire territory of the inner Solar System must now be seen as our domain, as a wild frontier in desperate need of the organizing hand of man. Properly understood, planetary defense is nothing less than the natural progress of mankind, progress that has already been long delayed, and progress that is absolutely necessary for the continued existence of mankind.

With the defense of the humanity at stake, we must respond with boldness and appropriately reinterpret the most ancient of directives from the standpoint of the challenges now facing mankind:

… Be fruitful and multiply, replenish the inner Solar System, and subdue it; and have dominion over all that moveth therein …

Amagase_Dam.jpg

The Amagase Dam and reservoir, Kyoto Prefecture, Japan. By controlling rivers, we turn a potential danger into a stable, dependable resource.

NAWAPA Update: Economic Development or 'Back to Nature'?

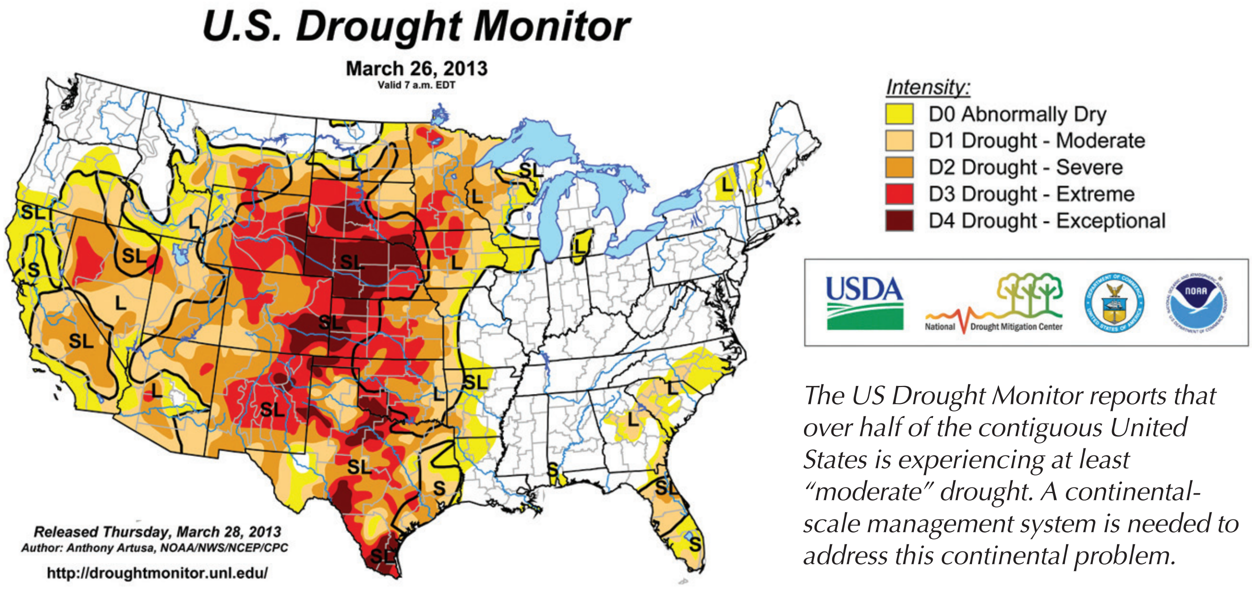
As of January 22, 2013, the U.S. Drought Monitor reported that the dry conditions which decimated the Great Plains throughout 2012 are showing no signs of abatement, reporting that nearly 58% of the contiguous United States remains in at least "moderate" drought. They project that these conditions are likely to remain entrenched through April, and that the drought may even worsen across the Plains states to the Rockies, and into the Southwest. The impact this has had on the food supply continues to be a disaster, threatening our wheat, corn, and soy production, and causing the U.S. cattle herd to shrink to its lowest level in 60 years. The consequences of this natural disaster are already being felt by every consumer visiting the grocery store.

It may come as a surprise to many, but a solution to these cyclical droughts, and the worsening shortage of potable water for cities and irrigation water for farmers, was formulated more than 50 years ago. The North American Water and Power Alliance (NAWAPA) project, designed during the 1960s, and supported by then-President John F. Kennedy, proposed to put millions of acre-feet of freshwater runoff in Alaska and Canada to work, irrigating the continent's western states via an integrated system of dams, reservoirs, lifts, tunnels and canals, replenishing the rivers and groundwater before flowing back into the Pacific Ocean water cycle once again.

This diversion of now-wasted runoff water would not only solve the shortage problems in the western states, it would create a reliable national water grid, like our electrical grid, of constantly replenishable surface and groundwater supply and transform the climate of many regions throughout the continent, and create, directly and indirectly, 14 million new, highly productive jobs.

However, due to the cultural and economic paradigm shift after the assassination of President Kennedy, and the philosophical hegemony of the "zero growth" so-called "environmentalist" movement by the late 1960s, NAWAPA has remained stalled on the books of the Army Corps of Engineers and private engineering firms, replaced by the self-destructive ideology that man should go "back to nature."

In 2010, under the direction of Lyndon LaRouche, a team of economists and researchers began revamping and expanding the original 1960s NAWAPA project to include additional water management extensions and a nuclear power component for the project's heaviest pump lifting operations. The updated proposal, NAWAPA XXI, which includes draft legislation for financing the project, is currently making its way through the halls of the U.S. Congress, provoking a storm of polarized responses. Among our elected representatives, the most common argument is that NAWAPA will "cost too much." This argument is



The US Drought Monitor reports that over half of the contiguous United States is experiencing at least "moderate" drought. A continental-scale management system is needed to address this continental problem.

The U.S. Drought Monitor is jointly produced by the National Drought Mitigation Center at the University of Nebraska-Lincoln, the United States Department of Agriculture, and the National Oceanic and Atmospheric Administration. Map courtesy of NDMC-UNL.

easily countered, however, as it is easily shown that only by vectoring federal credit and investment in to great development projects, as in President Franklin Roosevelt's TVA, that not only can you reverse the current economic depression, but the basis is laid for fundamental breakthroughs in science, technology, and human capital, for the future.

Then, on January 5, in response to the current nation-wide mobilization to implement NAWAPA, The Nature Conservancy's Brian Richter attacked the project by name in an article published in *National Geographic*. Richter asserted that the best thing we could do for the greater Colorado River Basin would be to end the "top-down decision making" for water management, instead taking a "laissez faire" approach to environmental stewardship and by doing so, reduce the amount of water allocated to farms and cities, letting "nature take its course." Richter does not address the question of how many millions of Americans would have to go without food, or would be washed away in floods, were "nature to take its course." What is the survivable population density in the Western states, if, as he suggests, we reverse two centuries of developing our environment to reach the standard of living we have today, and go "back to nature?"

If this proposal sounds remarkably similar to the "free market" argument used by leading transatlantic banks, to deregulate flows of capital, letting the "market forces" work their magic, it is because it is the same argument. The same people who are heading up the Nature Conservancy are also the board members of such "charitable organizations" as Goldman Sachs, as in the case of Henry Paulson, who not only was the Nature Conservancy's board chairman and the CEO of Goldman Sachs, but was also the U.S. Treasury Secretary under George Bush Jr. when the hyperinflationary bank bailout process was first launched five years ago. The "environmentalist" movement, from its very beginning, was funded by the established international banking institutions, whose sole interest it is to enforce policies that keep their financial system intact.

But there is an opportunity for physical reality to trump both stupidity and ideology. NAWAPA is now on the table.

Embassy of Ukraine

Benjamin Deniston (far right) of 21st Century Science & Technology addresses the Vernadsky seminar; Andriy Novikov, Embassy Science Counselor, is seated at the opposite end of the table.

Russia and Ukraine Celebrate Vernadsky's Anniversary

By Marsha Freeman

In December of last year, Russian President Vladimir Putin announced the formation of a committee to plan the activities to celebrate the 150th anniversary of Valdimir Vernadsky's birth, to take place this year. Many activities were planned, including the complete publication of Vernadsky's works in Russian, publication of an English edition of Vernadsky's "Selected Works," and a series of conferences throughout Russia. In Ukraine, where Vernadsky carried out scientific research from 1917-1921, and was the founder and first president of the All-Ukraine Academy of Sciences, celebrations were also planned. The participation of representatives of *21st Century Science & Technology* and *Executive Intelligence Review* (*EIR*) magazines in a number of these events, brought to light the extraordinary accomplishments of Vernadsky, from an American viewpoint.

On the anniversary of Vernadsky's birth, March 12th, the Embassy of Ukraine in Washington, DC, held a seminar and reception to celebrate the scientist's life and work. Ambassador Olexander Motsyk sent greetings to the symposium, stating that Vernadsky "is considered the founder of at least three separate scientific disciplines—biogeochemistry, geochemistry, and radiogeology." The Ambassador pointed to the major milestones in Vernadsky's scientific career, and reported that in recognition of his fundamental contributions to science, two minerals bear his name, as does a mountain ridge in Antarctica, and the Ukrainian Arctic station.

The Ambassador's welcoming remarks were followed by a presentation by Dr. Mark McMenamin, professor of geology at Mount Holyoke College, who had annotated the first complete edition of Vernadsky's seminal work, *The Biosphere*. Professor McMenamin presented a review of the basic scientific concepts of Vernadsky, including the role of life processes in the development of the Earth, the notion of life as a cosmic phenomenon, that the universe is governed, not by chance, but by discrete laws, and that human thought is a geological force.

Following this overview presentation, Benjamin Deniston, representing *21st Century Science & Technology*, concentrated on the concept of energy-flux density, as a characteristic of the anti-entropic development of species. This quality of increasing energy-flux density, he demonstrated, is an organizing principle of the biosphere, and represents a fundamental law of the universe, as well as the development of human society, through the noösphere.

Finally, *EIR* Washington Bureau Chief, William Jones, pointed out to the participants, that the building of the Embassy of Ukraine, in which the celebration took place, was the one in which George Washington negotiated with local landowners in1788, to acquire the land needed to build the new nation's capitol. George Washington, as well as Abraham Lincoln, were revered in the Vernadsky household, Jones reported.

Vernadsky: The American Distortion

The American "misunderstanding" of Vladimir Vernadsky's work was the focus of a recorded video presentation by William Jones, delivered to a conference celebrating the Vernadsky anniversary, on March 15, in Moscow.

The two-day conference was organized by the Alexander Solzhenitzyn House of Russia Abroad, and brought together a number of Vernadsky scholars, from Russia, Ukraine, Germany, and the United States.

Jones' presentation centered around the "refashioning" of Vernadsky, carried out in the U.S. starting in the 1930s by G. Evelyn Hutchinson, whose characterization of Vernadsky as "the father of ecology," spawned the notion, completely antithetical to Vernadsky's, that man is a pestilence upon the Earth. Substituting Vernadsky's concept of the creative development of the biosphere by man with a zero-growth "green" agenda, to shut down modern industry and reverse man's scientific advancements to improve nature, created the most commonly held view of Vernadsky in the United States. Jones pointed out that the "Biosphere" cover story of *Scientific American* magazine in September, 1970, which main article was written by Hutchinson, moved this previously more "academic" issue in to the political mainstream, and issued the "clarion call for a green movement."

This purposeful misrepresentation of Vernadsky's scientific breakthroughs to the English-speaking world, was taken up again by Jones, at a celebration of the great scientist's birth, held at the Russian Cultural Center, in Washington, DC, on March 27th. The speakers and audience included prominent Russian scientists, living in the United States.

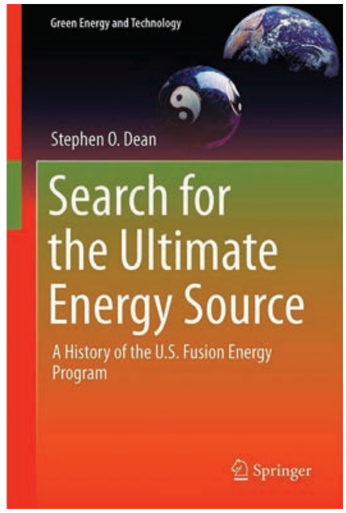
Chairing the event was Roald Sagdeev, a member of the Russian Academy of Sciences, and former director of the Space Research Institute in Moscow. Sagdeev remarked that Vernadsky was an "organizer of science," and then stressed the importance of improving the conditions of scientific research in Russia, which, for years, has been his great concern.

But a later speaker—Edwin Squiers, a professor of biology from George Washington University—tried to turn Vernadsky into a "Greenie," making the incredible statement that if he were alive today, having witnessed Hiroshima, Vernadsky would have changed his mind about nuclear power, and been a proponent of solar energy!

Although Jones was not scheduled to speak at the event, he was given the floor, to comment. Vernadsky, Jones said, "was no ecologist, no environmental activist, but a humanist thoroughly committed to the notion of progress, which he saw as an underlying law in the universe." Jones recounted Vernadsky's attacks on Malthus and Darwin, juxtaposing the "survival of the fittest," to Vernadsky's view of development through man's creative breakthroughs in science. Even through two world wars and Stalinism, Jones said, Vernadsky maintained tremendous optimism. It is that spirit of optimism that must guide mankind today, he concluded, to "move man forcefully into space," and defend mankind from the cosmic threats that could end human civilization.

Why Has It Taken So Long To Develop Fusion Energy?

by Marsha Freeman

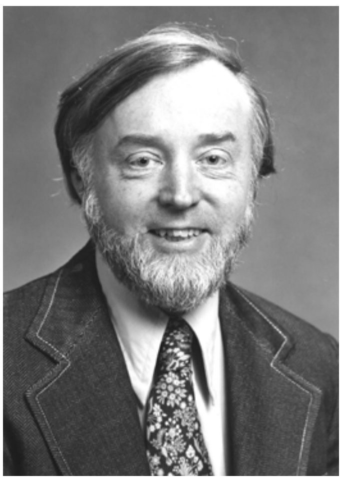


Search for the Ultimate Energy Source: A History of the U.S. Fusion Energy Program
Stephen O. Dean
New York: Springer, 2013
Hardcover, 262 pp., $129.00

Over the more than five decades that scientists and engineers have carried out theoretical research and conducted experiments to reproduce on Earth the energy of the Sun, there has been no argument on the part of policymakers that developing fusion energy is necessary. Not only are reserves of today's energy natural resources finite, thermonuclear fusion, as a qualitative leap, will create entirely new capabilities and applications in fields such as materials processing and space propulsion.

So, why has it taken so long to develop fusion energy?

There is no better person to tackle this question than Dr. Stephen Dean. With a scientific background, and experience in federal government fusion research programs—from the early 1960s Atomic Energy Commission to the multi-hundreds of millions of dollar fusion program in the late 1970s—through his present leadership in the private Fusion Power Associates, Dr. Dean has been a tireless advocate for fusion research and development. In a field where very limited budgets have, at times, led scientists to pit their approaches to fusion energy against one another, in order to compete for funding, Dr. Dean has been a "disinterested" party, with no personal stake in any one program, and the personal integrity to evaluate projects on their merit.


Stephen Dean, the founder of Fusion Power Associates, in Gaithersburg, Maryland.

Search for the Ultimate Energy Source begins with a primer on fusion for the layman, and describes the rich history of various alternative approaches to reaching the goal of fusion energy. But it is the succeeding chapters, which answer the question posed above, from the standpoint of one of the major players in fusion, which is a unique contribution. Dr. Dean's book describes the "glory years" of the 1970s, to the twists and turns through subsequent Republican and Democratic Administrations, which have, today, left the U.S. fusion program struggling for its very survival.[1] It is an insider's view of why fusion "is always 50 years away," as critics opine, regardless of the progress that has been made.

It is a history in which the predecessor to *21st Century Science & Technology*, the Fusion Energy Foundation, played a major role in the late 1970s through the mid-1980s, bringing the science and technology of fusion to policymakers, and to the general public,[2] and which role this publication continues to the present.

As he should be, Dr. Dean has been recognized for his contributions to fusion. In 2004, he received the American Nuclear Society's "Senior Statesman of the Fusion Program Award." The citation recognizes Dean for "stimulating the development of young scientists; maintaining a focus on the end product of fusion; keeping industry and utilities involved; and providing a platform for policy discussions."

This is a book that should be in every library, and read by citizens and policymakers, alike. Due to the current irrational budgetary environment in Washington, there is no more important time to do so.

1 "Scientists Launch a Fight To Save The U.S. Fusion Program," p. 78, Fall/Winter, 2012-13, *21st Century Science & Technology.*

2 "The True History of the U.S. Fusion Program–And Who Tried to Kill It," p.15, Winter 2009-2010, *21st Century Science & Technology*.

Evidence of Advanced Civilization in the Ice Age

by Charles Hughes

Maps of the Ancient Sea Kings: Evidence of Advanced Civilization in the Ice Age
by Charles H. Hapgood
Adventures Unlimited Press
316 pp., $19.95
Kempton, Illinois 1996

As Lyndon LaRouche has pointed out for over thirty years, the founders of our civilization, our ancestors, were sea peoples who sailed all the oceans of the earth, invented the science of spherics by observing the heavens, knew that the earth was a sphere and accurately calculated its circumference, and made calendars and maps (some very beautiful and artistic), which have been passed down to us, copied thousands of times. They provide the material for this amazing book by the late Professor Charles Hapgood, who taught the history of science at Keene State College in Keene, New Hampshire in the 1960s.

This book, which was first published in 1965, deserves to be more widely known today, for it destroys many of the most prized axioms of the scientific establishment about early civilizations and science.

Hapgood states in the book that those who follow through on suggestions made by others often make important discoveries. The person who made the suggestion in this case was Captain Arlington Mallory, himself an investigator of ancient civilization, and the author of the book *Lost America*. Mallory believed that an old map discovered in the palace of the Turkish Sultans in Constantinople in 1929, was indeed, as was claimed, the property and work of a 16th century Turkish admiral named Peri Re'is. This map depicted parts of the world, such as South America and Antarctica, with an accuracy that should have

been totally impossible for the map's date of 1513.

The map had notes around the edge in Turkish, by Admiral Re'is, which said that there was no map in the whole world like this map, and furthermore, that the map was a composite of many maps from archives now lost, including maps from the time of Alexander the Great. Dating the ancient origin of some of the source maps, Mallory thought that the Antarctic area had been drawn before the continent had become covered with ice!

Professor Hapgood told Mallory he would carry out an investigation of the Peri Re'is map as a project with his students. During the seven years required for the investigation, Hapgood expanded his investigation to include other "impossible" maps located in libraries around the world, and even got the U.S. Air Force involved in his project. He realized that he was an amateur in this field, which we might call "paleo-cartography," although he did know something about the history of science.

The author explains that he began with a very wrong assumption, that the Peri Re'is map was unique, as the map itself said. He was later to find other maps that were far too advanced to have been drawn in the Middle Ages, Renaissance, or even in classical Greece or Rome. As we might expect, the surviving maps drawn by Claudius Ptolemy were rather incompetent examples of map work. On page 10, a map by Ptolemy is compared with one called the Dulcert Portolano, which looks almost modern, despite its alleged date of 14th century. The Ptolemy map is badly distorted. The original Dulcert was probably made by competent sea people of the Ice Age.

The first problem was to find out where the center of the Re'is map was located, what type of projection it was, and what was the length of a degree of latitude and longitude. After that was accomplished, Hapgood would locate points on the map: islands, bays, headlands, river mouths, mountains and such, and note if they were located at the correct latitude and longitude, as compared to a modern map.

Hapgood and his students found that the Peri Re'is map showed most of the Atlantic area, including northwest Africa, parts of the Americas, the West Indies, and of course, parts of Antarctica. The center of the map was found to be the intersection of the Tropic of Cancer, about 23.5 degrees north latitude, and the longitude of around 30°E, a location in Egypt, but not at any known ancient city. Although the basis for measuring longitude is arbitrary, the relative distances on the map were found to be internally consistent, and quite close to modern values. Unusually, the projection was found to be azimuthal equidistant, a projection which distorted the Americas. The West Indian area was rotated, so that Cuba was vertical. This whole area was placed on the map obliquely. More than fifty points on the Peri Re'is map were found to be accurate to within a modern degree, and in some cases, as accurate as a modern map. However, it was obvious that the source map for the West Indies had been placed incorrectly in relation to the other land areas. The reason that this is so unusual, and shows that the map or the source maps used by Admiral Re'is could not have been contemporary, nor even from the classical world, is that the finding of exact longitude in particular, has only been possible since the invention of accurate clocks that could be used at sea, and not malfunction due to the rocking motion of the ship, an invention developed in the mid-18th century.

Proposing that the source maps came from an ancient sea people culture, such a culture would have attained accurate longitudes in two ways. Either they had invented the ice age equivalent of Harrison's chronometer of 1740, or they were expert in timing total eclipses of the moon. In the latter case, they would have needed to set up observatories all over the earth, and to maintain a master observatory that kept data for centuries. In addition, they would have had to have almanacs predicting lunar eclipses for future times, which would be carried on ships and supplied to their many observatories all over the then civilized world.

An eclipse would be noted for local time, for example at Cape St. Vincent in Spain, and then the same eclipse would be compared to its occurrence at the master observatory, for example Stonehenge in England. The difference in time between the two events would give the longitude of the unknown land. The main observatory would probably be at zero longitude in their system. There was another method, called lunar distances, which was used prior to the invention of the chronometer, which depended on accurate measurements with a sextant of the moon and a nearby star, for a given day and hour. In contrast to the difficulty of measuring longitude, latitude could be found much more easily, by measuring the altitude of the North Star above the horizon, or the altitude of the sun at local noon.

The surviving half of the Peri Re'is world map from 1513.

After the completion of the analysis of the Peri Re'is world map, Hapgood wondered if there were more or similar maps, which showed Antarctica, or accurate placement of the landmasses of the globe. He requested that the Library of Congress let him examine such maps in their archives. He found that the most anomalous maps were of a type called "portolanos," which suddenly turned up in Europe about the time of the collapse of the Byzantine Empire in the 15th century, and were used by sailors who could depend upon their accuracy. Another class of maps, such as the maps of Ptolemy, were very poor, and were used by academics throughout the ages in Western Civilization, but shunned by seamen whose lives depended on accurate maps. It is possible that these maps were copied and recopied from sea people originals, and restricted to the use of sailors. The two map traditions were kept separate. The academics would never mention the portolanos in their writings, but would stick to Ptolemy.

When Professor Hapgood was well into his map project, it turned out that one of the students involved in his project had been a cartographer in the Air Force. He introduced Hapgood to Colonel Harold Olemeyer of the map section of the Strategic Air Command base at Westover, Massachusetts. Olemeyer was very interested in the project, and agreed to have his department check Hapgood's data.

Olemeyer's Technical Reconnaissance Section sent the Professor a report on their findings on July 6, 1960. The report confirmed Hapgood's findings, and is reproduced on page 243 of the book. The Air Force examined other maps provided by Hapgood; one in particular, called the Orontius Finius world map, showed Antarctica very plainly, with rivers and mountains, and open areas of water now covered with ice. The Zeno Map of the North, of 14th Century provenance, shows Greenland as two major landmasses, before the island was covered with ice.

Hapgood's evidence shows that a civilization of sea people flourished in the Ice Age, that is 10,000-12,000 B.C., and sad to say, that all of our map technology has been "hand me downs," as a heritage from these people, until we caught up in the 18th century!

This book is well illustrated, with chapters on geometry and trigonometry, showing how maps are constructed. If the material in this book were known to most academics, I'm sure it would produce heart attacks among them, and end the nonsensical idea that oceans are barriers to the transmissions of culture.