21st CENTURY SCIENCE & TECHNOLOGY

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Features

Lilly Library, Indiana University, and Svenskt Press

Hermann Muller, receiving his Nobel Prize in 1946, for his discovery that mutations can be induced by X-rays.

A well-known toxicologist discusses his startling discovery that the linear no-threshold or LNT hypothesis, which governs radiation and chemical protection policy today, was founded on a deliberate lie to further a political agenda.

Departments

ON THE COVER: The Soda Dam on Jemez Creek near Jemez Springs, New Mexico, was formed by mineral deposits (mostly calcium carbonate) over centuries, dissolved from rocks deep under the Earth, and brought to the surface by the hot springs. Photo courtesy of Blake Arden Downs; cover design by Alan Yue.

News

Zbigniew Jaworowski

Michael R. Fox

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We Need a Hamiltonian Solution!

This issue of *21st Century* honors two men (p. 28) whose life's work was for the benefit of mankind, making use of the most advanced technologies to uplift the human race and provide for a growing world population. They shared a view of man as a creative being, who could solve problems. As Zbigniew Jaworowski, a multidisciplinary scientist based in Warsaw, eloquently stated: "We shall humanize the biosphere of the Earth, and then the worlds beyond. This our future role, as the discovery of radioactivity itself, is a result of natural evolution."

Mike Fox, a nuclear chemist who worked in nuclear for decades in the United States, and who shared much of Jaworowski's outlook, characterized electrical energy as "a substitute for human backs, or for slavery." Both saw the unique contribution of nuclear in increasing the energy-flux density necessary to power an industrial society, and both were adamant in attacking the "sunbeams and breezes" approach popularized by the Malthusian death cult as power sources.

But to realize these goals requires a more explicit definition of the solution to the present problem facing our nation and the world. The survival of civilization depends upon reviving the principle of the Hamiltonian credit system, which was the foundation of the early survival of our Republic and the basis of its continuing strength. Whenever that principle was overthrown, as in the nearly 50 years since the assassination of President John F. Kennedy, the nation has fallen under the control of a monetary system, and suffered the consequences.

The opponents of Hamilton's National Bank, including Jefferson and Madison, claimed, like today's populists, that government had no authority to charter such an institution. In answering them, at President Washington's request, Hamilton noted that the authority for his credit system derived from the General Welfare clause of the Preamble to the Constitution. The government's authority to coin money and regulate its value and to borrow on the credit of the United States was specified in Article 1, Section 8 of the Constitution. Nothing blocked it, while the fulfillment of the crucial clause "to protect the General Welfare" required the government's role in the creation of credit to that end.

To leave the matter in the hands of private banking interests, which meant international, and especially British banking, was to abandon sovereignty and to lose in the marketplace the very thing that had been gained on the battlefield.

The same precise principle applies today. The very same argument against Hamilton's credit system, the "free market" fraud of British East India Company employee Adam Smith, is the one still invoked against it today, often by ignorant fools who suppose themselves patriots. The Hamiltonian principle of a credit system, first embodied on these shores in the conception of the Pinetree Shilling, recognizes that a nation's wealth resides in the creativity of its people, and in the ability of government to foster projects that permit its fullest realization.

The opposite principle, of a money system, is founded on a belief in the magical power of money to create wealth, and the inherent right of the possessor of money to a rate of profit. When that magic fails, as in today's devastating world economic depression, the only recourse of the believers in this system is to attempt to squeeze the money needed to pay the mass of unpayable obligations which they have created from the growing mass of impoverished citizens. The result of such measures, usually invoked in the name of budget balancing, is to foster growing impoverishment.

The Way Out

There is only one way out. It can be summarized in two measures requiring urgent implementation, as elaborated by

VIEWPOINT

Fukushima: Different Reactions In the West and East

by Thomas Grønlund Nielsen

The earthquake on March 11, 2011, with its epicenter near the coast of Japan, was 9.0 on a Richter scale, the highest ever recorded in Japan territories. It gave rise to a 10-meter high tsunami that reached the east coast of Japan shortly after. This wave killed 20,000 people when it hit and flooded vast parts of Japan—a catastrophe of unseen proportions in a rich industrialized country. To my knowledge, however, not one of these casualties was caused by the accident at Fukushima Daichi Nuclear Power Plant.

As severe earthquakes are not unusual in the "land of the rising Sun," all Japan's nuclear reactors were prepared for earthquakes and shut down immediately on March 11, by lowering the reactor control rods. This stopped the fission process in the reactors, i.e. the chain reactions where the uranium-235 isotopes are bombarded with neutrons that cause them to split, emitting two or three new neutrons that hit other uranium isotopes, which split and continue the process.

This safety measure did certainly work as it should all across Japan, and so any kind of a new Chernobyl was ruled out from the beginning of the accident.

Still, the nuclear reactors need to be cooled long after shutdown because of the radioactive decay that produces heat. Right after shutdown, this heat production corresponds to 6 percent of full-power capacity of the nuclear plant, that is, 60 megawatts for a 1 gigawatt plant—a massive amount of heat that needs to be channeled away from the core of the reactor to avoid damaging the core and making it useless.

Since most of these radioactive decays have half-life periods of seconds, minutes, or hours, the power of the heat production quickly decreases after shutdown; after one week it is only a fraction of 60 megawatts, but still not insignificant. Therefore, the reactors need to be cooled for weeks or even months after shutdown.

This is normally done with water circulation within the reactor core. If this circulation is stopped, the heat from the radioactive decay will evaporate the water, until, finally, the uranium fuel melts down.

In the 1970s, there was some hysteria among anti-nuclear protesters that this fuel could melt through the steel vessel that encapsules the nuclear reactor core and farther through the concrete containment building, and in the end all the way through the Earth to China! This was popularized as "the China Syndrome."

But after the accident at Three-Mile Island in 1979, this threat could be fully dismissed, as it was proven there that even though the reactor core fully melted, it was incapable even of melting anything of importance in the steel vessel.

Continued on next page

economist Lyndon H. LaRouche.[1] First, the immediate reinstatement of the Glass Steagall Act, which asserts the principle of separation of commercial banking from speculation. This will allow, and require, the government to legally separate itself from the mass of fraudulent unpayable paper which hangs over the heads of all citizens, so long as the obligation to bail out the firms supposedly "too big to fail" can be invoked.

Second, the reinstitution of a Hamiltonian credit system embodying the principle of the National Bank.[2] New issue of government credit is required to fund the great projects of today, equivalent to the canals, roads, and improvement of harbors and waterways of the previous National Bank. Today that means space exploration, the North American Water and Power Alliance, a vastly expanded and open-ended nuclear and fusion energy development program, and an expansion and upgrading of the nation's transportation, utility, and infrastructure grid.

The small-minded patter we hear from our friends who try to fight a piecemeal battle for the little crumbs, which they define as "practical," must end.

The future of the nation today depends on securing a reliable and plentiful power supply. For an advanced industrial economy, this means the most energy-flux-dense form of power—fission now, fusion tomorrow, and new more advanced forms of power production yet to be discovered in the future. New nuclear plants and research into advanced energy are properly the sphere of Federal credit, long-term credit at low-interest for projects—over 25, 50, and 100 years—that will guarantee the electricity and process heat needed for a growing industrial economy and a population with a high standard of living.

The Apollo program, a giant Federal program, *paid for itself*—as will an Apollo-style nuclear program. Every dollar put into the Apollo program, yielded $10 to the economy, measured by conservative standards. Hundreds of thousands of young people became scientists, engineers, or technicians. A similar number of entrepreneurial businesses flourished, as did spinoff inventions. In the days of Apollo, there was a "can-do" spirit, the scientific optimism that any problem could be solved, because the nature of man and society was to progress.

How pitiful the contrast with today's nuclear situation, where beleaguered nuclear supporters lobby for one reactor type against another, or make cost/benefit arguments within the controlled monetarist straitjacket. Of course nuclear is "cost-effective"! Without it, we will not survive as a nation.

1. Information on Glass Steagall can be found here.

2. For more on Hamiltonian economics, see "A Matter of Principle: Hamilton's Economics Created Our Constitution," by Nancy Spannaus.

Viewpoint

Continued from previous page

The Damage at Fukushima

The earthquake and tsunami at the Fukushima Power Plant destroyed three reactors and buildings, but there was no devastating radioactive leakage. The problems at this plant, close to the sea, started when the 46 to 49-foot-high (14-15 meters) tsunami waves hit, about 41 minutes after the earthquake. The emergency diesel-driven generators started up, to keep on the water circulation system to cool the reactors that had automatically shut down, as mentioned above.

But these generators became flooded and stopped operating, which halted the circulation of water in the reactor cores. Thus, the core temperatures started to increase to a critical level. In the following weeks, voluntary operators and engineers fought to get things under control at the plant. Radioactive gases were released from the reactor, but these consisted of iodine and cesium in limited amounts, and thus were not of critical long-term danger, although the plant had to be evacuated temporarily for some hours after leakage until the radioactivity dropped again.

Also, hydrogen gas from the evaporated water had to be released, causing the explosions in the plants that damaged the roof of the reactor buildings. This gave birth to a lot of hysteria in the mass media, but the important factor here is that the reactor cores remained fully isolated by both the steel vessel and the concrete surrounding it, and thus no highly radioactive materials like uranium or plutonium had a chance to escape.

As was repeatedly underscored by the International Atomic Energy Agency and other nuclear authorities, no radioactivity of threat to human health had been leaked from the power plant.

Comparison with TMI

The Fukushima accident had many similarities with the 1979 accident at Three-Mile Island. Both plants were built in the beginning of the 1970s, and as first-generation nuclear plants, they do not have the enhanced safety systems of the second-generation plants and the passive safety systems of the third-generation plants in construction today.

Mishina/Yazawa Science Office

Many areas in Japan remain to be restored to normal after the devastating tsunami that caused 20,000 deaths. Here, a July 2011 scene in Kesennuma Miyagi Prefecture, which was ravaged by the tsunami.

But what was more critical at the Fukushima plants was the difficulty of supplying electricity and other means to the emergency crew, as the rest of the surrounding Japanese society was reeling from the disaster that struck.

Not Like Chernobyl

The accident/disaster at Chernobyl was a totally different (and very long) story, which I shall only briefly mention here. The Chernobyl reactor was poorly designed, with inherent instabilities. The control rods, for instance, had the fault that when lowered into the core (to decrease activity) they would quickly increase the fission activity, causing more nucleons to be split and hence more energy to be released, before starting to decrease it. (This is called a positive void coefficient.)

As the reactor was already in a critical unstable stage, this very short moment was enough to totally loosen the operator's grip on the chain reaction. In few seconds, the reactor went from 200 megawatts power to 350,000 megawatts. The reactor exploded, sending massive amounts of highly radioactive materials more than 1,000 meters into the atmosphere, from where it was spread by the wind.

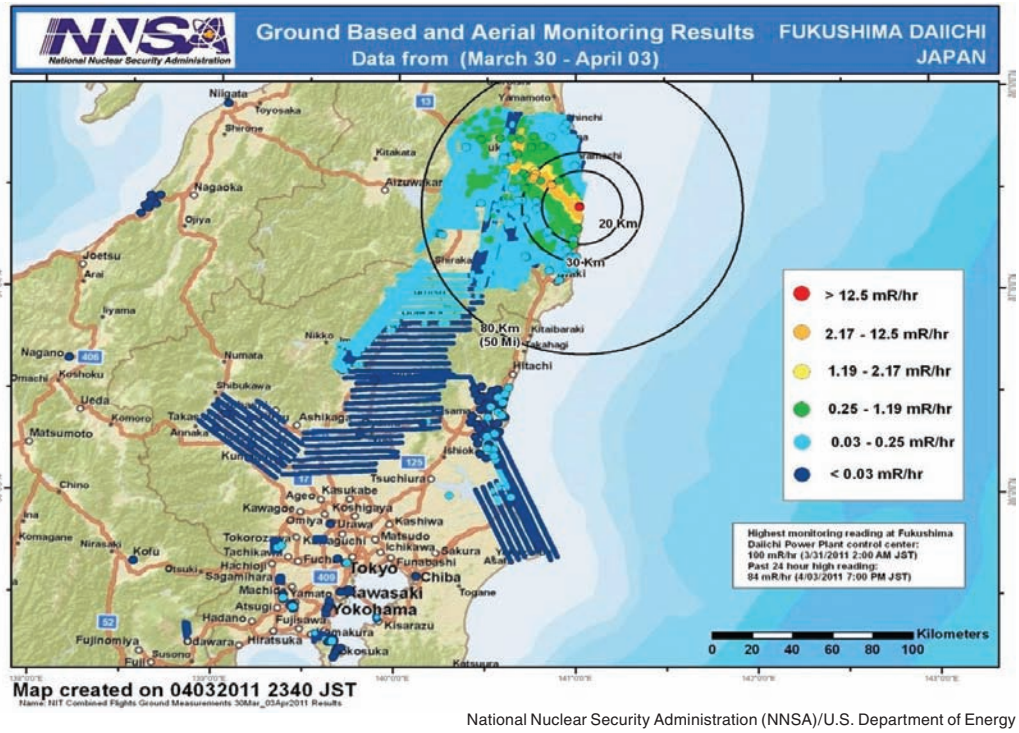
Unlike all reactors in the Western world, the Chernobyl RBMK reactor had no concrete containment structure, so the radioactive materials were free to disperse, after the steel vessel had been blown apart.

Moreover, the Chernobyl reactor used graphite as moderator (to slow down the neutrons), instead of water, and because graphite is flammable, a fire was started that lasted for 10 days, sending more highly radioactive material in the air. Thus, there were measured radioactive levels of 200,000 millisieverts/hr, 4 miles away from the Chernobyl plant. The highest readings I have heard of at Fukushima were 400 millisieverts/hr (which do pose a threat to health) *inside* the plant and orders of magnitude less outside.

Differing Reactions

The reactions around the world to the Fukushima accident have been widely different. Germany has retreated to its former law, which mandated closing all nuclear reactors by 2022. Just months before the accident, Germany had extended this deadline to 2034. There does not seem to be any scientific reasoning behind this decision, as it is highly unlikely that Germany should ever be hit by a 10-meter high tsunami.

China has taken a completely different approach. Although extra safety checks



National Nuclear Security Administration (NNSA)/U.S. Department of Energy

The map shows the combined results of 211 flight hours of aerial monitoring operations and ground measurements made by the Department of Energy, Department of Defense, and Japanese monitoring teams from March 30-April 3, 2011.

To put these levels in perspective, U.S. nuclear pioneer Dr. Ted Rockwell has pointed out: "The reality is that, while some people in the Fukushima housing area are wearing cumbersome rad-con suits, filtered gas-masks, gloves and booties, and putting the same on their children, other people are living carefree in places like Norway, Brazil, Iran, India where folks have lived normal lives for countless generations with radiation levels as much as a hundred times greater than the forbidden areas of the Fukushima homes."

A technical review of the Fukushima accident can be found here.

are being conducted at its nuclear plants, there is no sign of change to the 2020 plan of doubling the present nuclear capacity of the nation. In fact, I have talked with Chinese nuclear experts who tell me that the Chinese Central Government sees the accident as a reason to promote nuclear reactors with passive safety mechanisms, where water circulation will not be shut off by lack of electricity, but be kept in circulation by the physical laws of gravity and convection.

China is importing such technology from the United States, for example, the so-called Westinghouse AP-1000 reactors, and China and the United States have signed a memorandum of understanding on cooperation on nuclear technology.

The U.S. Situation

The United States is the nation that gave birth to nuclear technology. It was here that the first man-controlled nuclear chain reaction took place in 1941, and the U.S. is still a technical and industrial leader in civilian nuclear power. But this is on the threshold of abrupt change—if the White House does not take a much more active stand, and start walking the walk instead of just talking the talk.

America's nuclear industry has been in decline for the last 30 years, and although both Democrats and Republicans speak as though they support the technology, in reality, very little is moving forward. Westinghouse, for instance, is owned today by the Japanese company Toshiba. And, just to take one example, the only American company that enriches uranium for nuclear power plants, the United States Enrichment Corp. (USEC), has long been appealing to the Federal government to fund its ongoing construction of a modern plant that will hugely save energy and cost.

In August 2008, the USEC applied for a $2 billion loan from the Department of Energy with its project, which is "in close alignment with the objectives and regulations of The Loan Guarantee Program." The Energy Policy Act of 2005 made nuclear power a clear priority for the United States. Yet, USEC could not begin construction of the plant before 2007, after waiting two and a half years for the Nuclear Regulatory Commission to issue a license to build and operate the plant.

To this day, USEC has not been granted the loan, and the only thing that has kept the project from shutting down is investments from Toshiba. Thus, it is a Japanese company and not the U.S. government that has been promoting world-class American nuclear technology, which would create 8,000 high-level jobs for American industry, and help lower the dependence on imported oil. As could be expected, the Fukushima accident has for now not promoted further investment from the Japanese in USEC. But, interestingly, many local Japanese in the Fukushima area, have been voting in favor of nuclear power after the accident.

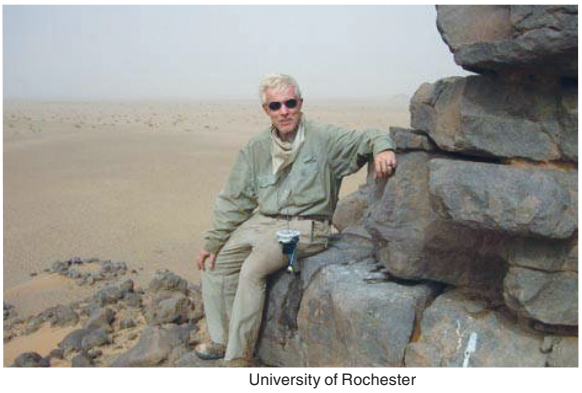
The question of nuclear power is becoming an issue of whether a country believes in industrializing new technologies, or if it prefers not to invest in its future, leaving the nation's welfare to financial bubbles.

The author has a M.Sc. in Physics from the Niels Bohr Institute. He has lived and worked in Canada, Switzerland, and Denmark, and is a founder of UPstream Invest A/S, which invests in nuclear energy and other 21st Century technology.

NASA

NASA

Artist's depiction of CloudSat, the most advanced radar designed to measure the properties of clouds, is part of the "A-Train" constellation of three other Earth Observing satellites including Aqua, Aura, and the French CNES's PARASOL. Inset: Dr. Graeme Stephens.



University of Rochester

Dr. John Tarduno is Professor of Geophysics at the University of Rochester, here in a clearing sandstorm in the Sahara (northeastern Mauritania).

On the Ground at the AGU, Dec. 5-9, San Francisco

The American Geophysical Union held its annual fall meeting Dec. 5-9, 2011 in San Francisco, where 20,000 attendees from around the world presented research on everything from deep earth processes to the physics of the outer reaches of the heliosphere. Peter Martinson, Alexandra Peribikovsky, and Oyang Teng from 21st Century *attended, with a focus primarily on current developments in space weather and earthquake forecasting, which will be the subject of upcoming articles.*

Here are some highlights of other research from the poster sessions and oral presentations, compiled by Oyang Teng.

CLOUDS AND CLIMATE CHANGE

For all the attention climate scientists pay to global mean surface temperature, it is virtually irrelevant when it comes to clouds and cloud dynamics. Such was the message of Graeme Stephens's standing-room-only lecture on "Climate Change: A Very Cloudy Picture," which addressed the complexities of cloud properties and their varying influences on the climate as a whole, in particular through the hydrological cycle. These complexities have bedeviled climate models as the single greatest source of uncertainty, and "muddled up" water vapor feedback in the reports of the Intergovernmental Panel on Climate Change.

Stephens, director of the Center for Climate Sciences at NASA's Jet Propulsion Laboratory, said that rather than attempting to tweak current climate models into submission, "the way forward is to dig into the key processes and try to understand them at the building-block level, the process level," which is only possible through such dedicated multi-sensory platforms as NASA's A-Train constellation of Earth-observation satellites.

THE EARLY MAGNETIC FIELD AND LIFE

In spite of several billion years of upheavals that have erased most of the record of Earth's infancy, traces of the planet's most ancient magnetic field live on in microscopic magnetic particles lodged inside of millimeter-sized quartz crystals. In discussing his poster titled, "Magnetic Field Strength, Water, and Life on the early Earth," John Tarduno of Rochester University explained that because such inclusions have escaped the ravages suffered by most larger rock samples over time, they have allowed him and his associates to establish the oldest record of the existence and strength of the geomagnetic field, which 3.47 billion years ago was approximately 25 percent its current strength.

One of the consequences of such a weak field at a time when it is believed the young Sun was spinning more rapidly, and therefore producing a more intense solar wind, is that much of the initial supply of water vapor in the Earth's atmosphere would have been blown away—implying that the planet was much wetter to begin with, and perhaps shedding light on conditions necessary for the appearance of the first living organisms.

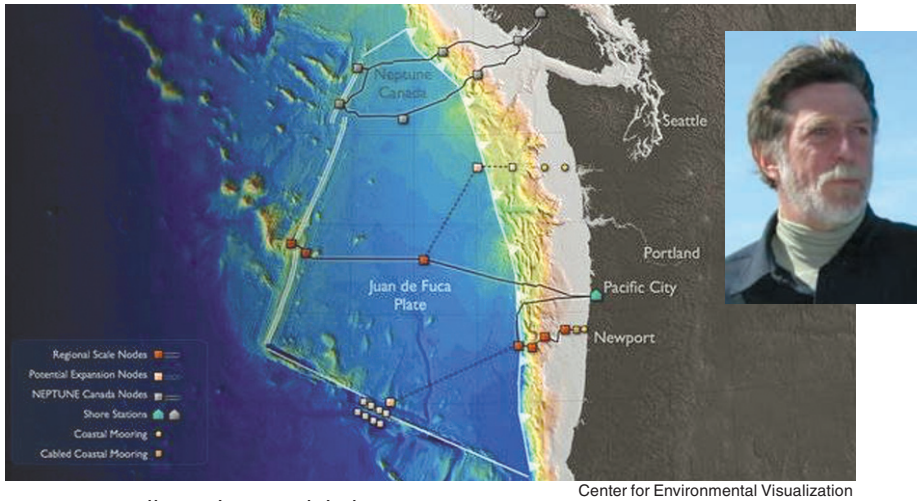
Tarduno noted, that the oldest microfossil evidence of life coincides in time with the earliest evidence of the geomagnetic field. He said he is now studying zircon inclusions in rock conglomerates that are older than 4 billion years, for even more ancient signs of the geomagnetic field. (Such work could also serve as a constraint on current geophysical models for the generation of the geomagnetic field itself.)

WIRING THE OCEAN FLOOR TO MONITOR VOLCANOES

As humanity has steadily expanded its sensorium into space through an increasing array of Earth-orbiting satellites, we are only now beginning to reach into the depths to probe the deep seafloor, which covers some 60 percent of Earth's surface. Under the National Science Foundation's Ocean Observatories Initiative, an integrated network of advanced *in-situ* monitoring instruments is being constructed around the volcanically active seafloor spreading region of the Juan

de Fuca tectonic plate, situated several hundred miles off the coast of the Pacific Northwest.

The University of Washington's John Delaney, discussed the prospects in his talk on "Active Submarine Volcanoes and Electro-Optical Sensor Networks: The Potential of Capturing and Quantifying an Entire Eruptive Sequence at Axial Seamount, Juan de Fuca Ridge." Delaney explained that this will allow scientists to study, for the first time, the full sequence of an underwater volcano, its biogeochemical consequences for the marine environment, as well as clues about the nature of the deep biosphere, which periodically vents microorganisms into the ocean during such eruptions.



Center for Environmental Visualization and OOI-RSN program, University of Washington

Dr. John Delaney (inset) and a University of Washington research team are implanting robotic sensor arrays along the Juan de Fuca Ridge and elsewhere on the ocean floor and water column, which link to the Internet using submarine electro-optical cables.

"We're not just talking about Axial Seamount—we're talking about a global system," Delaney stressed, pointing out that the Juan de Fuca Ridge is representative of the global dynamics of ocean crust. Although not explicitly mentioned in his presentation, the Juan de Fuca Ridge is also the origin of the Cascadia Subduction zone, which has the potential to unleash a mega-earthquake and tsunami that could devastate both the Pacific Northwest as well as Japan, as it has in the past.

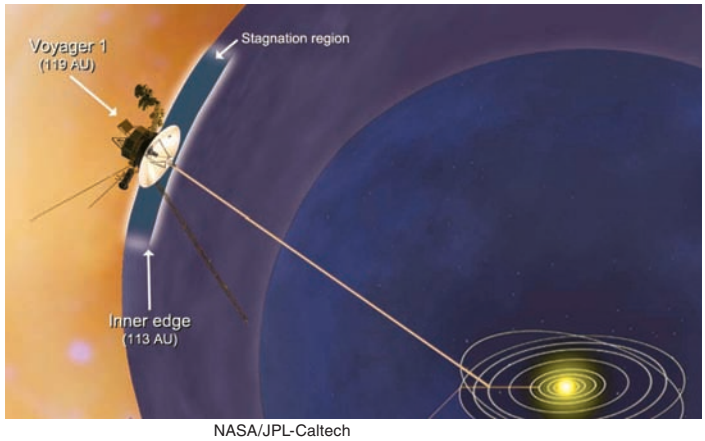
Advanced, real-time monitoring of this area, once the system comes online in the next couple of years, could be key for developing an early warning system.

EXPECT THE UNEXPECTED: UPDATE ON VOYAGERS 1 AND 2

Voyagers 1 and 2, launched in 1977 and now roughly 11 and 9 billion miles from Earth, respectively, continue their encounter with the weird outer edges of the Solar System. In a talk on "Voyager Observations in the Heliosheath: An Overview," project scientist Ed Stone discussed the so-called stagnation zone Voyager 1 has entered, in which the solar wind has apparently slowed to a halt in the outer fringes of the heliosphere. Stone, former director of JPL lab, is now a professor of physics at Caltech.

It is expected that the spacecraft could punch through to interstellar space within several months or years. In a following presentation on "The Dynamics of the Heliosphere from 1961 to Voyagers 1 and 2 in 2011," Eugene Parker, the astrophysicist who first theorized the existence of the solar wind in the mid 1950s, described the excitement of the near-term prospects for directly sampling the interstellar environment.

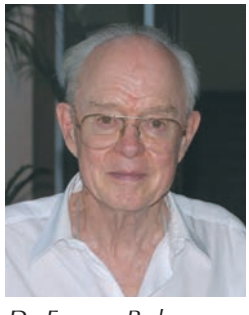
"The spacecraft are plunging into unknown, uncharted regions of space with the usual unexpected surprises. It reminds me of the early days of space exploration studying the solar wind, when practically any measurement would turn up something interesting," Parker said.



NASA/JPL-Caltech

Artist's illustration of NASA's Voyager 1 spacecraft entering a new region between our Solar System and interstellar space, called the stagnation region. There the wind of charged particles streaming out from the Sun has slowed and turned inward for the first time, the Solar System's magnetic field has piled up, and higher-energy particles from inside the Solar System appear to be leaking out into interstellar space.

Dr. Ed Stone with a model of Voyager.



Dr. Eugene Parker, a solar astrophysicist, is a professor emeritus at the University of Chicago.

Are Carbonate Solutions Alive?

Bicarbonate aqueous systems, the necessary constituents of all biological liquids, exhibit a sustained non-equilibrium state and sensitivity to cosmic events.

by V.L. Voeikov, Do Minh Ha, N.D. Vilenskaya, S.I. Malishenko, and E.V. Bouravleva

Ian Britton

Solutions of bicarbonates, such as ordinary baking soda, show life-like properties.

The authors are from the Lomonosov Moscow State University, Faculty of Biology, in Moscow and can be reached via e mail at v109028v1@yandex.ru .

A version of this article appeared in the Italian publication La Medicina Biologica, *Oct.-Dec. 2010, pp. 45-53. Additional figures have been supplied by V.L. Voeikov.*

Carbonates (bicarbonate, carbonic acid, and CO_2) are the necessary constituents of cell cytoplasm and of all biological liquids. The bicarbonate content is strictly maintained in the organism. Its deficiency results in impaired cell and tissue respiration, followed by the development of a variety of pathological states. Both normal and healing drinking waters are usually bicarbonate solutions, and supplementation with bicarbonate is a universal healing method in complementary medicine. However, the true mechanism of action of carbonates is still a matter of debate.

We discovered that the addition of iron oxide Fe(II) salts to bicarbonate solutions induces a wave of photon emission. The intensity of the wave is boosted in the presence of luminol, the probe for the reactive oxygen species (ROS), indicating that spontaneous chain reactions with the participation of reactive oxygen species take place continuously in aqueous bicarbonate solutions. The addition of hydrogen peroxide (H_2O_2) in sub-millimolar (mM) concentrations to 1-5 mM bicarbonate solutions initiates a process accompanied by spontaneous low-level photon emission, which is amplified with luminol.

Hermetically sealed test-tubes containing activated bicarbonate solutions continue to emit photons for many months when kept in complete darkness. Drastic changes in photon emission from both plain and activated bicarbonate solutions were observed during and after solar and lunar

eclipses, indicating a very high sensitivity of these highly non-equilibrium, and yet stable, systems to extremely low-intensity natural factors.

Such properties of bicarbonate aqueous systems imply that they have a complex dynamic structure, that they acquire a continuous supply of energy from the environment, and that they may be sensitive to extremely low-intensity resonant factors. The behavior of these systems agrees with the theory of coherent domains developed by G. Preparata and E. Del Giudice.

The mechanism to explain the long-lasting effects of solar and lunar eclipses on photon emission from aqueous systems can be considered only hypothetically at this point. Both events represent special cases of gravitational influence upon the Earth. It is clear that the direct effect of variations in the gravitational attraction upon water samples is practically negligible. However, the total effect on such a massive body as the Earth may result in changes in the parameters of manifold physical fields associated with it, which, in turn, may trigger changes in the behavior of non-equilibrium aqueous systems. It should be noted that cosmic events may influence the behavior of practically all non-equilibrium aqueous systems on the Earth, including water in living organisms, and may produce long-lasting effects in them.

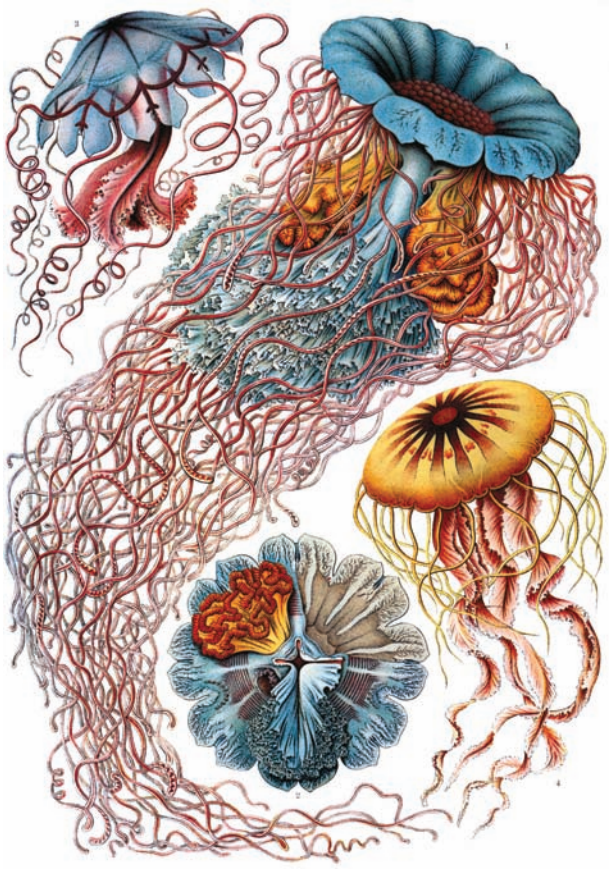
Introduction

According to Ervin Bauer's major principle of theoretical biology, the Principle of Stable Non-equilibrium:

> Living systems are unique in that they are never at equilibrium. They perform work against equilibrium, ceaselessly, and in a manner demanded by the physical and chemical laws appropriate to the actual external conditions.[1]

In other words, in order to maintain the stability of its non-equilibrium state, a living system transforms *all* of its free energy into work aimed at sustaining or changing its parameters in response to changing conditions. The non-equilibrium state of matter, in the sense of Bauer's principle, is an excited state, in which the structure of matter and its properties differ significantly from those characteristic of the equilibrium (ground) state of the same matter. Stable non-equilibrium is displayed at all levels of organization of a living system, including the molecular one.

Water is, by far, the dominant molecular constituent of all living systems. On a molar basis, water constitutes more than 99 percent of the molecules of any living cell and of the extracellular matrix. Biological molecules can exert their functions only in aqueous milieu; no biological processes can occur in a system whose water content is below a certain threshold.[2,3] Thus, water should participate directly both in keeping living matter



Drawings by Ernst Haeckel of four medusa-like organisms, Discomedusae*, a subclass of jelly fish. There may be as many as 2,000 molecules of water for every molecule of "living" carbon in organisms like these.*

in the excited state, and in the performance of its work against equilibrium.

Living systems belong to the class of *confined open systems* (the term coined by Prof. E. Tiezzi[4]). The term *open* means that they are able to exchange energy and matter with their environment, and to receive information about changes in their environment and react to this information by adaptation of their internal processes. Basically, all vital processes may be seen as processes of energy gain and transformation: The conversion of different forms of potential energy into free energy and of the latter into the work against equilibrium which is "demanded by the physical and chemical laws appropriate to the actual external conditions."

The term *confined* means that a system has boundaries and is segregated from its environment. Vital processes take place in the confined space of living systems. The internal space of living systems represents a gel-like aqueous phase[5] (more precisely multiple aqueous phases) formed by the indissoluble union of organic molecules and the water in which they are imbedded.

1. E.S. Bauer, 1935. *Theoretical Biology.* (Moscow-Leningrad: VIEM Publishing House). (see also V.L. Voeikov, E. Del Giudice, 2009. "Water Respiration—The Basis of the Living State," *WATER; A Multidisciplinary Research Journal*, Vol. 1, No. 1 (July), pp. 52-75.)

2. J.S. Clegg, A.C. Zettlemoyer, H.H. Hsing, 1978. "On the residual water content of dried but viable cells." *Experientia,* Vol. 34, No. 6, p. 734.

3. N. Marchettini, E. Del Giudice, V. Voeikov, E. Tiezzi, 2010. "Water : A medium where dissipative structures are produced by a coherent dynamics" *J. Theoret. Biology,* doi:10.1016/j.jtbi.2010.05.02

4. E. Tiezzi, G. Cecconi, N. Marchettini, 2010. "Confined ontic open systems." *Int. J. of Design and Nature and Ecodynamics*, Vol. 5, No. 1, pp. 3-9.

5. G.H. Pollack, 2001. *Cells, Gels and the Engines of Life: A New Unifying Approach to Cell Function.* (Seattle: Ebner and Sons).

The major organic molecules responsible for structuring the internal space of living systems are the acidic polysaccharides and collagen-like proteins. In some cases (for example, in medusa-like animals, such as jellyfish) these substances may bind up to 2,000 parts of water per 1 part of organic carbon,[6] and this "living water" exhibits the same vitality as in any other organism. Thus, living systems may be provisionally defined as *organic (carbonaceous) aqueous systems* in a persistent state of energy transformation.

Although we encounter an enormous diversity of living systems expressing an overwhelming complexity of dynamic structure and vital activities, the fundamental principles of their structure and mechanisms of activity should be common to all. We believe that these principles can be traced to confined aqueous systems containing carbonaceous compounds, in the simplest case, inorganic carbonates. Here we present evidence that aqueous bicarbonate solutions represent stable non-equilibrium systems. Further, one of the intrinsic properties of living systems is their ability to react to extremely low-intensity external factors—"informational stimuli." Indeed, we have observed changes in the "behavior" of non-equilibrium bicarbonate solutions in response to cosmic events, in particular to lunar and solar eclipses.

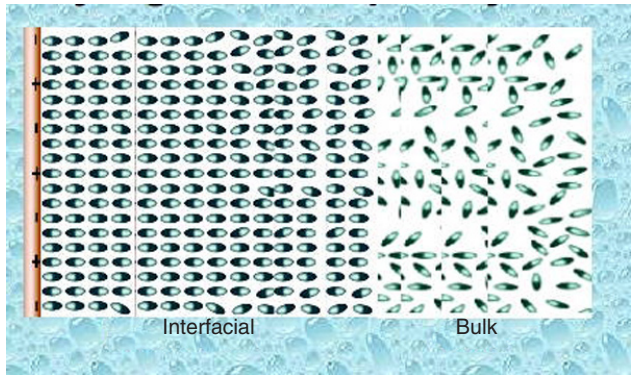


Figure 1
INTERFACIAL WATER (EXCLUSION ZONE WATER)
Interfacial or EZ water is different from bulk water in density, freezing temperature, relative permittivity, viscosity, and (lower) "structural temperature." It is dynamically organized, liquid crystalline, quasi-polymeric, coherent water.

The Non-equilibrium State of Water

Any "real" water sample is never a homogenous collection of water molecules interacting exclusively with each other. Rather it represents an *aqueous system* that is intrinsically heterogeneous for at least two reasons.

The first reason is that liquid water always resides in a vessel. Some water is adjacent to the boundaries of the vessel, and to the water-air (gas) interface; other water molecules are located at a certain distance from the boundaries. Recently, G.H. Pollack and his group have demonstrated convincingly that water near the boundaries forms a peculiar phase with many properties different from that of the "bulk" water at a distance from these surfaces.[7] Depending upon the properties of the wetted surface, the thickness of this phase may reach hundreds of microns.

The second reason is that even ultra-pure water always contains impurities. These may include the gases dissolved in it, ionic and molecular species, and the products of water dissociation (H_3O^+ and OH^-). During a long history of water research, it has been shown that even the tiniest impurities can significantly change the colligative properties of water. Recently, direct visualization has demonstrated the presence of stable-water-clusters of tens of nanometers to micron size in very dilute sodium chloride solution.[8]

The common feature of the interfacial aqueous phase (named "Exclusion Zone" water, or EZ-water, by Pollack), and the stable water clusters visualized by Lo et al., is that both possess negative electrical potential, reaching fractions of volts, in respect to "bulk" water. (See Figure 1.) That means that any


St. David Spring, near Moscow, which is enriched with bicarbonates of magnesium and calcium.

6. M.R. Reeve, M.A. Syms, P. and Kremer, 1989. "Growth dynamics of a ctenophore (Mnemiopsis) in relation to variable food supply, I.Carbon biomass, feeding, egg production, growth and assimilation efficiency," *J. Plankton Res.*, Vol. 11, p. 535-552.

7. J.M. Zheng, W.C. Chin, E. Khijniak, E. Khijniak, Jr., and G.H. Pollack, 2006. "Surfaces and interfacial water: Evidence that hydrophilic surfaces have long-range impact," *Adv. Colloid Interface Sci.*, Vol. 23, pp. 19-27.

8. S.Y. Lo, X. Geng, and D. Gann, 2009. "Evidence for the existence of stable-water-clusters at room temperature and normal pressure," *Physics Letters A.* Vol. 373, pp. 3872-3876.

"real" water is a non-equilibrium system in which high electrical and other gradients always exist between different aqueous phases. It is important to stress here that such properties of aqueous systems have been predicted by G. Preparata and E. Del Giudice, in their Quantum Electrodynamics coherence theory of the condensed state of matter.[9] If the conditions for the flow of electrons from negatively charged water to electron acceptors are present, potential energy may be released as free energy, and work may be performed both within the system and in its surrounding environment.

A natural electron acceptor whose reduction gives the highest yield of free energy is oxygen. It is always present in water, even if in minute quantities, because under relatively mild conditions water can split and produce oxygen.[10] Many "impurities," such as nano- and micro-bubbles, nanoparticles, and ions facilitate this process. Thus, EZ-water in contact with bulk water containing dissolved oxygen represents a donor-acceptor pair, and, under appropriate conditions, the complete oxygen-reduction reaction may proceed within it:

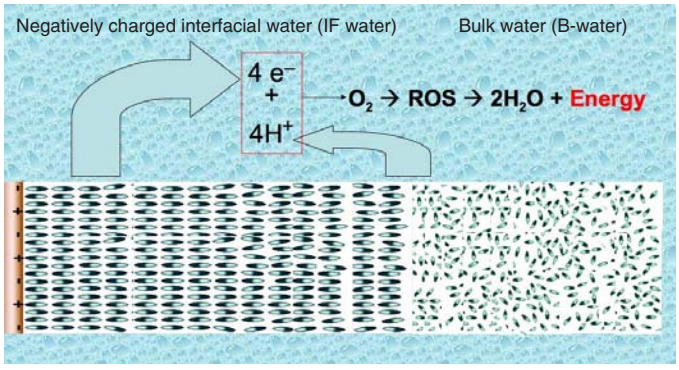


Figure 2
THE PRINCIPLE OF 'WATER BURNING'
Burning refers to the oxygen reduction by electrons that are abstracted from the fuel. It requires catalysts, such as impurities and carbonates, to proceed efficiently.

$2H_2O$ (EZ-water) + $O_2 \rightarrow O_2$ + ***$2H_2O$*** (Bulk water) + n·hν (Energy)

Although the molecular species on the left and right sides of this equation are the same (water and oxygen), a high-grade, highly condensed energy of electron excitation (a total of up to 8 eV per O_2 molecule) may be donated by this reaction. Water on the left side of the equation (in bold) belongs to a stable non-equilibrium (excited) structure, that is, EZ-water. Water on the right side of the equation is ground-state (bulk) water. It is the "structural energy" of EZ-water that is released when water molecules belonging to this stable, non-equilibrium structure revert to ground-state water molecules.

The process of EZ-water "burning" (meaning oxygen reduction by electrons extracted from the "fuel") outlined in the equation in Figure 2 shows some ideal situation that probably cannot be realized in "pure" water. Certain catalysts are needed for the process of water "burning" to proceed efficiently. The most common "impurities" that may serve as catalysts for the processes related to water splitting and burning are the members of the carbonate family:

9. R. Arani, I. Bono, E. Del Giudice, G. Preparata, 1995. "QED Coherence and the Thermodynamics of Water," *Int. J. Modern Phys.* Vol. B9, pp. 1813-1841.

10. V.L Voeikov, 2006. "Biological significance of active oxygen-dependent processes in aqueous systems." *In Water and the Cell,* eds. G. Pollack, I. Cameron, and D. Wheatley (The Netherlands, Springer Press, pp. 285-298).

Author Voeikov (left) and his collaborator Do Minh Ha at the Lomonosov Moscow State Univerity. Voeikov is pictured with a molecular model of ``structured hexagonal water" (ice). The large balls are oxygen, the small ones are hydrogen. The red sticks depict hydrogen bonds.

Luminol ($C_8H_7N_3O_2$) exhibits chemiluminescence, giving off a blue glow when it is mixed with an oxidizing agent. Presence of Luminol boosted the intensity of the photon emission-wave in the bicarbonate solutions.

$$CO_2 + H_2O \leftrightarrow H_2CO_3 \leftrightarrow HCO_3^- + H^+$$

Carbonates are present in practically all aqueous systems, because of the very high solubility of CO_2 in water and the wide distribution of carbonates in nature. More and more experimental data are demonstrating a very important functional role for carbonates, particularly bicarbonates, in a variety of biochemical reactions, including the fundamental processes of photosynthesis[11] and respiration.

Carbonates Promote Respiration

According to textbook knowledge, cellular respiration is the process of energy gain caused by the oxidation (burning) of sugars and fats by oxygen. In this process, organic molecules serve as donors of "hot" electrons; oxygen accepts them, turning into water; and the energy released is used to propel vital functions. However, even when fuel and oxygen are not limited, respiration may be halted if the living system is severely deficient of carbonates. Thus, carbonates present in water may participate in (bio)energetic processes based on respiration on a very fundamental level.

At the end of the 19th Century, the Swiss biologist Friedrich Miescher discovered that the intensity of physiological respiration (breathing) depended much more strongly on small changes in the CO_2 content in alveolar air, than on the oxygen content in the inhaled air. He described this in a poetic phrase: "Carbon dioxide spreads its protective wings over the body's oxygen supply—especially as it cares for the brain. . . ."[12]

Later, prominent physiologists Christian Bohr, John Haldane, and Yandell Henderson confirmed that carbonates are no less vital to life than oxygen. Bohr and Haldane discovered that carbon dioxide regulates oxygen binding to hemoglobin, and *vice versa*. Henderson claimed that CO_2 (and carbonates in general) is the major hormone of the body; that it is produced in every tissue and exerts its effects on all the tissues; and that a decrease of carbonates below some critical level, especially in the brain, may result in fatigue and death due to cessation of respiration.[13]

Henderson supposed that the effect of carbonates is mediated by their regulation of acid-base balance, but he also noted that carbonates may exert some more specific action upon molecular targets.

In fact, it was demonstrated that CO_2 and bicarbonates support respiration in isolated leucocytes,[14] and are necessary for DNA replication and cell division in primary cultures of eukaryotic cells.[15,16] There are multiple mechanisms for the action of carbonates on the cellular level. One of them may be related to the reaction of CO_2 with the amino groups in peptides and proteins, forming unstable carbamino adducts:

$$\text{Protein-}(NH_2) + CO_2 \leftrightarrow \text{Protein-NH-COOH} \leftrightarrow \text{Protein-NH-}COO^- + H^+$$

Generally, the activity and stability of modified proteins are increased.[17]

In light of what was said above about interfacial water, it is interesting to speculate that the net increase in the negative charge of carbamylated proteins may promote the building up of additional layers of EZ-water around them, resulting in the energizing of such an aqueous system.

Another important property of carbonates is less acknowledged. Carbonates modulate oxidation, peroxidation, and nitration both *in vivo,* and *in vitro*. The carbonates possess such a property because they react with the active oxygen species, and turn into relatively long-living and more selectively acting free radicals[18] and peroxycarbonates.[19] In particular, they exert striking effects on the activity of the enzymes involved in the metabolism of the reactive oxygen species.

11. P.A. Castelfranco, Y.-K. Lu, A.J. Stemler, 2007. "Hypothesis: the peroxydicarbonic acid cycle in photosynthetic oxygen evolution," *Photosynth. Res.,* Vol. 94, pp. 235-246.

12. F. Miescher, 1885. "Bemerkungen zur Lehre von den Athembewegungen," *Arch. Anat. Physiol. Physiol Abth.* 3555. 1885.

13. Y. Henderson, 1938. *Adventures in Respiration: Modes of Asphyxiation and Methods of Resuscitation* (Baltimore: Williams & Wilkins).

14. W. Bicz, 1960. The influence of carbon dioxide tension on the respiration of normal and leukemic human leukocytes. I. Influence on endogenous respiration," *Cancer Res.,* Vol. 20, pp. 184-190.

15. T. Mitaka, G.L. Sattler, H.C. Pitot, 1991. "The bicarbonate ion is essential for efficient dna synthesis by primary cultured rat hepatocytes," *In Vitro Cell. Dev. Biol.,* Vol. 27A, pp. 549-556. 0

16. R.S. Chang, H. Liepius, M. Margolish, 1961. "Carbon dioxide requirement and nucleic acid metabolism of HeLa and conjunctival cells," *Proc. Soc. Exp. Biol. Med.,* Vol. 106, pp. 149-152.

17. J.S. Morrow, P. Keim, F.R. Gurd,1974. CO_2 adducts of certain amino acids, peptides, and sperm whale myoglobin studied by carbon 13 and proton nuclear magnetic resonance," *J. Biol. Chem.,* Vol. 249, pp. 7484-94.

18. D.B. Medinas, G. Cerchiaro, D.F. Trindade, O. Augusto, 2007. "The carbonate radical and related oxidants derived from bicarbonate buffer. Critical review," *IUBMP Life,* Vol. 59, pp. 255-262.

19. M.G. Bonini, S.A. Gabel, K. Ranguelova, K. Stadler, E. DeRose. "Direct magnetic resonance evidence for peroxymonocarbonate involvement in the Cu, Zn superoxide dismutase peroxidase catalytic cycle." http://www.jbc.org/cgi/doi/10.1074/jbc.M804644200

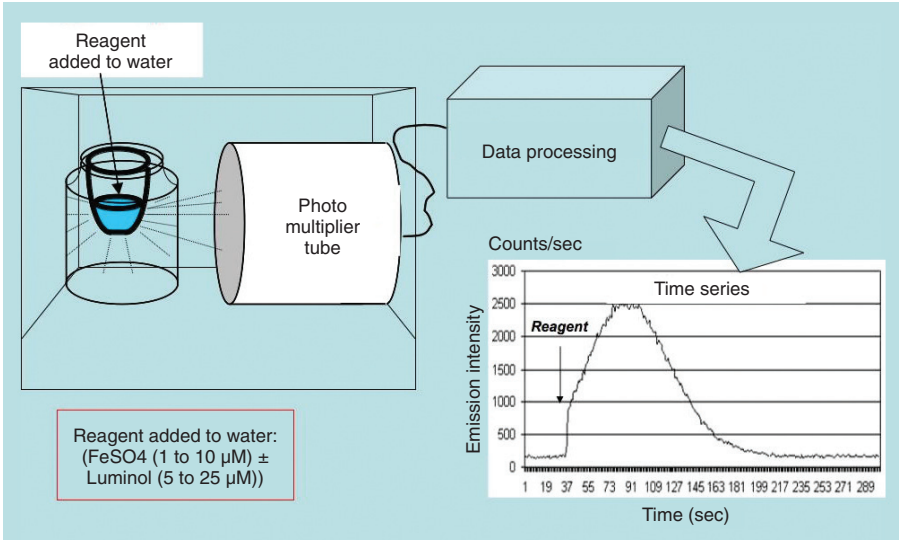


Figure 3
PHOTON EMISSION IN BICARBONATE WATERS

Shown here schematically is the addition of iron oxide, Fe II, salts in catalytic quantities to bicarbonate water, which results in the development of a wave of Luminol-amplified photo emission from the water. This indicates that processes in which reactive oxygen species participate go on continuously in bicarbonate waters.

The least, but probably not the last, is the ability of carbonates to participate directly in the synthetic reactions which give rise to the organic compounds, and in the processes in which (bio)polymers originate.[20]

Thus, carbonates are needed for multiple vital processes, and especially for the most basic one—respiration, both on the organismal and cellular levels. Inasmuch as a significant part of consumed oxygen is reduced by one electron, and spent for combustion, and since water in principle may be used as a fuel, it can not be excluded that carbonate solutions may themselves "respire."

Intrinsic Activity of Aqueous Bicarbonate Solutions

'Plain' Bicarbonate Solutions. Using sensitive single photon counters we found that a wave of photon emission in the visible range of the electromagnetic spectrum may be initiated in bicarbonate artesian waters and in aqueous bicarbonate solutions, following the addition of Fe(II) salts ($FeSO_4$ or $FeCl_2$) in concentrations as low as 5 μM (micromoles). The intensity of the photon emission-wave was increased in the presence of luminol, the probe for the reactive oxygen species (Figure 3). The development of a luminol-amplified photon emission-wave from bicarbonate solutions of Fe(II) salts, indicated that spontaneous chain reactions with the participation of reactive oxygen species continuously take place in aqueous bicarbonate solutions. The amplitude of the wave and its duration was dependent upon bicarbonate concentration. The addition of Fe(II) to a bicarbonate solution, after the decay of the first photon emission-wave, could induce the appearance of a new photon emission-wave, with the same or even higher intensity as the previous one; this effect could be reproduced many times.

Just after the bottle with bicarbonate artesian water was opened, the amplitude of photon emission-waves was low. But provided that the water was in contact with the surrounding air, the wave amplitude increased and reached a quasi-stationary level, displaying circadian variations (Figure 4). However, in the experiment illustrated in Figure 4, when the activity of the water was monitored several times a day for 11 days, a strong decline in the amplitude of the induced photon-emission-wave was observed after 6 days.

The minimal amplitude of the photon emission-wave coincided with the time of the New Moon (16:00-18:00 hours on Aug. 8, 2002), but two days later the amplitude returned to the same level as before.

Bicarbonate Solutions Activated with Hydrogen Peroxide. When hydrogen peroxide (H_2O_2) was added to 1-5 mM bicarbonate solutions in final concentrations as small as 0.001-

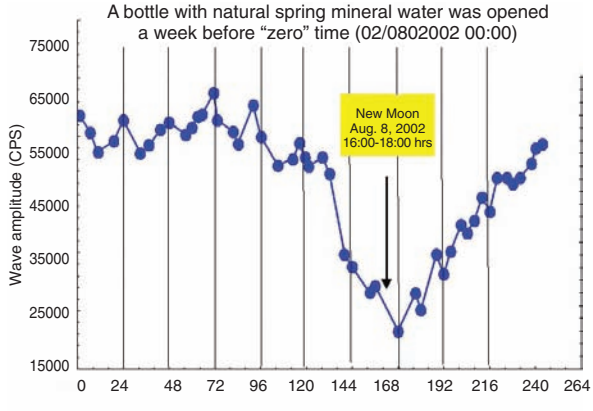


Figure 4
CHANGES OF SPRING WATER PROPERTIES COINCIDE WITH NEW MOON

Long-term monitoring of spring water with the addition of Fe(II) and Luminol reveals circadian rhythms and strong changes of water properties coinciding with the New Moon. A bottle with natural spring mineral water was opened a week before "zero" time, Aug. 8, 2002 at 00.00.

20. M.F. Guly, D.A. Melnichuk, 1978. "The role of carbon dioxide in the regulation of metabolism in heterotrophic organisms," *Naukova Dumka*, Kiev.

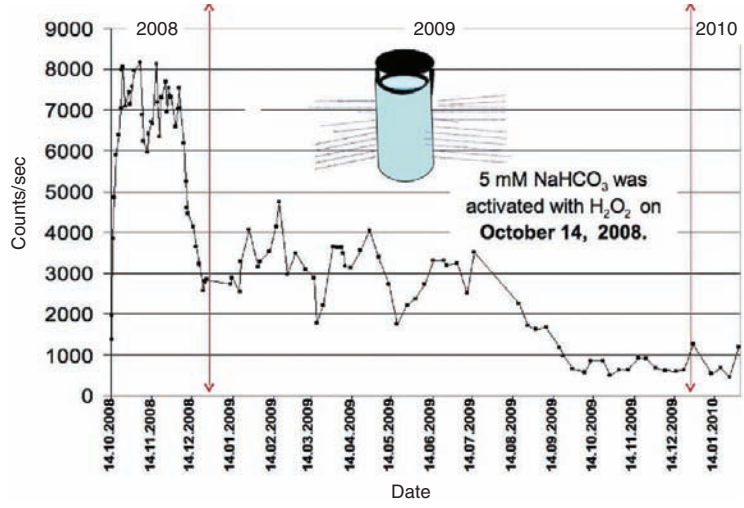


Figure 5
HYDROGEN PEROXIDE-ACTIVATED BICARBONATE SOLUTION 'BURNS' FOR MORE THAN A YEAR

In this experiment, hydrogen peroxide was added to a bicarbonate solution ($NaHCO_3$) of 5 mM, on Oct. 14, 2008, and continued emitting photons for more than a year. Photon emission could increase or decrease (depending on the initial concentration of H_2O_2) for one to two days, and then stabilize around some mean level. The reaction system was kept in a tightly closed test tube or sealed ampoule, to prevent any exchange of gases with the environment.

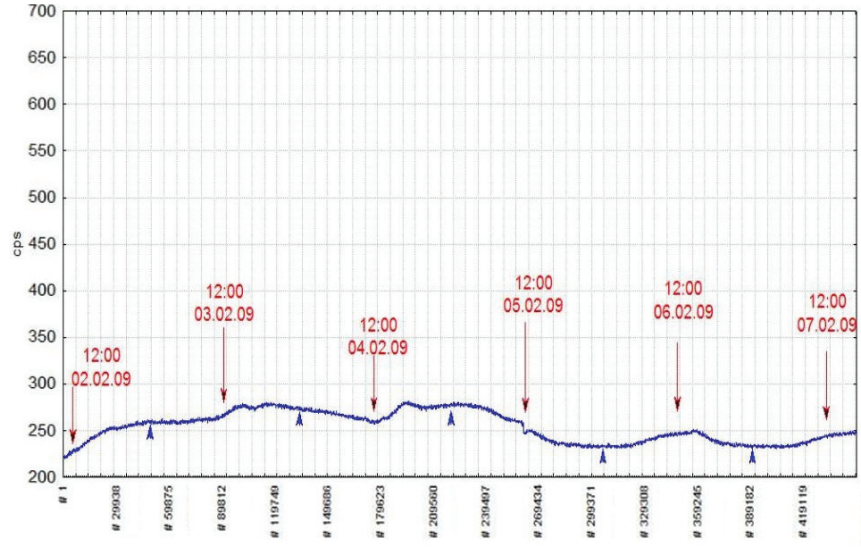


Figure 6(a)
AVERAGE INTENSITY OF PHOTON EMISSION

In an experimental setup like Figure 5, a bicarbonate solution activated on Nov. 11, 2008 was monitored continuously from Jan. 26, 2009. To exclude any handling or light effects, a test-tube with the solution was placed into a single photo counter chamber, in complete deprivation of ambient light. The emissions were rather stable, but there were some circadian variations around the mean value.

0.0005 percent, stable luminol-amplified photon emission could be observed even in the absence of a metal. Depending on the initial concentration of the H_2O_2, the photon emission could increase or decrease for 1-2 days, before stabilizing around some mean level. Figure 5 illustrates that a test-tube with 1 ml of 5-mM NaHCO in distilled, deionized water can serve as a source of photon emission for more than one year.

It should be mentioned that the reaction systems were kept in tightly closed test tubes or sealed ampoules, to prevent any exchange of gases with the environment. Although photon emission intensity obviously declined after 15 months of observations, it was still 25- to 50-fold higher than the dark current of the photomultiplier.

In the experimental setup illustrated in Figure 5, occasional measurements of photon emission were performed during the period of observations. To exclude the effects of handling the samples and their exposure to ambient light between measurements, a test-tube containing the active solution was placed into a single photon counter chamber, and continuous measurement of the photon emission was performed for several weeks. Under conditions of complete deprivation of ambient light, the average intensity of photon emission from the active solution was rather stable, although some circadian variations around the mean value could be observed (Figure 6a).

However, during the next week, drastic changes in the photon emission patterns from the same sample were observed (Figure 6b). These changes correlated with specific time points characteristic of the lunar eclipse that started in Moscow on Feb. 9, 2009, at 17:34 P.M. The photon emission intensity began to increase exactly at this moment of time. At 19:38, at the moment of totality, a spike on the kinetic curve was observed (see first insert in Figure 6b). After the end of the lunar eclipse, the photon emission intensity did not decrease to its initial values, but oscillated in a pronounced circadian pattern with the intensity exceeding the previous one by two- to three-fold. Two days after the start of the Moon's eclipse, the photon emission

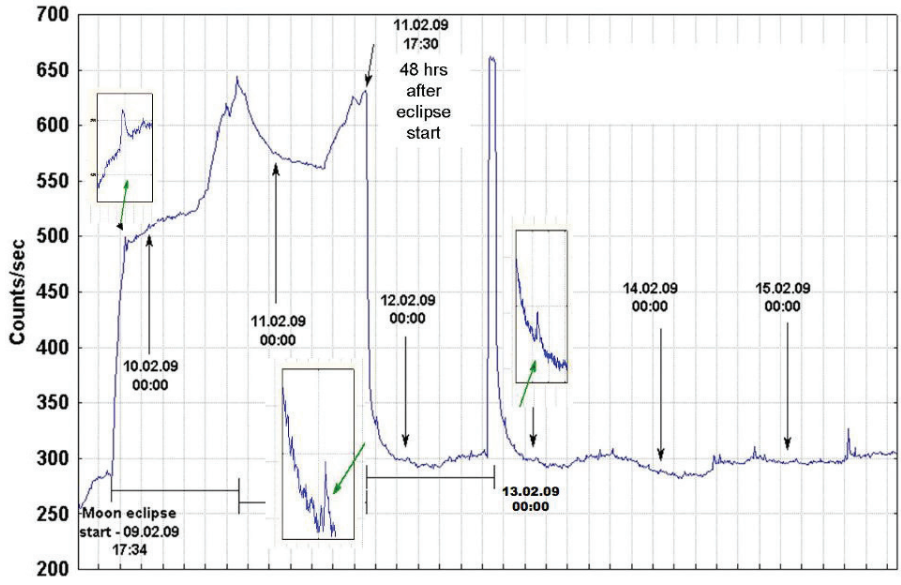


Figure 6(b)
CHANGES IN PHOTON EMISSION INTENSITY AT TIME OF LUNAR ECLIPSE

Photon emissions from the sample in Figure 6(a) changed drastically on Feb. 9, 2009, with the beginning of a lunar eclipse in Moscow. A splash on the emission curve occurred at the moment when the Moon's eclipse was total. After the end of the eclipse, photon emissions oscillated in a circadian pattern, dropping to the pre-eclipse level after two days, with periodic splashes.

dropped to the level preceding the eclipse.

It is notable that exactly 48 hours after totality, at 19:38 on February 11, a spike similar to the one observed at the moment of total eclipse again appeared on the curve (see second insert in Figure 6b, and Figure 6c). Three days after the Moon's eclipse, the photon emission intensity again rose more than two-fold, and two hours later it fell back to the initial level. During the next three days, occasional spikes were observed on the kinetic curve.

A reaction of activated bicarbonate solution to the solar eclipse was also registered (Figure 7). This time, the H_2O_2-activated bicarbonate solution was prepared in a 10-mm × 10-mm × 40-mm glass cuvette. The cuvette was installed in a thermostatic jacket that was fixed in the chamber of a single photon detector. The jacket was kept at constant temperature (~20°C ±0.1°C), with the help of flow-through water. For continuous temperature measurements, a thermosensor (a germanium diode) was placed in the solution. Photon emission from the active bicarbonate solution and the signal from the Ge-diode were recorded simultaneously.

It can be seen in plots presented in Figure 7 that the average temperature in the solution, after its equilibration with

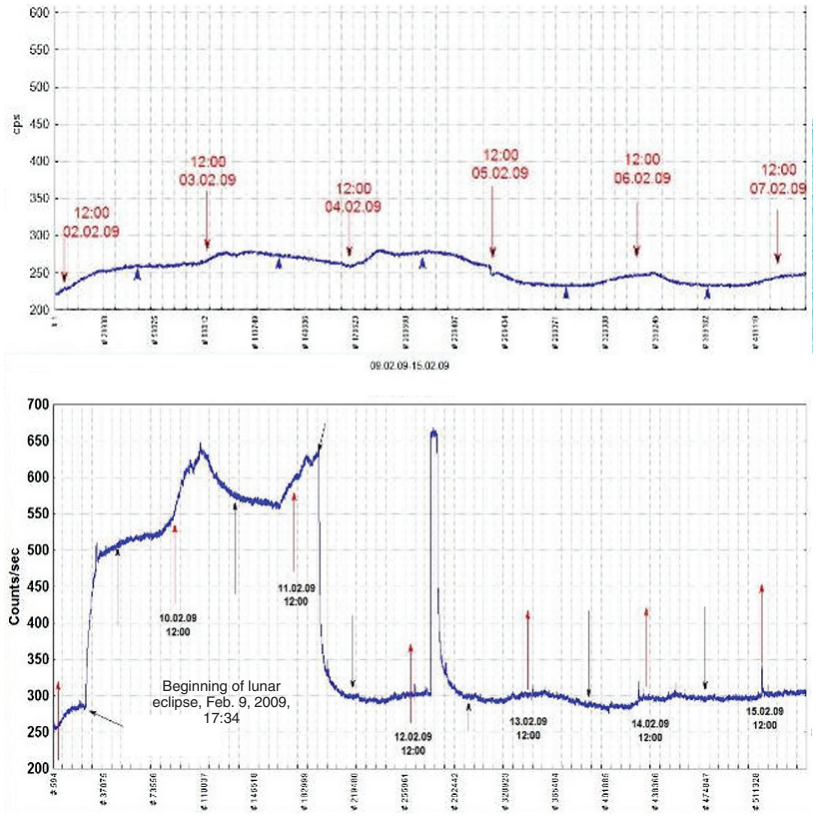


Figure 6(c)
PHOTON EMISSION BEFORE AND AFTER THE LUNAR ECLIPSE

Compared here is photon emission from the same sample for the week preceding (top) and the week following the lunar eclipse.

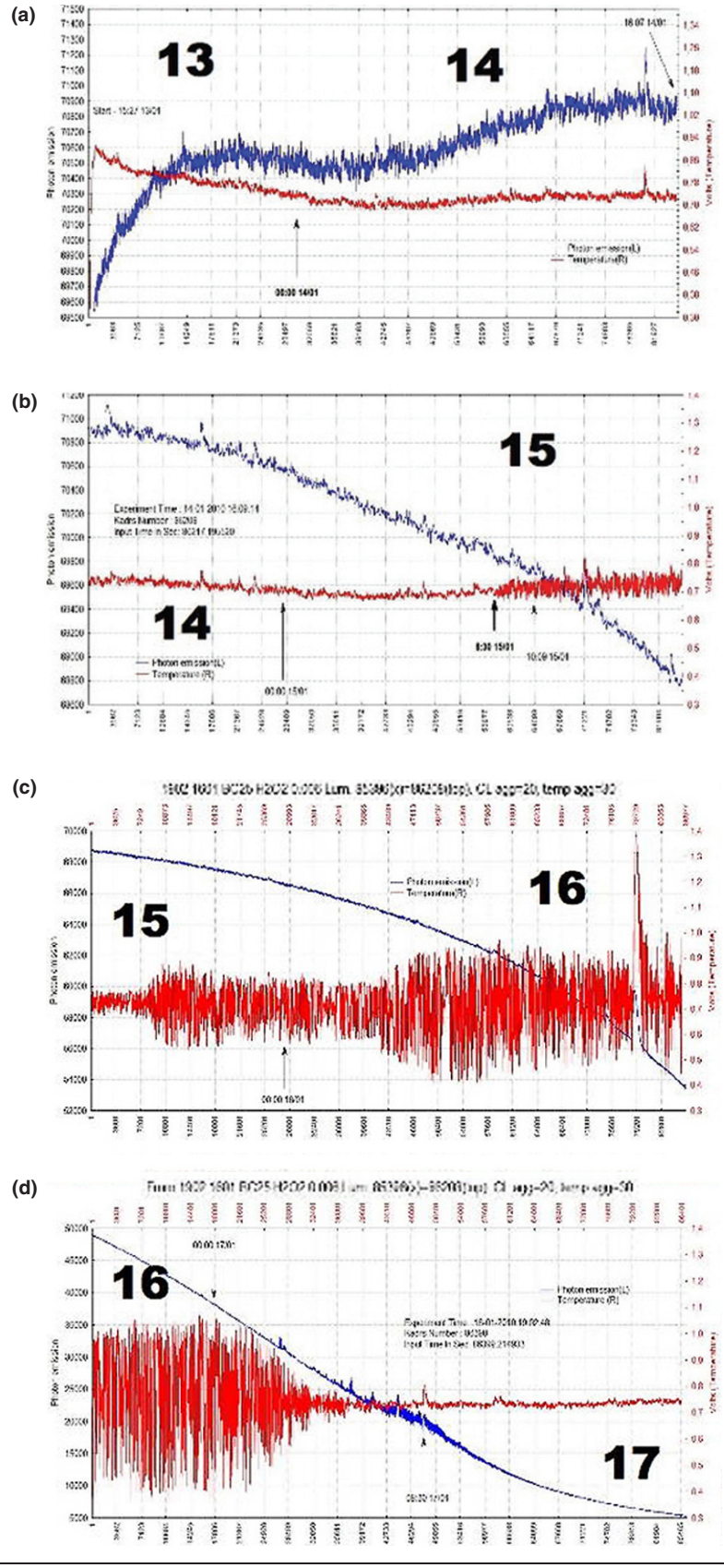


Figure 7 (a-d)
BEHAVIOR OF BICARBONATE SOLUTION BEFORE, DURING, AND AFTER THE ANNULAR SOLAR ECLIPSE ON JAN. 15, 2010

In this experiment an H_2O_2-activated carbonate solution was prepared in a glass cuvette, which was then installed in a thermostatic jacket fixed in the chamber of a single photon detector. The temperature of the jacket was kept constant, and temperature fluctuations were measured with a thermosensor. Both photon emissions (blue) and temperature (red) increased at the start of the annular solar eclipse.

the jacket temperature (Figure 7a), was rather stable (~20°C) during the whole period of observation (January 13-17, 2010). Temperature fluctuations around the set value were rather small during the first 40 hours and the last 10-13 hours of monitoring, although occasional temperature splashes coinciding with the splashes in photon emission were observed.

The pattern of temperature variations changed suddenly at 08:30 on January 15 (Figure 7b). It is notable that on Jan. 15, 2010, there was an annular eclipse of the Sun in the equatorial region of the Earth. Although it was not observed in Moscow, a full eclipse at Moscow's longitude (37.5° E) took place at 05:30 universal time (08:30 Moscow time). Exactly at this moment, the amplitude of fluctuations of the signal from the Ge-probe began to elevate. The swing of the signal from the Ge-diode increased during the next two days, and by the evening of January 16 and night of January 17, the amplitude of oscillations reached values equivalent to consecutive heating and cooling of the solution in the range of 4.2°C! (Figure 7d)

Close to two days after their emergence, the fluctuations in the signal disappeared. It is interesting to note here that the increase in photon emission intensity from the active bicarbonate solution also lasted for about two days after the lunar eclipse (Figure 6b).

Since the periods of typical fluctuations of the Ge-probe signal were in the range of 1-1.5 minutes (see, for example, Figure 8),

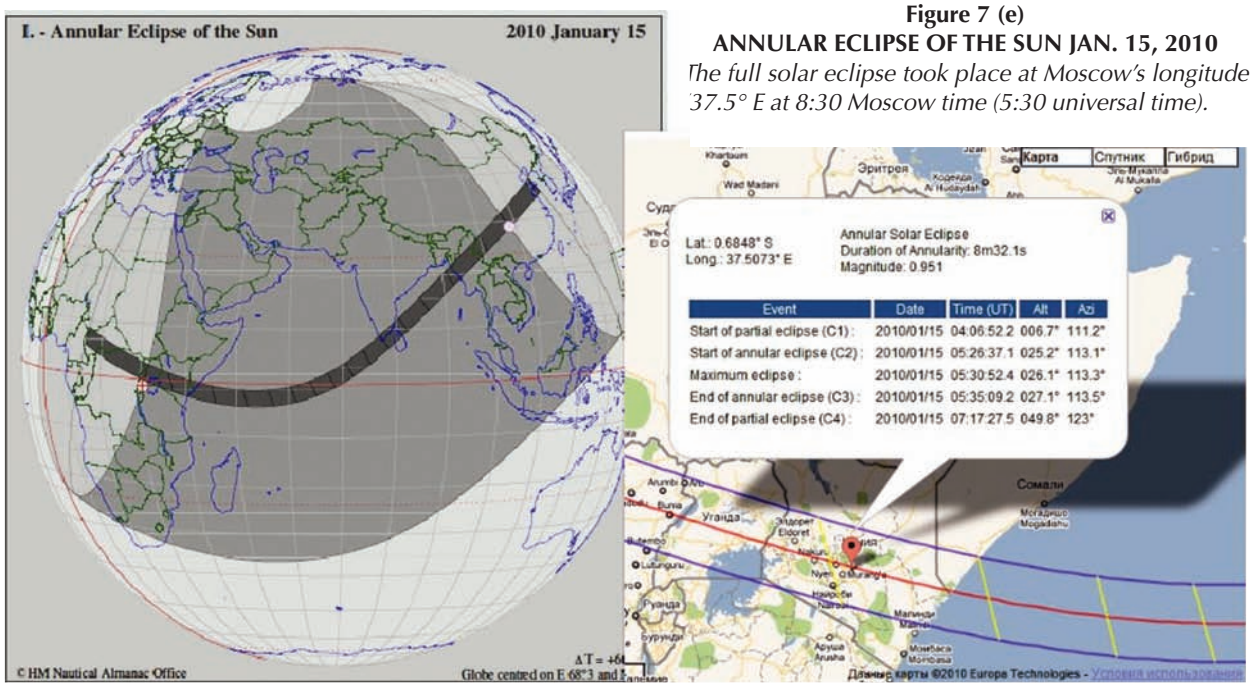


Figure 7 (e)
ANNULAR ECLIPSE OF THE SUN JAN. 15, 2010
The full solar eclipse took place at Moscow's longitude 37.5° E at 8:30 Moscow time (5:30 universal time).

with the fastest fluctuations lasting for only 20 seconds, they are very unlikely to reflect the cycles of heating and cooling of the solution in the thermostatted cuvette, because a water thermostat is unable to produce such fast temperature variations. On the other hand, one should take into account that the Ge-diode commonly used as a temperature sensor is in fact a photodiode, sensitive to the near-infrared part of the electromagnetic spectrum. In this part of the electromagnetic spectrum, water is the nearly exclusive absorber (and, obviously, emitter) of photons.

Having this in mind, it is interesting to speculate that the profound fluctuations of the Ge-diode signal observed in Figure 7 are marking variations in near-infrared radiation in the vicinity of this probe. Such variations may originate from collective excitations and de-excitations of water domains, if they have dimensions comparable to the dimensions of the germanium probe (at least, fractions of a millimeter).[7–9]

That the oscillations of the signal are artifacts from the Ge-diode is unlikely, because in some cases these temperature oscillations coincided with photon emission oscillations, while in others there was no such correlation. Indeed, as may

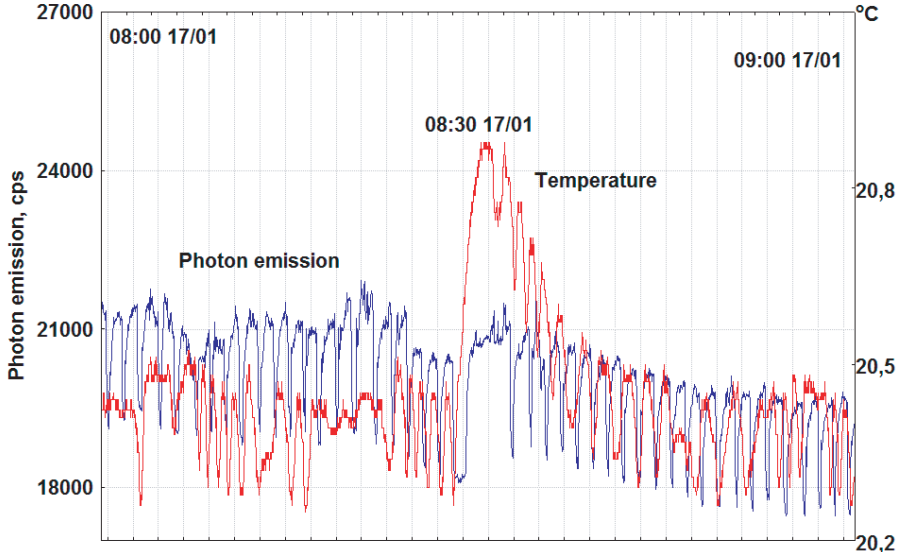


Figure 8
RELATIONSHIP BETWEEN THE TWO SIGNALS AT TIME OF SOLAR ECLIPSE
One-hour fragment of simultaneous recording of photon emission, and the signal from the Ge-diode thermosensor during the period of pronounced oscillations of photon emission. Note the significant elevation of the signal from the Ge-diode at 08:30 17/01, 2010, exactly 48 hours after the moment of the total solar eclipse event at the longitude of Moscow. Note also the periods of correlations and anticorrelations between the two signals.

be observed in Figure 7(a-d), splashes of signals from the Ge-diode coincided with the splashes of photon emission during the calm periods (January 13, 14, and 17). However, the most pronounced correlations (and anti-correlations) between the two signals were observed during the period of decay of fluctuations of the Ge-diode signal (Figure 8).

Here one can see both the profound, more or less regular fluctuations of photon emission intensity and synchronous fluctuations of the signal from the Ge-diode. It should be stressed that such fluctuations in photon emission intensity may be registered only if the processes resulting in photon emission go on collectively in the whole volume of the solution, because the photon emission is registered not at a local site, but from the whole surface of the cuvette facing the photomultiplier.

Coincidences in the oscillations of both signals probably indicate that energy in the form of photons is released both in the visible and near-infrared ranges of the spectrum, more or less coherently.

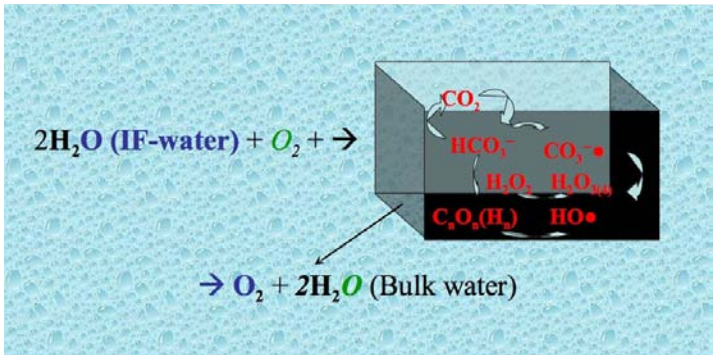


Figure 9
'BURNING' REQUIRES THE PRESENCE OF CATALYSTS
Shown is the overall reaction of interfacial (IF) and bulk water with the introduction of carbonate catalysts, which provide a capability for proto-respiration. The authors state, "If the system has access to nitrogen and other non-organic compounds, it may grow and develop (evolve), turning at a certain stage of its development into a proto-organism." Although such systems evolve in a self-organized fashion due to their intrinsic activity, their behavior is "modified by the external informational influences to which they are always open."

Non-Equilibrium and Water 'Burning'

Our data indicate that even "common" bicarbonate solutions display stable, non-equilibrium properties, which can be revealed by the appearance of a wave of photon emission occurring after the addition of a small quantity of an electron donor, Fe(II). Bicarbonate aqueous solutions activated with small quantities of hydsrogen peroxide (H_2O_2) demonstrate stable non-equilibrium much more impressively.

There are many known chemiluminescent systems in which free radical reactions proceed. However, in the vast majority of cases luminescence fades out as the reagents are exhausted. The activated bicarbonate solutions described here preserve the capability for spontaneous photon emission for many months, in complete darkness, and under conditions when exchange of matter (oxygen, water vapor, volatile reaction products) with the environment does not occur. That means that the processes accompanied by the generation of energy of electron excitation proceed continuously, and in a cyclic-like manner in these systems, without irreversible consumption of any reagents.

Further, the system can accumulate the high-density energy that it generates, because it can react to subtle irritations by strong and prolonged rises in photon emission intensity.

It is premature to suggest a more detailed model of the processes responsible for this permanently excited state of activated bicarbonate solutions, and for its continuous pumping. However, some preconditions that should be taken into account in developing such a model should be mentioned.

Aqueous systems can be regarded in first approximation as consisting of two-phases. One of the phases is represented as an organized quasi-liquid crystalline aqueous phase having the properties of a reducer. The other phase is a more "gas-like" water, containing the terminal oxidizer, oxygen.

Carbonates present in such water may perform several functions simultaneously. CO_2 may support water structuring,[21] and structured water splits more easily under the action of multiple physical factors. Water splitting results in the appearance of free radicals (H atoms and hydroxyl radicals), and HCO_3^- is easily oxidized by a hydroxyl radical (HO·), turning into a carbonate radical CO_3^-.

The latter may participate in multiple reactions. In particular, the carbonate radical may support organized water oxidation, by oxidizing hydrogen peroxide that is always present in water, even in trace quantities,[22] and recombining it after the emergence of organic compounds, such as oxocarbons.[23]

As a result, a network of coupled and mutually supporting redox reactions emerges; the energy yield for most of them is in the range of the energy of electronic excitation. Thus, carbonates may act as intermediates between reagents and products of the ideal reaction of water burning outlined above. On the one hand, they diminish the energy of activation for this reaction; and on the other, they introduce new cycling pro-

21. L. Pauling, 1961. "A molecular theory of general anesthesia," *Science*, Vol. 134, pp. 15-21.

22. G.G. Komissarov, 2003. *Photosynthesis: Physical-chemical approach* (Moscow: URSS, pp. 154-170).

23. P. Mazellier, E. Leroy, J. De Laat, B. Legube, 2002. "Transformation of carbendazim induced by the H2O2/UV system in the presence of hydrogenocarbonate ions: Involvement of the carbonate radical," *New J. Chem.*, Vol. 26, pp. 1784-1790.

cesses into the system. They enrich the network of redox reactions in the system and make it more stable. Thus, (bi)carbonates may be regarded as peculiar catalysts of (reversible) water "burning."

Regarding the role of H_2O_2, it is important to stress that the reactions of combustion generally proceed as branching (avalanche-like) chain reactions, and obey particular laws pertaining to such processes.[24] Combustion may start only when the oxygen concentration exceeds a threshold, and a certain triggering stimulus (a "spark") with high enough potential is needed for its initiation. H_2O_2 probably carries out this dual role introduced into a bicarbonate solution. Part of it is decomposed with an energy release which acts as the "spark," or trigger. At the same time, the initial level of oxygen in the solution increases over the threshold needed for the kindling of the chain reaction.

When burning is initiated, the energy released promotes excitation of both the fuel and oxygen, resulting in reinforcement or invigoration of the burning process. (See Figure 9.) When the availability of either oxygen or electrons falls below threshold levels, burning is dampened. During this period, oxygen—a product of the reaction outlined above—again accumulates, and a new wave of water "burning" may arise. Thus the process could become oscillatory.[25] In turn, energy will be released in an oscillatory manner and may serve as a pacemaker for coupled reactions. On the other hand, the oscillatory character of the processes occurring in such systems permit their responsiveness to resonant effectors.

Source of Energy

Whatever mechanism is producing the stable non-equilibrium state of bicarbonate aqueous systems, its capability to induce permanent photon emission demands a permanent supply of energy. The natural source for this energy, that is always available, is the thermal bath in which the system resides. Pollack and associates have shown that the structural temperature of exclusion-zone (EZ) water is lower than that of the less organized water with which it is in contact.[7] Hence, a temperature gradient exists between these two water phases, and EZ-water can continuously draw heat energy (infrared-radiation) from the environment and transform it into energy of a much higher potential—the energy of electron excitation which appears as radiation in the visible and ultraviolet-range of the spectrum. From this, it follows that bicarbonate solutions represent *step-up energy transformers,* rather than energy generators.

Exact temporal coincidences of the changes in pattern of photon emission (Figures 4 and 6b) and the amplitude of oscillations of (presumably) the excitations in the near-infrared range (Figure 7) with cosmic events can hardly be explained as chance or coincidence. In fact, the dependence of processes in aqueous systems upon cosmic events was first conclusively demonstrated by Professor Giorgio Piccardi, who discovered the effect of Solar activity on the behavior of colloidal solutions.[26] Regarding this experimentally demonstrated effect, he noted:

> . . .[I]t must be taken into account from an ecological-climatic point of view, because everything that is made up of water or which contains water—solutions, colloidal solutions, suspensions—is subject to the same activity from space (*in particular, the action of the Sun*) as are living organisms, and is modified as a result. Thus, the water of rivers, lakes, seas, marshes, and ponds, their inorganic, organic, and biological colloids, clay sediment, mud, in short what is found in a dispersed state and which has not yet attained a state of thermodynamic equilibrium.[25] (p. 127)

The mechanism to explain the long-lasting effects of solar and lunar eclipses on photon emission from aqueous systems, can be considered only hypothetically at this point. Both events represent special cases of gravitational influence upon the Earth. It is clear that the direct effect of variations of gravitation upon water samples is practically negligible. However, the effect on such a massive body as the Earth may result in changes in the parameters of manifold physical fields associated with this body, and these variations may trigger changes in the behavior of non-equilibrium aqueous systems.

It should be noted that cosmic events may influence the behavior of practically all non-equilibrium aqueous systems on the Earth, including the water in living organisms, and produce long-lasting effects in them.

To conclude: Aqueous systems in which a stable non-equilibrium phase of organized water and a much less organized phase of bulk water coexist, and in which oxygen (its active species), and protons (hydroxonium ions) are present, are capable of a sort of *proto-respiration* catalyzed by carbonates. If the system has access to nitrogen and other non-organic compounds, it may grow and develop (evolve), changing at a certain stage of its development into a *proto-organism*.

It should be stressed that such systems evolve because of their intrinsic activity, provided by the inherent properties of water and carbonates, rather than from the action of external forces upon them. However, their behavior is modified by external informational influences to which they are always open. This behavior represents the phenomenon of true self-organization that gives rise to the emergence of more and more complex systems, which are basically similar to each other, but possess individuality, providing for the emergence of diversity, biodiversity, in particular.

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24. V.L. Voeikov, V.I. Naletov, 1998. "Weak Photon Emission of Non-Linear Chemical Reactions of Amino Acids and Sugars in Aqueous Solutions. Evidence for Self-Organizing Chain Processes with Delayed Branching," In *Biophotons,* eds. Jiin-Ju Chang, Joachim Fisch, Fritz-Albert Popp. (Dortrecht, The Netherlands, Kluwer Academic Publishers) pp. 93-108.

25. V.L. Voeikov, V.V. Koldunov, D.S. Kononov, 2001. "Long-Duration Oscillations of Chemiluminescence During the AminoCarbonyl Reaction in Aqueous Solutions," *Russ. J. Phys. Chem.,* Vol. 75, pp. 1443-1448.

26. G. Piccardi, 1962. *The Chemical Basis of Medical Climatology* (Springfield, Ill.: Charles C. Thomas Publisher).

INTERVIEW: DR. EDWARD CALABRESE

How a 'Big Lie' Launched The LNT Myth and The Great Fear of Radiation

Dr. Edward Calabrese is Professor in the Environmental Health Sciences Division at the University of Massachusetts at Amherst. As a toxicology specialist, he has written scores of articles about the nonlinearity 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.

Laurence Hecht

Dr. Calabrese recently made the startling discovery that the linear no-threshold or LNT hypothesis, which governs radiation and chemical protection policy today, was founded on a deliberate lie to further a political agenda. According to LNT, there is no safe dose of radiation; the known deleterious effects of very high dose levels, under LNT, can be extrapolated linearly down to a zero dose.

As Dr. Calabrese elaborates in the interview, the contrary evidence was deliberately suppressed by Nobel Laureate Herman Muller, who won the 1946 Nobel Prize in medicine for his discovery that X-rays induce genetic mutations. Muller stated flatly in his Nobel speech that there was "no escape from the conclusion that there is no threshold," although he knew at the time that there was reliable contrary evidence.

Society is still paying for this "big lie" in billions of dollars spent to meet unnecessarily strict regulations, in generations of people taught to be irrationally scared of any radiation, and in millions of lives lost as the cost of not going nuclear.

Dr. Calabrese was interviewed on Sept. 26, 2011 by Managing Editor Marjorie Mazel Hecht.

Lilly Library, Indiana University, and Svenskt Press

Hermann Muller (1890-1967) receiving his Nobel Prize from the King of Sweden in 1946, for his discovery that "mutations can be induced by X-rays." In his Dec. 12, 1946 Nobel speech, Muller stated that there is "no escape from the conclusion that there is no threshold" for radiation effects, although he knew this to be untrue, based on the research results of a respected colleague.

21st Century: You have long argued that the science does not support the establishment dogma of LNT, the linear no-threshold view of radiation, which proclaims any radiation dose down to zero to be bad. How did you come across the duplicity of Nobel Laureate Hermann Muller, who lied about his results to justify the LNT theory?

Calabrese: It happened somewhat unexpectedly. I was preparing a manuscript on the history of the dose-response relationship, and I had reached what I felt was a final stage where I could show it to someone. I sent it to about 12 people whom I felt could be somewhat friendly, but critical, reviewers, before I would send the manuscript out for publication consideration. I received various comments; one of these reviewers indicated that I needed to do a better job on evaluating Hermann Muller from the time of his Nobel Prize in 1946 through probably the next 10 to 15 years and his impact on the acceptance of the linear dose response.

Agreeing with that criticism, I spent several months following up on this suggestion. During this process, I developed several new insights and that's what actually brought me to this point.

What I learned was that one of the critical studies that the low dose linearity radiation work was based on was a 1948 publication from the University of Rochester, by the eminent geneticist Dr. Curt Stern, and his co-researcher Dr. Warren Spencer. During that same year, there was another publication by Stern and Dr. Ernst Caspari. The data of these papers were collected during the 1943/1944 and 1945/1946 time periods, respectively. Hermann Muller, then a professor at Amherst College, was a paid consultant on these projects. The manuscripts could not be submitted for publication until they were given a U.S. government clearance, sometime in 1947, after the end of World War II.

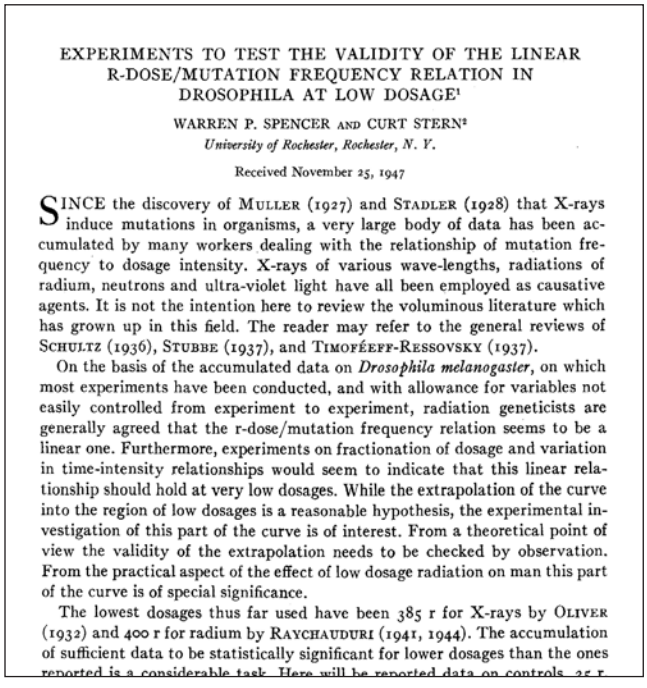
The earlier research of Spencer and Stern, a study of an acute exposure to ionizing radiation, supported the linear dose response, whereas the Caspari and Stern research, which involved chronic exposures, showed no support for the linear model; it supported a threshold interpretation.

This finding of Caspari was unexpected and created a problem for Stern, who was hoping to support a linear perspective. The Caspari findings were of considerable importance since it was the strongest study that had been done on low-dose ionizing radiation and mutation in *Drosophila*. The dose rate employed was far lower than any previous study of ionizing radiation.

The study also included key improvements in various experimental methods, execution, and data analysis over the Spencer and Stern study. Thus, in a number of important ways, the findings were more reliable than the Spencer and Stern paper and more relevant to public health concerns, as it was dealing with exposures in a low-dose zone. In fact, the dose rate of the Caspari study was only about 1/15,000 of the Spencer acute study.

The research of Caspari was concluded in August 1946. One month later Muller was notified that he was going to receive the Nobel Prize in Biology and Medicine. I was aware of the fact that in his Nobel Prize Lecture on December 12, 1946, Muller strongly rejected even the possibility of the threshold dose response model for radiation, passionately arguing for the adoption of the linear at low dose model. So the following question arose in my mind: Did Muller actually know of this major finding by Caspari prior to his Nobel Prize Lecture?

If he did, then why would he have made the statement that the one could no longer even consider it as a possibility? So I tried to track down an answer to this question. I had read a couple of Ph.D. dissertations about Muller from this era before, so I re-



EXPERIMENTS TO TEST THE VALIDITY OF THE LINEAR R-DOSE/MUTATION FREQUENCY RELATION IN DROSOPHILA AT LOW DOSAGE[1]

WARREN P. SPENCER AND CURT STERN[2]

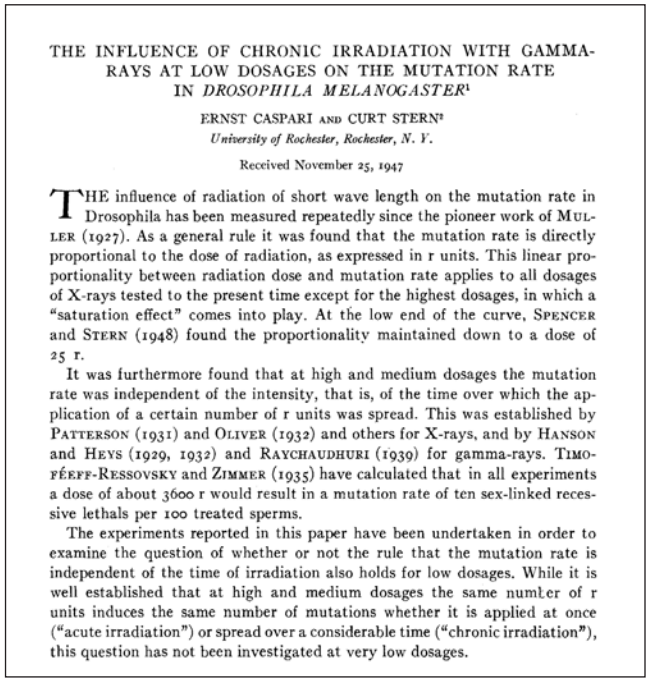
University of Rochester, Rochester, N. Y.

Received November 25, 1947

SINCE the discovery of MULLER (1927) and STADLER (1928) that X-rays induce mutations in organisms, a very large body of data has been accumulated by many workers dealing with the relationship of mutation frequency to dosage intensity. X-rays of various wave-lengths, radiations of radium, neutrons and ultra-violet light have all been employed as causative agents. It is not the intention here to review the voluminous literature which has grown up in this field. The reader may refer to the general reviews of SCHULTZ (1936), STUBBE (1937), and TIMOFÉEFF-RESSOVSKY (1937).

On the basis of the accumulated data on *Drosophila melanogaster*, on which most experiments have been conducted, and with allowance for variables not easily controlled from experiment to experiment, radiation geneticists are generally agreed that the r-dose/mutation frequency relation seems to be a linear one. Furthermore, experiments on fractionation of dosage and variation in time-intensity relationships would seem to indicate that this linear relationship should hold at very low dosages. While the extrapolation of the curve into the region of low dosages is a reasonable hypothesis, the experimental investigation of this part of the curve is of interest. From a theoretical point of view the validity of the extrapolation needs to be checked by observation. From the practical aspect of the effect of low dosage radiation on man this part of the curve is of special significance.

The lowest dosages thus far used have been 385 r for X-rays by OLIVER (1932) and 400 r for radium by RAYCHAUDURI (1941, 1944). The accumulation of sufficient data to be statistically significant for lower dosages than the ones reported is a considerable task. Here will be reported data on controls 25 r.



THE INFLUENCE OF CHRONIC IRRADIATION WITH GAMMA-RAYS AT LOW DOSAGES ON THE MUTATION RATE IN *DROSOPHILA MELANOGASTER*[1]

ERNST CASPARI AND CURT STERN[2]

University of Rochester, Rochester, N. Y.

Received November 25, 1947

THE influence of radiation of short wave length on the mutation rate in Drosophila has been measured repeatedly since the pioneer work of MULLER (1927). As a general rule it was found that the mutation rate is directly proportional to the dose of radiation, as expressed in r units. This linear proportionality between radiation dose and mutation rate applies to all dosages of X-rays tested to the present time except for the highest dosages, in which a "saturation effect" comes into play. At the low end of the curve, SPENCER and STERN (1948) found the proportionality maintained down to a dose of 25 r.

It was furthermore found that at high and medium dosages the mutation rate was independent of the intensity, that is, of the time over which the application of a certain number of r units was spread. This was established by PATTERSON (1931) and OLIVER (1932) and others for X-rays, and by HANSON and HEYS (1929, 1932) and RAYCHAUDHURI (1939) for gamma-rays. TIMOFÉEFF-RESSOVSKY and ZIMMER (1935) have calculated that in all experiments a dose of about 3600 r would result in a mutation rate of ten sex-linked recessive lethals per 100 treated sperms.

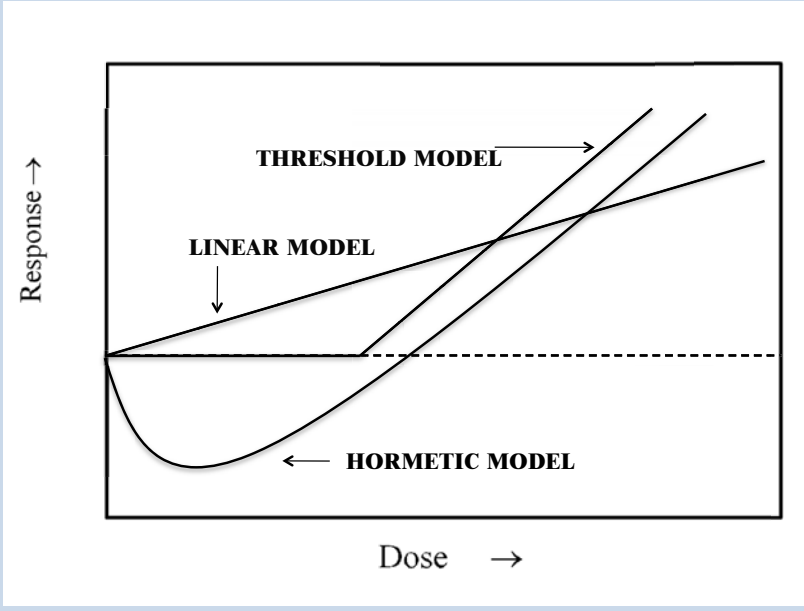
The experiments reported in this paper have been undertaken in order to examine the question of whether or not the rule that the mutation rate is independent of the time of irradiation also holds for low dosages. While it is well established that at high and medium dosages the same number of r units induces the same number of mutations whether it is applied at once ("acute irradiation") or spread over a considerable time ("chronic irradiation"), this question has not been investigated at very low dosages.

The Spencer and Stern article and the Caspari and Stern articles, which both appeared in the journal Genetics. *Calabrese documents from Muller's correspondence that Muller knew of Caspari's dose-response results and their significance before his Nobel speech.*

THE HORMESIS 'J' CURVE

Both radiation and chemicals demonstrate a threshold dose response, the 'J' curve shown here, where the effects are beneficial (called hormesis) up to a threshold, and high doses are harmful. The response curve is the same for radiation and other chemical and biological agents. However, against the empirical evidence, the threshold dose response model was replaced by the linear no-threshold model, which extrapolates linearly the harmful effects from the known damage of high doses all the way down to zero.

The shift from a threshold to the dominant linear model resulted from a campaign initiated by geneticist Hermann Muller, who, in his 1946 Nobel Prize speech stated flatly that there was no evidence for a threshold effect, although he knew this to be untrue.



Source: Dr. Edward Calabrese

read key portions but could not find an answer to my question.

So I tracked down the researcher who was the most relevant; he went through his files and could not find an answer. So this forced me to obtain the correspondence, the unpublished communication between Curt Stern and Muller and between Caspari and Stern and Caspari and anyone else who was connected to them. I tried to obtain any conceivably relevant written communication. In the case of Muller, I made sure that I obtained his communications with Stern and Stern's with him from different sources.

Then one day when I was returning from one part of campus to my office around 6 o'clock, I found this big stash of letters and other communications sent by the American Philosophical Association. Too excited to eat, I read through hundreds of pages of material. At some point, I came across a series of letters in the key 1946 time period. In going through those, I found that there was a letter from Stern to Muller which said that they had finished the Caspari study, asking Muller if he would be willing to review the manuscript.

During the research, Muller had made a fair number of trips from Amherst to Rochester to meet with Stern; in fact, Muller even provided the strain of flies that Spencer and Caspari used in their experiments. So he had a reasonably close relationship with Stern and the group. He knew everybody and how things worked.

Upon the receipt of Stern's letter, Muller wrote back indicating that he would critique the findings. The manuscript was finally sent to Muller on November 6, 1946. For me the smoking gun occurred in a Nov. 12, 1946 letter from Muller back to Stern. In this letter he indicates that he received the manuscript, scanned through the entire document, saw its significance, knew that the findings were refuting the low-dose linearity concept, that the study was done by Caspari, whom he viewed as a very competent person, so he couldn't challenge the findings.

Muller indicated that the study needed to be replicated, because the findings were so diametrically opposed to their linearity perspective. He concluded that he would get his de-

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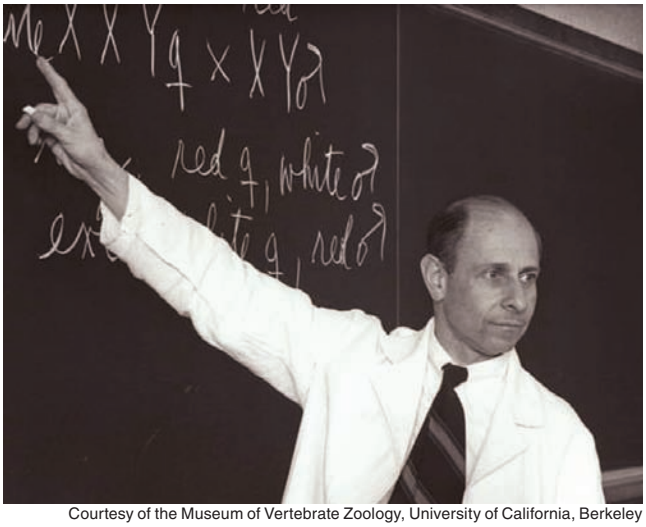
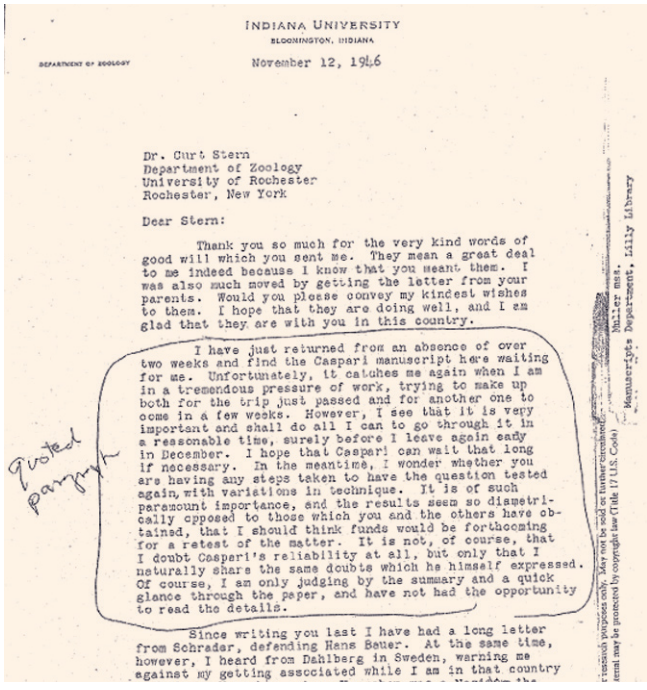
Hermann Muller and two staff members in the "fly room" at Indiana University. Muller began teaching at Indiana University in 1945.



Courtesy of the Museum of Vertebrate Zoology, University of California, Berkeley

Curt Stern in March 1951 in a photo by Oliver P. Pearson. As the editor-in-chief of the journal Genetics*, Stern marginalized the significance of the Caspari results when they were published, thus saving Muller's reputation.*



INDIANA UNIVERSITY
BLOOMINGTON, INDIANA
DEPARTMENT OF ZOOLOGY

November 12, 1946

Dr. Curt Stern
Department of Zoology
University of Rochester
Rochester, New York

Dear Stern:

Thank you so much for the very kind words of good will which you sent me. They mean a great deal to me indeed because I know that you meant them. I was also much moved by getting the letter from your parents. Would you please convey my kindest wishes to them. I hope that they are doing well, and I am glad that they are with you in this country.

I have just returned from an absence of over two weeks and find the Caspari manuscript here waiting for me. Unfortunately, it catches me again when I am in a tremendous pressure of work, trying to make up both for the trip just passed and for another one to come in a few weeks. However, I see that it is very important and shall do all I can to go through it in a reasonable time, surely before I leave again early in December. I hope that Caspari can wait that long if necessary. In the meantime, I wonder whether you are having any steps taken to have the question tested again, with variations in technique. It is of such paramount importance, and the results seem so diametrically opposed to those which you and the others have obtained, that I should think funds would be forthcoming for a retest of the matter. It is not, of course, that I doubt Caspari's reliability at all, but only that I naturally share the same doubts which he himself expressed. Of course, I am only judging by the summary and a quick glance through the paper, and have not had the opportunity to read the details.

Since writing you last I have had a long letter from Schrader, defending Hans Bauer. At the same time, however, I heard from Dahlberg in Sweden, warning me against my getting associated while I am in that country

Quoted paragraph

Manuscripts Department, Lilly Library

tailed comments back before he took off on his next trip, which was his boat trip from New York to Stockholm.

Muller didn't send the detailed review in until January, after he came back. But in that November 12 letter, all the essential points were established: that he knew it was a competent study, detailed, significant, that it challenged his basic theme substantially, and he knew it. He also knew that he could not dismiss it. It would have to be scientifically confronted.

So now that I knew that Muller knew of the Caspari study prior to his Nobel Prize Lecture, I next wondered how he could have given this most significant of lectures—one truly on the world's stage—in Stockholm, and actually said that there is no longer any possibility to adhere to a threshold model. He had seen the data, he knew the investigators, he was their paid consultant. He could have—and should have said—as I indicated in my article, "I think that this is an area where more research needs to be done," but he had an agenda that wasn't scientific.

The strangest thing to me is that he knew this study was going to be published. Surely he knew the other shoe was going to drop—so to speak? At some point in the not-so-distant future, he would have to confront the fact that he knew there was this other study, that it was relevant, and that it challenged and actually rebutted what he said in his Nobel Prize Lecture.

If this study ever made the light of day, then it would profoundly affect his credibility. So the question is, how would Muller, and perhaps Stern, deal with this? That became even more intriguing to me. I needed to try to figure this one out as well. How would he get out of this potentially profoundly damaging situation? He knows that ultimately the study would be published.

And that leads to the next crazy and unpredictable course of action. When Caspari and Stern ultimately publish their work, they devoted the entire discussion to arguing that their data should not be accepted until it can be learned why their data differed from that found in the Spencer and Stern paper.

Photos courtesy of Hermann Hartwig, in "Seventy-Five Years of Developmental Genetics: Ernst Caspari's Early Experiments on Insect Eye Pigmentation, Performed in an Academic Environment of Political Suppression," by Ulrich Grossbach, Genetics*, April 2009*

Geneticist Ernst Caspari (1909-1984) is second from left in this 1934 photo of the Alfred Kühn laboratory staff at Göttingen University, where he began his career. Inset is Caspari around 1933. Although a Protestant, Caspari's family heritage was Jewish, and he, along with dozens of other Jews, was dismissed by the Nazis. Caspari fled to Istanbul to continue his work, and in 1938, he came to the United States. The Göttingen Center for Molecular Biosciences has a building named after Caspari.

Lilly Library, Indiana University

Muller with a fruit fly model, teaching a class at Indiana University.

Now the Spencer and Stern paper had at least two dozen major differences with the Caspari and Stern paper, as my article reports. One used male flies, and the other used females; they used fundamentally different diets; one administered X-rays, and the other gamma rays; different rearing temperatures were used—there were many other differences. And now, 60 years later, no one has ever attempted to explain these differences. Today, you couldn't get away with comparing the two experiments, because there are too many differences between them.

But Stern and Caspari set up a straw man, a foolish premise.

21st Century: Did they raise the straw man because Muller intervened, to make sure that they dampened any enthusiasm about their actual findings?

Calabrese: What Muller actually said was: I can support the publication of this because there are so many caveats in the discussion, that essentially nobody can use the data anyway.

And, to top it all off: You would think that writing a paper in this way, that you could never actually get it through peer-review. How could you submit a paper, with your data, and then disavow the use of your data—unless you were submitting it to the journal for which you were the editor-in-chief?

21st Century: Which they did.

Calabrese: Yes, they submitted it to Curt Stern's journal, *Genetics* where he was the editor-in-chief. And they submitted the paper on Nov. 25, 1947, and it's a very long paper, as is the Spencer and Stern paper. And they submitted them both on the same day. Both papers were published essentially about one month later, in January 1948, which meant to me that they actually were not sent out for peer-review; they weren't corrected or changed—nothing, given snail mail, given everything. I've seen the papers that were submitted, and I've seen the papers that were published, and there really isn't any difference between them.

So, I'm 99 percent sure that the papers weren't submitted for peer-review. Basically, Curt Stern controlled the reality of these papers. He published them the way he wanted to, and had all the caveats that he and Muller desired. And so that achieved a couple of key goals for Muller and Stern. It allowed Caspari to get the publication of all the work that they did, which they owed to the government that was paying for the research.

But even more important to them, they marginalized the Caspari findings that supported the threshold and basically gave Muller protection, by concluding that you couldn't even use/accept the Caspari work. Thus, Muller's Nobel Prize Lecture assertion—that you could no longer accept the threshold model—could not be effectively challenged. Stern was saving Muller's reputation, all for a common ideological agenda centered on the dose response.

Stern did try to follow up on the Muller suggestion, which was to try to replicate the work of Caspari. However, at that point Caspari and Spencer were leaving Rochester; Spencer returned to his faculty position at the College of Wooster in Ohio, and Caspari to a faculty position at Wesleyan University in Connecticut. So Curt Stern turned to a new graduate student, Delta Uphoff, who took over the role of trying to replicate the Caspari study.

Stern gave her three major experiments . . . but each ended in confusion. In reality, she was new to the research game, just coming from an undergraduate situation. In the first attempt to replicate at least part of Caspari's findings, Uphoff reported control group mutation rates that were aberrantly low, being about 40 percent lower than expected from the literature and their group's experience.

Initially, Stern tried to use Uphoff's findings to discredit the work of Caspari, by saying that his control group was too high, by chance or whatever reason, and that was the reason that Caspari did not see any treatment-related effects.

Caspari, however, fought back. He went into the literature in great depth, contacted Muller, got a lot of unpublished findings from Muller, and ultimately assembled a very large amount of data that demonstrated that his control group values were consistent with the vast body of published and unpublished literature on that model and control group responses.

So Stern had to back down. Stern then made Uphoff the "fall guy," blaming the low control values on her possible bias . . . a comment that was actually included in the manuscript submitted to the Atomic Energy Commission. In their own language the aberrantly low control values made this experiment "uninterpretable." The second experiment fared no better, as Uphoff's data again displayed an aberrantly low control group value. With two key experiments unusable, things were not looking too good.

21st Century: How would her bias make the control group have such a low response?

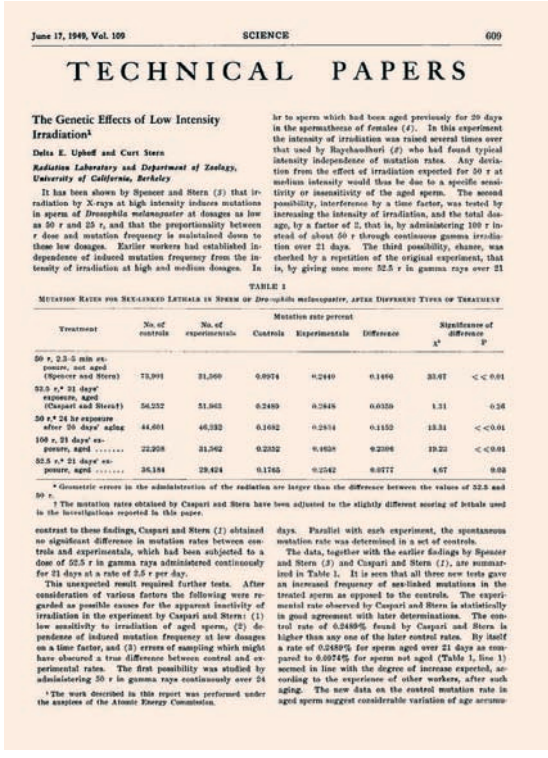
Calabrese: As you count the recessive mutations shown under a binocular microscope, there can be a certain amount of uncertainty at times, in terms of whether something would be considered a mutant form or not. As it turns out, there was also a potential for bias. They also didn't have double-blind read-

ings, so they knew what the control group was, so there's a potential for bias there.

21st Century: So it's human decision about whether it's one thing or another.

Calabrese: It could also have been inexperience—it's her first research experience. I went back and found a paper in 1928 or '29 or so, by Muller, who was attempting to get information on background mutation rates in *Drosophila*, and he was working with somewhat inexperienced people in the lab in Texas; he became frustrated and quit the experiment because they were having such a difficult time properly doing this. It takes an awful lot of effort to do it. He attributed it to inexperience, and I was able to cite that in my more detailed paper.

Mostly it's probably inexperience. There may be some bias, but nobody really knows. Whatever it was, in the write-up that Stern sent to the Atomic Energy Commission in 1947, they had all the data, and they also had the disavowing of their results, saying that their results were unreliable, and uninterpretable.



June 17, 1949, Vol. 109 SCIENCE 609

TECHNICAL PAPERS

The Genetic Effects of Low Intensity Irradiation[1]

Delta E. Uphoff and Curt Stern

Radiation Laboratory and Department of Zoology, University of California, Berkeley

It has been shown by Spencer and Stern (*3*) that irradiation by X-rays at high intensity induces mutations in sperm of *Drosophila melanogaster* at dosages as low as 50 r and 25 r, and that the proportionality between r dose and mutation frequency is maintained down to these low dosages. Earlier workers had established independence of induced mutation frequency from the intensity of irradiation at high and medium dosages. In contrast to these findings, Caspari and Stern (*1*) obtained no significant difference in mutation rates between controls and experimentals, which had been subjected to a dose of 52.5 r in gamma rays administered continuously for 21 days at a rate of 2.5 r per day.

This unexpected result required further tests. After consideration of various factors the following were regarded as possible causes for the apparent inactivity of irradiation in the experiment by Caspari and Stern: (1) low sensitivity to irradiation of aged sperm, (2) dependence of induced mutation frequency at low dosages on a time factor, and (3) errors of sampling which might have obscured a true difference between control and experimental rates. The first possibility was studied by administering 50 r in gamma rays continuously over 24 hr to sperm which had been aged previously for 20 days in the spermatheca of females (*4*). In this experiment the intensity of irradiation was raised several times over that used by Raychaudhuri (*2*) who had found typical intensity independence of mutation rates. Any deviation from the effect of irradiation expected for 50 r at medium intensity would thus be due to a specific sensitivity or insensitivity of the aged sperm. The second possibility, interference by a time factor, was tested by increasing the intensity of irradiation, and the total dosage, by a factor of 2, that is, by administering 100 r instead of about 50 r through continuous gamma irradiation over 21 days. The third possibility, chance, was checked by a repetition of the original experiment, that is, by giving once more 52.5 r in gamma rays over 21 days. Parallel with each experiment, the spontaneous mutation rate was determined in a set of controls.

The data, together with the earlier findings by Spencer and Stern (*3*) and Caspari and Stern (*1*), are summarized in Table 1. It is seen that all three new tests gave an increased frequency of sex-linked mutations in the treated sperm as opposed to the controls. The experimental rate observed by Caspari and Stern is statistically in good agreement with later determinations. The control rate of 0.2489% found by Caspari and Stern is higher than any one of the later control rates. By itself a rate of 0.2489% for sperm aged over 21 days as compared to 0.0074% for sperm not aged (Table 1, line 1) seemed in line with the degree of increase expected, according to the experience of other workers, after such aging. The new data on the control mutation rate in aged sperm suggest considerable variation of age accumu-

TABLE 1

MUTATION RATES FOR SEX-LINKED LETHALS IN SPERM OF *Drosophila melanogaster*, AFTER DIFFERENT TYPES OF TREATMENT

Treatment	No. of controls	No. of experimentals	Mutation rate percent: Controls	Experimentals	Difference	Significance of difference: χ^2	P
50 r, 2.3-5 min exposure, not aged (Spencer and Stern)	73,991	21,900	0.0074	0.2440	0.1466	33.67	$<<0.01$
52.5 r,* 21 days' exposure, aged (Caspari and Stern†)	54,252	51,862	0.2489	0.2848	0.0359	1.31	0.26
50 r,* 24 hr exposure after 20 days' aging	44,601	46,332	0.1682	0.2814	0.1153	13.31	$<<0.01$
100 r, 21 days' exposure, aged	22,208	21,762	0.2252	0.4528	0.2206	19.22	$<<0.01$
52.5 r,* 21 days' exposure, aged	36,184	29,424	0.1765	0.2542	0.0777	4.67	0.03

* Geometric errors in the administration of the radiation are larger than the difference between the values of 52.5 and 50 r.

† The mutation rates obtained by Caspari and Stern have been adjusted to the slightly different scoring of lethals used in the investigations reported in this paper.

[1] The work described in this report was performed under the auspices of the Atomic Energy Commission.

The Uphoff and Stern technical note, which appeared in Science *magazine June 17, 1949. In this note, which is only one-page and two paragraphs long, Stern used a meta-analysis to make the Caspari results on dose/response "disappear." Details were promised, but never appeared, and subsequent researchers cite this article, and ignore the original Caspari work.*

They then tried a third and final experiment. Stern had now moved from Rochester to the University of California at Berkeley. And Delta Uphoff followed him out there a few months later. This time, the control group was in the range that it should have been. However, the treatment response was very high in terms of a mutation rate. The response was about threefold higher than expected if it were in a linear relationship.

It's unlikely that their results were reliable and it made me think that this was an aberrantly high value, comparable to their aberrantly low value for the controls. So, in either case, it was very disconcerting, to say the least.

For reasons that are hard to explain, Stern—and this is a really key point in the story—decides to integrate all five studies together, the three Delta experiments and the Spencer and Caspari studies. He wraps them up all together in his own version of a meta-analysis, publishing a one-page paper, a technical note, in *Science* in which he presents a table and some introductory and conclusionary remarks.

Even more bizarre, he reverts to the two-year earlier position he had, that the original Caspari paper was due to an aberrant control, and that the Delta Uphoff controls of the first two experiments, that were aberrantly low, were now called normal. Stern basically reversed his position on these matters, never sharing with the *Science* readership his previous disavowals. It was only by such indefensible actions that was he able to make a case to support a low-dose linearity.

21st Century: So, he makes the Caspari study go away.

Calabrese: That's what he did. A key for me is the last sentence in that paper. Stern did not present any of their methodology, and other supportive material in the *Science* paper—only summary findings. However, he (and Uphoff) promised that they would publish the details in a subsequent paper. Thus, the bottom line is that he used his connections to get a note in *Science* but then never delivered on the promise to provide the necessary experimental details that reviewers and others needed to see.

In the aftermath of this episode, various investigators who published papers began to discredit the Caspari study, saying that it had aberrantly high control values and uncertain findings, and they began to marginalize the Caspari paper, which was the strongest study. They began to cite the *Science*/Uphoff and Stern paper which had a one-page summary and the weaker and less relevant effort by Spencer.

21st Century: And no data—

Calabrese: And no data, and the scientific community, especially the radiation geneticists never demanded of Stern and Uphoff to actually present/publish their findings along with their detailed methods and supplementary data. In the end, the Spencer and Stern and the Stern and Uphoff papers became the two key studies for the Biological Effects of Atomic Radiation (BEAR 1) committee, when it recommended the change from a threshold to a linear model. It's unbelievable. In effect, Stern was successful in distorting the scientific reality. Muller was only too happy to lead the charge.

21st Century: What's the date on that?

Calabrese: The Committee met from November of 1955 to April of 1956, so they issued their report in the Spring of 1956.

21st Century: It seems like he orchestrated the entire 10-year campaign.

Calabrese: In any case, the facts are there. Muller and Stern manipulated the field and the course of risk assessment history. There is some historiography that I've put together on it. I think it holds together.

21st Century: I think you're absolutely right. Here you have a Nobel Laureate who lied and who established a policy which has contributed to killing people—to put it in its starkest

terms—has cost the public billions of dollars, and has created fear. So why not tell the story?

Calabrese: Given the significance of the issue, it should be a front-page story in the *New York Times*.

21st Century: Except that the *New York Times* has been on the other side. That's really the problem.... For the general readership, the technical discussion you've presented on the fruit fly experiments might still be a bit difficult to get a handle on.

Calabrese: Yes, it's a hard story to tell.

21st Century: I think that to go from fruit flies to human protection and make a policy based on a lie is crazy.

Calabrese: That makes it even more bizarre.

21st Century: Yes, because you're talking about a handful of experiments, a big lie, and a policy that is costing people billions of dollars and is really at the basis of creating all this fear of radiation that we see with Fukushima.

Calabrese: In 1957, the future Nobel prize-winning geneticist E.B. Lewis, right after that BEAR 1 committee meeting and report, published a crucial paper in *Science,* where he generalized this linear relationship from a reproductive endpoint to somatic cells, to cancer. He relied very heavily in the Stern and Uphoff *Science* paper and the Spencer and Stern paper, which I was critical of as well.

Almost as soon as that paper was published, the National Committee for Radiation Protection, the NCRP, generalized the linearity concept to cancer, and then many other national advisory committees did copycat acceptances, and linearity became a done deal. The tide turned. It was a paradigm shift within a very short time period.

About 20 years later, the U.S. Safe Drinking Water Committee used the BEAR 1 report—with very little further consideration—and transferred the linearity concept to chemicals. The U.S. adopted low-dose linearity for all chemical carcinogens. And it was really like an environmental ideological coup affecting all the classrooms, all the media, all regulations, the risk communication message—almost overnight.

21st Century: It's an enormous brainwashing, really.

Calabrese: Absolutely amazing. It's a story to be told and a history to be rewritten.

21st Century: Well, you've launched the re-writing. What I'd like you to talk about now, is the political motivation on the part of Muller in hiding his results. Because when I looked up just very briefly Muller's biography, I saw that he was a protégé of Julian Huxley, who was an infamous Malthusian eugenicist. After World War II, Huxley said that Hitler gave eugenics a bad name, but we needed to convince the population now to "make the unthinkable thinkable," and then he launched the environmentalist movement. He founded the World Wildlife Fund, and as the head of UNESCO, he pursued population reduction policies.

So he chose Muller to come to the new Rice Institute in Texas in 1915, and Muller wrote a eugenics book. I don't know if you've read it.

Calabrese: I haven't read the book.

"Burn Down Blog," Rice University

In this 1916 publication, Julian Huxley is top row, second from left and Hermann Muller is second from right, bottom row. Huxley, a eugenicist-environmentalist who became the first head of UNESCO, recruited Muller to teach at Rice in 1914-1915.

21st Century: It's hard to get—Used copies are $200 to $400,so I asked for it via Inter-library Loan. But if Muller is like Huxley, a population control eugenicist, how do you think that works into this? Is that what you were thinking about when you questioned his political motivation?

Calabrese: No. Actually it wasn't. I was looking at it differently. I saw this group of geneticists that he was the leader of. I viewed them as a cohesive "Band of Geneticist Brothers."

21st Century: Band of genocidal brothers....

Calabrese: They all had the same ideology, they believed, in my view, that they were the only ones who could understand the new biology and save the world, and save the human genome. They believed that they were confronting the medical community that had adopted a threshold model. The geneticists tried to gain influence on all the major health advisory committees, and get geneticists on all those committees. They were always outvoted on a series of committees, but then they got the majority to get appointed to the first BEAR committee of the National Academy of Sciences. And that's what they had to do to win the so-called "big one."

Muller had tried to estimate cosmic-radiation-induced mutation rates back in 1930, and he did this using a *linear* model. And his predictions were off by 1,300-fold! So he couldn't go further on it, but he never abandoned his flirtation with it. That should have told him that he was wrong, but it didn't.

What Muller and his band of radiation geneticists did was to scare everybody, from the press to politicians to the general public, and in a way it became a wildfire, and ultimately it

Bertrand Russell presiding over a press conference at to launch the Russell-Einstein manifesto in 1955. Hermann Muller signed this, and was recruited by Russell into the Pugwash and the Ban the Bomb movement, attending the first Pugwash meeting in 1957.

spread to all chemicals and then regulation, and ultimately a mindset that has affected the entire world.

And the interesting thing is that after the atomic bomb was dropped, one thing that was *not* observed in Japan was a significant increase in birth defects. And that is amazingly ironic.

21st Century: I have two other topics that I'd like to raise. One is that Muller was involved closely with Bertrand Russell's "Ban the Bomb" movement and Pugwash. Russell was an extreme Malthusian. So there you have another connection to a very upfront anti-population philosophy. And the question is really, how much did Muller share their views?

Calabrese: I am not sure, as I have not focussed on this aspect of his life.

21st Century: The same brief biography I read said that his 1935 eugenics book was translated into Russian, and Stalin didn't like it, for whatever reason, and that's why he had to leave Russia.

Calabrese: Muller had a very strong socialist philosophy that permeated his life, and probably affected a lot of his public life and viewpoints.

21st Century: Well, Huxley and Russell both had that same kind of "left" profile—they were fascists really, with a "socialist" cover.

The second thing that came to my mind is that the whole global warming package follows the same trajectory. And you get the same kind of people. I wrote an article a couple of years ago on how the global warming hoax got its start. Margaret Mead, who was head of the AAAS (the American Association for the Advancement of Science), and who fits the Bertrand Russell/Julian Huxley philosophical profile ideologically, pulled together a meeting of atmospheric scientists, and they did the same kind of thing. They established that you needed this kind of scare story, in order to get people to cut back on consumption, so we could further depopulation. And the people who were at that 1975 meeting were Stephen Schneider, all of the bigwigs of global warming. . . .

I don't know what kind of a reaction that you are getting now from the scientific community to your exposés of Muller, but it's very difficult to break through the created myth.

Calabrese: It is probably too early to know.

21st Century: But it will be hard to get around what you found in the archives. Somebody preserved that evidence.

Calabrese: I'm very fortunate to have the archives. It was amazing to see in the draft paper that they had used the word "threshold," "tolerance threshold," and that in the published version, they put in an acknowledgement to Muller and took out the threshold phrase.

21st Century: It is very similar to what happened with the global warming hoax, and the effects of both are extremely costly and not helping the population. . . .

Calabrese: I think that the story has to get out.

21st Century: Truth gets buried, truth just falls by the wayside.

Calabrese: That's right and my sense here is that I'd love to have other freelance writers pick up on this, write their own stories. UMass sent out a press release. . . .

21st Century: The press release was very good. We'll get the story out. We are not the *New York Times,* but we will tell the truth! And in this case, that's what you need. You need to get your smoking gun out there.

For Further Reading

Edward J. Calabrese, 2008. "Hormesis: Why It is Important to Toxicology and Toxicologists," *Environmental Toxicology and Chemistry,* Vol. 27, No. 7, pp. 1451-1474.

Edward J. Calabrese, 2011. "Key Studies Used to Support Cancer Risk Assessment Questioned," *Environmental and Molecular Mutagenesis, 2011.*

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Remembering Dr. Zbigniew Jaworowski: A Scientist Who Fought for Truth

Dr. Zbigniew Jaworowski died on November 12, while undergoing surgery in Warsaw. He was 84. An atmospheric chemist, radiation specialist, and medical doctor, Professor Jaworowski was a frequent contributor to *21st Century Science & Technology*. Dr. Jaworowski fought fearlessly for the truth, with major original contributions on subjects including the Chernobyl radiation hysteria, the Linear No-Threshold theory, and global warming, and he weathered every attack on him for his views with courage and equanimity.

Kamil Wróblewski

Zbigniew Jaworowski (1927-2011)

As the head of radiation protection for Poland at the time of the Chernobyl accident, he pushed the then-Communist regime (in the middle of the night) to act quickly to provide all Polish children with potassium iodide to protect their thyroids against the radioactive iodine released in the accident. Reflecting later on his action, he realized that the radiation levels were elevated, but too low to cause the reaction he was worried about at the time. Later he wrote several scientific analyses of Chernobyl, which were published in technical journals and in *21st Century,* debunking the exaggerated claims of radiation damage stemming from the nuclear accident.

His most recent exposé of the wild lies and radiophobia can be found on the *21st Century* website, "Observations of Chernobyl After 25 Years of Radiophobia." He was also the first in the West to report on the Belarus government's decision to repopulate the Chernobyl exclusion zone.

Dr. Jaworowski also fought against the Linear No-Threshold theory of radiation, which falsely holds that any amount of radiation, down to zero, is bad. He showed that there was no real health reason to remove people from any area beyond a 0.5-square-kilometer radius surrounding Chernobyl, and extending to a maximum distance of 1.8 km in a swath southwestward from the Chernobyl reactor.

An avid explorer and mountain climber, Dr. Jaworowski made scientific observations on mountain glaciers on six continents. He first measured the carbon dioxide content of atmospheric air at Spitzbergen in 1957-1958. His knowledge of the complex processes of ice formation led him to question the validity of historical CO_2 records that are based on analysis of absorbed gas in ice cores. In a 1992 article with Norwegian geologist Tom Victor Segelstad, he challenged the CO_2 historical record by showing that the melting and refreezing of ice layers, under actual, continuously varying conditions of wind and temperature, eliminated any record of the original atmospheric content of the gas.

CO_2: The Greatest Scientific Scandal Of Our Time

by Zbigniew Jaworowski, M.D., Ph.D., D.Sc.

Observations on Chernobyl After 25 Years of Radiophobia

by Zbigniew Jaworowski, M.D., Ph.D., D.Sc.

THE ICE AGE IS COMING!

Solar Cycles, Not CO_2, Determine Climate

by Zbigniew Jaworowski, M.D., Ph.D., D.Sc.

NUCLEAR UPDATE

Belarus Repopulating Chernobyl Exclusion Zone

Zbigniew Jaworowski, M.D., Ph.D., D.Sc.

The Sun, Not Man, Still Rules Our Climate

by Zbigniew Jaworowski, M.D., Ph.D., D.Sc.

Headlines from recent articles by Zbigniew Jaworowski, available at www.21stcentury sciencetech.com .

Zbigniew Jaworowski (above) and his wife Zofia Kielan-Jaworowska (left) in February 2010.

> *He was a man of a great heart and intellect, endowed with many talents: a brilliant world-known scientist, and an expert mountain climber. His mind was open and inquisitive, and with a great sense of humour. He was open to all that is human, a lover of nature, poetry, and life.*
>
> *—Zofia Kielan-Jaworowska*

A Scientific View of Climate Change

Dr. Jaworowski became an outspoken opponent of the global warming fraud, and came to recognize the Malthusian genocidal aims of its proponents. (See the January 2010 interview, "Global Warming: A Lie Aimed at Destroying Civilization.") His meticulous scientific studies of the Sun and carbon dioxide again made him the target of outrageous slings and arrows from the greens, but he persevered, and kept his sense of humor.

His knowledge of climate was firsthand. From 1972 to 1991, he investigated the history of the pollution of the global atmosphere, measuring the dust preserved in 17 glaciers: in the Tatra Mountains in Poland, in the Arctic, Antarctic, Alaska, Norway, the Alps, the Himalayas, the Ruwenzori Mountains in Uganda, and the Peruvian Andes.

Dr. Jaworowski was a member of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) from 1973 to 2010, and served as its chairman from 1980-1982. He held three advanced degrees, Doctor of Medicine, a Ph.D., and Doctor of Science in the natural sciences.

Born in Krakow in 1927, he was 12 years old when World War II began. After the Germans closed all the secondary schools and universities in Poland, he studied clandestinely, learning several modern languages as well as Greek, Latin, and some Sanskrit. He read widely during those years—literary classics, science, history, and poetry—and often cited Shakespeare and other classical history in his writings.

Dr. Jaworowski published more than 300 scientific papers and four books, and he wrote and edited many scientific documents for UNSCEAR, the IAEA, and the U.S. EPA.

He is survived by his wife, Zofia, who is a paleontologist and member of the Polish Academy of Sciences; their son, Mariusz; daughter-in-law, Monika; and two grandchildren, Zofia and Aleksander.

—Laurence Hecht and Marjorie Mazel Hecht

The Jaworowski family in their 2010 greeting card.

Glaciers, Graves, and Stratosphere Tracing the Prophets of Gloom

by Zbigniew Jaworowski

May 26, 2006

'We shall humanize the biosphere of the Earth, and then the worlds beyond. This our future role, as the discovery of radioactivity itself, is a result of natural evolution.'

Dr. Jaworowski's colleague, K. Cielecki, excavating an ice sample from a shaft in the middle of an ice cliff at Jatunjampa Glacier in the Peruvian Andes. The black lines reflect a summer deposition of dust on top of particular annual ice layers. The black layer near the top of Cielecki's head was formed after the 1963 eruption of volcano Gunung Agung in Bali, Indonesia, causing the highest volcanic dust veil in the atmosphere since 1895. Some of the other black lines reflect local eruptions.

EDITOR'S NOTE

In 2006, Dr. Jaworowski began to write an autobiography in Polish, a project that he did not live to complete. Here is his outline for the autobiography, in his own English. It was written as a book proposal for circulation to English-language publishers. We publish the outline here, along with his curriculum vitae, *because the two documents convey so much of Dr. Jaworowski's spirit and accomplishments. Subheads have been added.*

* * *

Audience

Glaciers, Graves, and Stratosphere is intended as a popular science book, addressed to a general public interested in environmental problems. It will summarize research on the current and pre-industrial contamination of the global atmosphere and population, based in large part on my own field and laboratory work, interlaced with narratives of the glacier expeditions (including my encounter with Idi Amin, the President of Uganda, who arrested all the members of the Ruwenzori expedition), of collecting human bones in such places as the Cathedral of Notre Dame de Paris, ruins of monasteries smashed up by the French Revolution, in catacombs of the Cathedral of San Francisco in Lima, in the oldest Christian churches in the then-Soviet Georgia, and in many sacred and archaeological sites in Poland.

The book will discuss the common fears and myths cultivated

Zbigniew Jaworowski (right) working with ion exchange columns in a laboratory tent at Kahiltna Glacier, Alaska, 1977.

by extreme environmentalists, such as radiophobia, chemiphobia, global warming, destruction of the ozone layer, and overpopulation, and will expose the origin of misanthropic catastrophism, as professed by leading representatives of the United Nations, of some governments, and of environmental movement.

Publication of the book will be timely, as the disastrous economic and social consequences of implementations of the Kyoto Protocol and former environmental restrictions imposed on industry, and especially on nuclear energy, are now becoming more interesting topics for the informed public than before.

Overview

Background

Glaciers of the world are a kind of history book that keeps a record of past natural and man-made pollution of the atmosphere—the annual ice layers that form the glaciers preserve ancient precipitation, together with impurities leached from the air by falling snowflakes. Contamination of the humans who lived in past ages is recorded in their bones.

Some forty years ago I started to analyze these layers, and ancient and contemporary human bones. In 1968, I published in *Nature* the first account of the secular changes of the lead content found in glacial ice and in man. I was looking for information about how modern industry changed the natural levels of heavy metals and radioactivity in the environment and the human body. For this aim, in cooperation with the U.S. Environmental Protection Agency, the Norwegian Polar Institute, and other institutions in several countries, I organized 11 expeditions to 17 glaciers in the Arctic, Antarctic, Alaska, Norway, the Alps, the Himalayas, the Ruwenzori Mountains in Uganda, the Peruvian Andes, and in the Tatra Mountains in Poland.

Using Soviet-made MIG fighter planes, I measured the long-term changes of radioactive dust and stable lead content in the troposphere and stratosphere, and the rate and range of the quiescent upward transport of particulate pollutants from the Earth's surface to high altitudes. I used the radioactive substances dispersed by nuclear test explosions and by the Chernobyl accident as tracers for a quantitative estimate of this transport, and of the flow of heavy metals from natural and anthropogenic sources into the global atmosphere.

This enabled a comparison of the mass of natural and man-made chlorine ascending to the ozone layer.

In churches, caves, and archaeological sites in Poland, France, Georgia, and Peru, I also collected hundreds of ancient human bones from the past 5,000 years, to find out, for the first time, what is the level of lead and other metals in modern man in comparison with that in our ancestors.

The results of these studies suggest that concentrations of lead, cadmium, vanadium, mercury, uranium, and radium in the global atmosphere were lower in the 20th Century than in the pre-industrial period (probably due to higher volcanic activity in the past ages); and that in contemporary snow, their highest concentrations were not in the European glaciers, but in remote regions of Africa and the Andes.

The human contribution to the flow of metals into the global atmosphere is small, ranging from 0.07 percent (uranium) to 7.8 percent (lead). In the Middle Ages, the level of lead increased in human bones by a factor of about 100 from a low prehistoric level, and remained high until the end of the 19th Century. In the 20th Century, at the same time when lead alkyls were introduced into automotive gasoline and the production of lead

Transporting supplies to Jatunjampa Glacier in the Peruvian Andes

Gathering ice samples at one of the 17 expeditions that Dr. Jaworowski organized. "Glaciers of the world are a kind of history book that keeps a record of the past natural and man-made pollution of the atmosphere. . . ."

increased dramatically, the content of lead in humans abruptly decreased to near the prehistoric level.

Heavy Metals

I found that the level of heavy metals in the bones and soft tissues of people living in the most polluted industrial region in Poland (Upper Silesia) is lower than that in less polluted regions. The level of metals in the Polish population depends on the geochemistry of particular regions, rather than on the pollution of the local atmosphere.

I studied the levels of radioactive lead-210 in the glaciers and in the stratosphere to elucidate a construction detail of nuclear weapons, important for estimation of risk from radioactive fallout. I was involved in studies and preparation for protection of the public against the radiation effects of nuclear attack and nuclear catastrophes.

These preparations, which were implemented in Poland, passed the exam of the Chernobyl accident well. I published several papers on radiation hormesis, i.e. the beneficial effects of ionizing radiation, and I analyzed the causes of radiophobia—an irrational fear of even the near-zero doses of radiation and of all things nuclear.

The Global Warming Hypothesis

The ice core records of greenhouse gases became a cornerstone of the man-made climatic warming hypothesis. My experience with polar and high-altitude glaciers led me to that part of climatology. I contributed several papers on the reliability of ice-core records for reconstruction of the chemical composition of pre-industrial and ancient atmosphere. I found that these reconstructions are biased by frequent rejections of inconvenient analytical results, unjustified assumptions, and the neglect of gas fractionation processes in the ice sheets and in the ice cores.

I also studied the influence of pollution and of the alleged man-made global warming on the Arctic biota.

Radiation and Radiophobia

My work with radiation and radioactivity convinced me that the discovery of radiation at the end of the 19th Century was one of the greatest achievements of science. It was a key to knowledge of intrinsic patterns of the micro-world and of the cosmos. Its important practical application is now nuclear energy, the fission form of which can support all the needs of humanity for several thousands of years, and the fusion form of which can extend this for billions of years.

Access to this unlimited energy source will enable the material and spiritual enrichment of humanity above what one can now imagine. It renders possible changing us from a merciless exploiter of the biosphere, into its defender and benefactor, responsible for its safety and survival for eons to come.

We shall humanize the biosphere of the Earth, and then the worlds beyond.

A glacier camp site. The highest concentrations of heavy metals, Dr. Jaworowski says, "were not in the European glaciers, but in remote regions of Africa and the Andes." Modern industry has had a detoxifying effect on the environment.

Surveying a glacier. In his studies, Dr. Jaworowski found that "concentrations of lead, cadmium, vanadium, mercury, uranium, and radium in the global atmosphere were lower in the 20th Century than in the pre-industrial period (probably due to higher volcanic activity in the past ages)."

This our future role, as the discovery of radioactivity itself, is a result of natural evolution.

Composition

I anticipate that *Glaciers, Graves, and Stratosphere* will be about 300 pages long. Writing is currently under way; about 150 pages are completed. This text is now in Polish. I shall translate it, and the rest of the book will be written in English. The book will be comprehensively illustrated by photographs from glacier expeditions, and diagrams.

I

The book will begin with an Introduction, answering the question: Do humans endanger the planet?, and address the following subjects:

(1) the fiasco of the catastrophic prophesies of the Club of Rome;

(2) current fears: radiation, nuclear war, nuclear power, heavy metals, CO_2 and climatic warming, exhaustion of raw materials and fossil fuels;

(3) causes of a negative approach to civilization;

(4) projection of local environmental disasters to the global scale, and the illusion of stability of the biosphere;

(5) illusion of the past Golden Age and of benevolent nature;

(6) how the span of human life changed between the Neolithic and present time; what were the living conditions in European cities around 1900 and before, and how moribund people suffered before the development of medicine in the 19th and 20th centuries; how old people were treated until the 19th Century in Europe and elsewhere (*Hexagenari ex ponte!*); hunger and cannibalism in Poland, Scandinavia, and elsewhere;

(7) the present period is the best in all of history—the Golden Age is now;

(8) how technology and mass enrichment caused a deep cultural change in the second half of the 20th Century, replacing the worrier virtues with more angelic ones, and changing our approach to nature, which is no longer seen as an enemy but as a precious endowment, loved and protected, comparing Dante, Joseph Conrad, and other classics with recent literature, as examples of this change.

II

Beneficial Radiation

Natural ionizing radiation and its levels in various regions of the world. Effects of high and low radiation doses. The administrative (linear no-threshold LNT) assumption that even a near-zero radiation dose brings deleterious effects; its history and conflicts within the United Nations Scientific Committee on the Effects of Atomic Radiation UNSCEAR.

Beneficial (hormetic) effects of low doses of radiation. Radiophobia: its sources. Economic and social costs of regulations based on LNT.

III

Nuclear War and Terrorism

Real and imaginary dangers. Current nuclear arsenals, strategic plans, and possible human losses. Why the danger of atomic war is greater now than it was

during the Cold War. Vehement protests against nuclear tests and nuclear power (from which populations receive trifling radiation doses), the weak reaction against the mass production of nuclear weapons, and no movement for banning their use. Psychological effects of building enormous nuclear arsenals and nuclear war planning, their influence on public disenchantment with science, pessimism of intellectuals, and development of the ecology movement.

"Why the danger of atomic war is greater now than it was during the Cold War."

IV
Nuclear power

Duration of global resources of nuclear fuels compared with other sources of energy. Limitations of renewable energy sources. Occupational and public health effects of various sources of energy. Radioactive wastes from global nuclear power compared with natural radioactivity in soil. Average doses of radiation received by global and regional populations, from all natural and man-made sources. Accident at Three Mile Island and strangulation of the U.S. nuclear power program. Overplaying of man-made climate warming by the atomic lobby, and ignoring of nuclear power by proponents of the Kyoto Protocol.

V
The Chernobyl catastrophe

The greatest psychological catastrophe in history. Comparison with other industrial catastrophes. Dispersion of radioactive material in the troposphere and stratosphere. Local, regional, and global contamination. Radiation doses received by rescue and operational teams. Radiation doses received by local and regional population. Radiation doses received by European and global population, in comparison with doses of natural radiation. Paranoid role of mass media, and scientific reports on mass fatalities and genetic disorders.

Realistic estimates by UNSCEAR of early fatalities and late health impacts. Economic and social losses and their causes. Lessons for the future.

VI
Heavy metals in ice and man

Lead and a false hypothesis of the fall of the Roman Empire. Toxic and beneficial effects of heavy metals. Natural levels of lead and other heavy metals in the environment and human population—models and reality. Secular changes of the concentration of heavy metals in the global atmosphere, based on analysis of ancient and contemporary glacier ice from both Hemispheres, and on results of the stratospheric sampling program. Changes of levels of heavy metals in humans during the past 5,000 years. Mass lead poisonings from the Middle Ages until the end of the 19th Century. Detoxification of the population by modern industry.

VII
CO_2 and man-made climate warming

History of the man-made climate warming hypothesis. Climatic cycles and temperature changes during the past 545 million years. Contribution of water vapor, CO_2, and other trace gases to the global greenhouse effect. High CO_2 concentrations measured in the 19th Century atmosphere ignored by modellers. Concentration of stable isotopes of carbon in 20th Century air do not support the assumption of a dramatic increase of anthropogenic CO_2 in the atmosphere.

Low pre-industrial levels of CO_2 in air recovered from Arctic and Antarctic ice cores became the cornerstone of the man-made warming hypothesis. However, these levels do not reflect the real chemical composition of the atmosphere, but of artifacts in ice sheets and in the ice cores.

Progress and retreat of glaciers between the 18th and 21st centuries. Lack of correlation between CO_2 concentration in air and temperature: Change in temperature precedes CO_2 change. Disagreement of model predictions of air temperature in the Arctic with measurements. Influence of solar cycles and galactic cosmic rays on the climate. Improper attribution of recent hurricanes to global warming. No danger of flooding the Maldives. Positive effects of current climate warming, which is a continuation of our emerging from the Little Ice Age.

VIII
Epilogue

Replacement of old imaginary fears with new ones, and their commercialization. Short history of the environmental movement, that started in pre-war Germany, and then gained power in the United States and elsewhere with the support of politicians, bureaucracy, and the media, and by dishonest manipulation of the altruism of the public. Real danger is not the environmental doom professed by ecological fundamentalists, but rather the consequences of implementation of their environmental ideology.

A multi-national glacier expedition. The findings on lead were startling: In the 20th Century, when the production of lead increased dramatically, the content of lead in humans "abruptly decreased to near the prehistoric level."

Curriculum Vitae of Zbigniew Jaworowski

I was born on 17 October, 1927, in Krakow, Poland. I graduated as a physician in 1952 at the Medical Academy in Krakow. In 1963, I received a Ph.D. in natural sciences (in Polish: *doktor nauk przyrodniczych*), and in 1967, a D.Sc. in natural sciences (in Polish: *doktor habilitowany nauk przyrodniczych*). I became a docent in 1967, and in 1977 I became a full professor.

Since 1958, I have been married to Zofia Kielan-Jaworowska, who is a professor emeritus of paleontology at the University of Oslo and at the Institute of Paleobiology of the Polish Academy of Sciences in Warsaw; and the editor of the *Acta Paleontologica Polonica*. She is a full member of the Polish Academy of Sciences, of the Norwegian Academy of Sciences, and of the Academia Europea. We have one son, and two grandchildren.

Between 1951 and 1952, I worked as an assistant at the Institute of Physiological Chemistry of the Medical Academy in Krakow, studying chemical carcinogenesis. Between 1953 and 1958, I worked in radiotherapeutics at the Oncological Institute in Gliwice. In 1957 and 1958, I served as a medical doctor of the Polish International Geophysical Year Expedition to Spitzbergen, where I studied the activity concentration in precipitation of radionuclides from nuclear test explosions, and concentration of CO_2 in the air.

Between 1958 and 1970, I worked in the Institute of Nuclear Research in Warsaw as a head of the Laboratory of Radiotoxicology. In 1960-1961, I worked at the Department of Physics of the Research Cancer Institute in London on a stipend from the International Atomic Energy Agency, measuring the content of lead-210 in the bones of the British population and in the hair of Polish uranium miners.

Between 1970 and 1987, I worked in the Central Laboratory for Radiological Protection in Warsaw as the head of the Department of Radiation Hygiene. Between 1982 and 1984, I worked in the Centre d'Etude Nucleaires in Fontenay-aux-Roses near Paris as a guest professor.

In 1987-1988, I worked at the Biophysical Group of the Institute of Physics, University of Oslo. In 1988-1990, I worked at the Norwegian Polar Research Institute in Oslo. Between 1990 and 1991, I worked for six months as a visiting professor at the National Institute for Polar Research in Tokyo. Between 1991 and 1993, I worked in the Institute for Energy Technology at Kjeller near Oslo.

Zbigniew Jaworowski as a young man.

Since 1993, I have been working at the Central Laboratory for Radiological Protection in Warsaw, now as the chairman of the Scientific Council.

Studies

I studied:

(1) internal contamination of man and animals with radionuclides;

(2) development of analytical methods for detection of pollutants in the human body and environment;

(3) metabolism of radionuclides;

(4) biological effects of ionizing radiation;

(5) impact of nuclear war on population;

(6) remedial measures in nuclear emergencies;

(7) environmental levels and migration of radionuclides and heavy metals;

(8) relationship between pollutants in the environment and in man;

(9) historical monitoring of radionuclides and heavy metals in man—the first discovery that lead level in human bones was up to two orders of magnitude higher between the 11th Century and the end of 19th Century than now;

(10) historical monitoring of radionuclides and heavy metals in the environment;

(11) vertical distribution of natural radionuclides, fission products, and heavy metals in the troposphere and stratosphere;

(12) determination of natural radionuclides, fission products and heavy metals in contemporary and pre-industrial ice from glaciers in both Hemispheres, for studying the geographical distribution, temporal changes, and flux of natural and man-made pollutants in the global atmosphere;

(13) regional and global impact of pollution caused by coal burning;

(14) validity of polar ice core records of greenhouse gases for reconstruction of the composition of the ancient atmosphere.

I was a principal investigator of three research projects of the U.S. Environ-

Dr. Jaworowski was a leading Polish mountaineer, with the nickname of Baca. In October 1948, he became famous, along with a friend, for climbing the 106-meter-high Wroclaw "needle." The glass and steel spire needed repair, after being damaged in a storm, so that it did not fall and injure passers-by. Dr. Jaworowski (one of the specks climbing the tower) used a new technique, called substrings to get the job done.

mental Protection Agency on: (1) historical and geographical changes in distribution of pollutants in the global atmosphere, components of the environment, and in the human body; (2) on vertical distribution of pollutants in the troposphere and stratosphere; and (3) on the toxicology of organically bound tritium.

I was a principal investigator of four research projects of the International Atomic Energy Agency on radiotoxicology.

I organized 11 expeditions to the polar and high-altitude temperate glaciers: Spitzbergen, Alaska, Northern Norway (Svartisen), Southern Norway (Jotunheimen), the Alps, the Tatra Mountains, Himalayas, Ruwenzori in East Africa, the Peruvian Andes, and Antarctica. Their aim was to measure (for the first time) the mass of stable heavy metals and activity of natural radionuclides entering the global atmosphere from natural and man-made sources, and to determine their pre-industrial and contemporary annual flows.

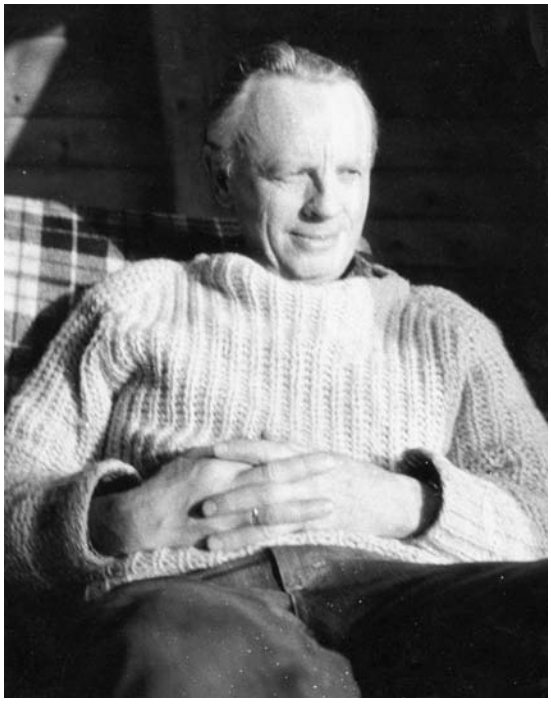
During these studies, the mass of global annual atmospheric precipitation was measured (for the first time) by means of radioactive tracers (natural lead-210, and cesium-137 from nuclear tests).

Scientific Memberships

I am or I was a member of the: (1) Polish Society of Radiation Research, (2) Polish Society of Medical Physics, (3) Commission of Radiobiology of the Committee of Medical Physics of the Polish Academy of Sciences, (4) Polish Commission of Nuclear Safety (until 1980), (5) Polish Society of Polar Research, (6) Polish National Council for Environmental Protection, until 1987, (7) Committee of the Basic Medical Sciences of the Polish Academy of Sciences, until 1987, (8) Health Physics Society (USA), until 1987, (9) Founding member of the International Society for Trace Element Research in Humans, (10) Commission of Radiological Protection of (Polish) National Council of Atomic Energy (1984-1988 chairman) until 1989, (11) Norwegian Physical Society, (12) International member of the Advisory Committee of BELLE (Biological Effects of Low Level Exposures), (13) Member of the Scientific Committee of Environmentalists for Nuclear Energy, and (14) Health Physics Society.

I am a member of the editorial boards and scientific committees of several Polish and foreign scientific journals.

Since 1973, I have been a member of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR); in the years 1978-1979, I was the vice-chairman, and in 1980-1982, the chairman of this Committee.



In mid-career.

I was a participant or chairman of about 20 Advisory Groups of International Atomic Energy Agency (IAEA) and of the United Nations Environmental Programme (UNEP).

In 1986, I was a member of the Polish Governmental Commission on the Effects of the Chernobyl Accident. I advised the Government to use stable iodine to protect Polish children against radioiodines from the burning Soviet nuclear reactor.

I have published about 280 scientific papers and 4 books, and I participated in writing and editing 10 published scientific documents of UNSCEAR, IAEA, and UNEP.

I have published about 100 articles in Polish newspapers and popular science magazines.

A more recent portrait.

Selected Recent Publications

"Radiation Risk and Ethics," 1999. *Physics Today,* Vol. 52, No. 9, pp. 24-29,

"Radiation Risk and Ethics: Health Hazards, Prevention Costs, and Radiophobia," 2000. *Physics Today,* Vol. 53, No. 4, pp. 11-15 and 89-90.

"Radiation Risk and LNT: The Discussion Continues," 2000. *Physics Today,* Vol. 53, No. 5, pp. 11-14 and 76.

"Anti-nuclear Hoaxsters Hide Benefits of Radiation," 2000. *Executive Intelligence Review,* Vol. 27, No. 41, pp. 42-51.

"Ionizing Radiation and Radioactivity in the 20th Century," 2000. *21st Century Science & Technology,* Vol. 13, No. 4 (Winter), pp. 10-16.

"Ionizing Radiation in the 20th Century and Beyond," 2002. *Atomwirtschaft-Atomtechnik* (atw), Vol. 47, No. 1, pp. 22-27.

"UNSCEAR on the Health Effects from Chornobyl," 2001. *Science,* Vol. 293, pp. 605-606.

"The Future of UNSCEAR," 2002. *Science,* Vol. 297, p. 335 (19 July).

"Solar Cycles, Not CO_2, Determine Climate," 2003-2004. *21st Century Science & Technology,* Vol. 16, No. 4, pp. 52-65 (Winter).

"Chernobyl, Nuclear Wastes, and Nature," 2004. *Energy & Environment,* Vol. 15, No. 5, pp. 807-823.

"Nature Rules the Climate," 2005. *Energy & Environment,* Vol. 16, No. 1, pp. 131-147.

A Passionate Voice for Science

Courtesy of Jennifer Fox

Michael R. Fox (1936-2011)

Mike Fox, who died Nov. 4, 2011, spent 40 years working in the nuclear industry and passionately advocating the benefits of nuclear technology. He was a dedicated teacher, spending as much time as necessary with those who wanted to know about nuclear, and writing carefully and clearly for the public, including several articles for *21st Century Science & Technology* and many columns in the *Hawaii Reporter*.

Courtesy of Jennifer Fox

Mike and his wife, Jennifer, in 2010.

A native of Olympia, Washington, Mike had a B.S. in mathematics and chemistry from St. Martin's College, and a Ph.D. in Physical Chemistry from the University of Washington. He began his career at the Idaho National Engineering Laboratory in 1965, and he taught chemistry at Idaho State University, before moving to the Tri-Cities area in 1973 to work at Hanford. After his retirement from Hanford, he continued to work as a consultant in the nuclear and energy areas.

Mike served as chairman of the American Nuclear Society's national public information committee for several years, and in 1985 was given the ANS public education award. He also was a member of the American Chemical Society.

Combatting Ignorance

Mike had little patience for greenies, especially ignorant ones, and he used his devilish sense of humor to lampoon their fibs and foibles. He relentlessly marshalled the evidence to correct ecolies, in words that could be understood by non-scientists. But he also had some choice words for his colleagues in the nuclear community, whom, he famously said, "lacked testosterone," because they would not combat their anti-nuclear foes. Their compromise with green lies was for him a sin. He expected more of his colleagues than wimpery.

As American culture changed, becoming less and less knowledgeable about science, Mike's education program expanded from nuclear to include science in general. He was interested in truth, whether it concerned DDT, global warming, energy policy, risk, or a host of other issues that suffer from misinformation.

Talking to Mike was refreshing and helpful. I knew I could count on him for sense and accuracy with technical questions, and for some humor. He was a forceful presence in person, on the phone, via e mail, or at a lectern. We only once shared the podium, as invited speakers at a conference of the Brazilian Nuclear Association in Rio de Janeiro. Not surprisingly, the topic was environmentalism.

Mike fought his cancer with the same spirit in which he fought ignorance—with knowledge and determination.

Our politics differed, especially so in recent years, but we each appreciated the other's commitment and contributions to the fight for science and truth. We will miss Mike, and send our condolences to his wife, Jennifer, children, grandchildren, and other family members.

—Marjorie Mazel Hecht

BOOKS

Why Hanford's Nuclear Waste Cleanup Wastes Your Money

by Michael Fox, Ph.D.

Hanford: A Conversation about Nuclear Waste Cleanup
By Roy E. Gephart
Columbus, Oh.: Battelle Press, 2003
Hardcover, 388 pp., $34.95
(available from www.battelle.org/bookstore)

To this day, the history of Hanford, the eastern Washington laboratory of the Manhattan Project, remains largely in the minds of its retirees, and in the highly technical old reports stored in several repositories. Prior to Roy Gephart's book, the histories which have been attempted are largely (but not completely) written either by anti-nuclear critics or newcomers to Hanford. The few attempts which have been written by scientists, are good as far as they go, but they are not nearly as comprehensive as the topic needs and deserves.

Dr. Gephart recognized the glaring need of setting the historical record straight regarding the activities at Hanford, and what has transpired there over the past 60 years. As such, he undertook the extraordinary task, with the support of his current employer, Pacific Northwest National Laboratories, of researching the often garbled or exaggerated by less qualified historians. For these reasons alone, I recommend his book for anyone curious to learn what actually transpired. The book is immensely readable, complete with helpful highlights in the margins.

I have a number of criticisms of the book, however. I'll start with his subtitle, "A Conversation About Nuclear Waste Cleanup." Conversations are fine, but what do comments of the critics of Hanford, which the author provides in many places, add to the conversation? Introducing the negative comments of Hanford critics may appeal to some, but it adds nothing to the understanding of Hanford, detracts from the overall presentation of important history, and reduces the rigor needed for such an important document.

Further, the critics' comments are well known for being predictable, judgmental, and relatively free of scientific insight. A hint of this emerges as early as in the book's Foreword, where the judgmental margin comments were disappointing, and continues in too many places throughout the book.

risks involved. To this day, the quantified risks to the public from Hanford (as demonstrated in all appropriate Environmental Impact Statements) are *statistically indistinguishable from zero!*

These risk analyses are not secret, but have been performed, and the risks quantified and published a number of times for many Hanford activities. For example, every Environmental Impact Statement (EIS) is required by law to include a study of the risks that would be incurred by doing nothing—the so-called "No Action" options. In the matter of the Interim Storage of Hanford Tank Wastes, the "No Action" option would produce estimated collective doses at the Hanford boundary that range between 2.6×10^{-4} to 1.6×10^{-2} person-rem. These are extremely small

Let's Tell the Truth About Plutonium and Hanford

by Michael R. Fox, Ph.D.

On July 10, 2010, the *New York Times* published another article about the Hanford nuclear site in Eastern Washington, this one by veteran reporter Matthew Wald. (http://tinyurl.com/2azj5kz). It requires some corrective comments.

During World War II, Hanford was chosen by the Army Corps of Engineers to be one of the sites in what was then called the Manhattan Project. Hanford produced the majority of the nation's inventory of plutonium, including that in the bomb dropped on Nagasaki.

Having many decades of experience working at Hanford, including working with plutonium and managing a plutonium laboratory, it gets wearisome to read such superficial, inadequate, and misleading articles.

Given this specialized background, I feel an obligation to comment on the article by *Times* reporter Wald, the report he reports on, the authors of the report,* and some of the references listed in the report. My objections include the huge lack of context, exaggerations, omissions of fact, omissions of key research findings regarding health effects of plutonium, omissions regarding interesting aspects of the Hanford environment, inadequate literature sourcing, and omission of comments on other materials such as americium.

Let's start with the headline: "Analysis Triples U.S. Plutonium Waste Figures." Nowhere in his article does the reporter provide the relative magnitudes of the before and after values. Therefore, the reader cannot assess for himself the amounts of plutonium involved. Three times a small number is still a small number, for example. As written, therefore, the headline is irrelevant and meaningless.

But in the universe of problems with this *Times* article and the report it is based on, the lack of information on "Plutonium Waste Figures" only hints at what lies ahead in terms of other irrelevancies.

The apparent purpose of the paper and the *Times* article is to create another image of looming doom related to the Hanford clean-up mission. Such stories of impending doom from Hanford have been frequent fare from Hanford critics for more than two decades, and all of them suffer from the same litany of exaggerated fears.

Central to the scare stories are the two familiar concepts—"deadly" plutonium and 24,000-year half-life. These have been common bugaboos since the 1970s, when the antinuclear forces and their friends in the media yapped in concert like Pavlovian dogs. The scare stories haven't changed for nearly 40 years, yet during this time thousands of workers operated quite safely with plutonium, because we happen to know a lot about it and how to work safely with it.

When one is managing a plutonium lab, with dozens of workers, personal safety of friends and colleagues was always of utmost importance and a nonsense part of everyday life. That safety effort paid off, in terms of establishing an excellent health and safety record. Obviously, we worked hard and carefully with safety training, laboratory conduct, practices, and habits.

Gee-Whizzy Half-Lives

Now for that big number. One is reminded of children discovering a gee-whizzy new word or big number for the

Two of Dr. Fox's articles on the 21st Century *website:* www.21stcenturysciencetech.com .

INTERVIEW: MICHAEL R. FOX

What We Can Learn from Fukushima

This interview with LaRouche Pac editor Alicia Cerretani, took place three days after the March 11 Fukushima accident. We present this edited version as a tribute to Mike. It exemplifies his spirited support of nuclear fission, and his passion for educating others.

Question: Please tell us about your background.

Fox: I retired after 40 years in the nuclear industry at Hanford and Idaho National Engineering Lab. I have taught thermodynamics at the university level. I have a Ph.D. in physical chemistry from the University of Washington.

Physical chemistry is kind of a discipline in between chemistry and physics. For example, in my five years of graduate school, I almost never touched a test tube; it's more theoretical than dirty lab work. And I have a mathematics and chemistry B.S.

Question: What is your view of the Fukushima situation?

I'm not a nuclear engineer, but know a lot of people who are reactor engineers, and I've talked with them about the failure mode at TMI and the failure mode at Chernobyl. It's a very, very interesting discipline that these people have. They go through the sequence of events that lead to the accident. And by knowing what happened, that's how we make reactors safer.

It turns out that failure is very, very informative—we learn a lot. Probably we learn more from failures than we do from successes, because the envelope of variables for success—temperature, pressure, viscosity, concentrations—can be reasonably small, in that if we run a successful test, why then we congratulate ourselves on how brilliant we are, but we may have been operating right at the edge of failure, so we don't learn as much as we could if we had actual failure. So that's the general philosophy, where I'm coming from.

I know people who have been to Chernobyl and who have been directly involved with the health effects of radioactivity, the environment, wildlife, plant life, isotopes, and all that. My favorite author, by the way, on the Chernobyl events is one of your favorites—Zbigniew Jaworowski.* He's super, and extremely knowledgeable; his writing skills are just perfect for me. Because as soon as he says something that raises a question in my mind, the next couple of sentences answer the question. He's a guy you don't want to lose contact with.

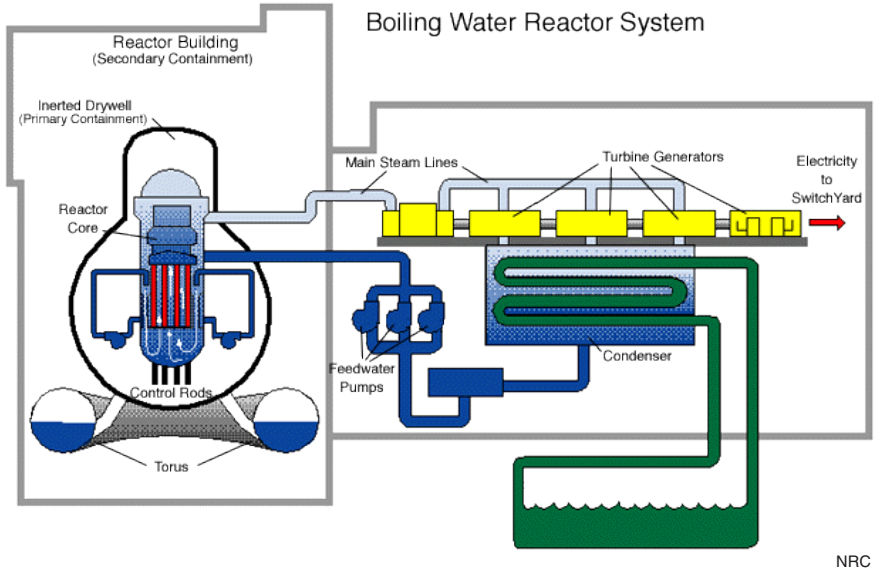
Question: There's just so much ignorance about how nuclear reactors actually work, so when people hear about the accident and explosion, their imaginations get carried away in fear. From your perspective, can you give people a sense of what you know happened with the reactor and what the real dangers are in a situation like this?

Fox: I know some of the people who did the examination of the fuel debris ob-

HOW A BOILING WATER REACTOR WORKS

Water circulates through the reactor core, where the fission process heats it to boiling, converting it to steam. Steam separators remove water droplets from the steam, and the steam is sent to the turbine generator, which produces electricity. From the turbine, the steam goes to the condenser, where it is condensed into water. The cooled water is pumped from the condenser and sent back to the reactor core to begin the cycle again.

The control rods in the BWR come up from the bottom, instead of from the top. There is also a Torus or Suppression Pool below the reactor, which is used to remove heat in an emergency.



NRC

Areva

A nuclear fuel assembly (left). The long tubes are zirconium-alloy-clad fuel rods which are fastened together into large bundles that form the core of a nuclear reactor. Uranium oxide fuel pellets are stacked inside each rod. Individual fuel rods are shown in the inset.

tained from the Three Mile Island reactor in 1979, so we know damn well what happened.

Visualize a reactor core with 100 fuel assemblies, each fuel assembly maybe containing 100 fuel rods held in a vertical position. A fuel rod is typically composed of an alloy of zirconium, and it contains the actual fuel pellets that are loaded into it when they are fabricated. These rods go into the reactor and, to make a very long story short, by manipulating the water, water pressure, and heating the water, we extract heat from the fuel and pump it around to heat exchangers. Then that is expanded into turbines, and the turbines drive generators, and we get electricity.

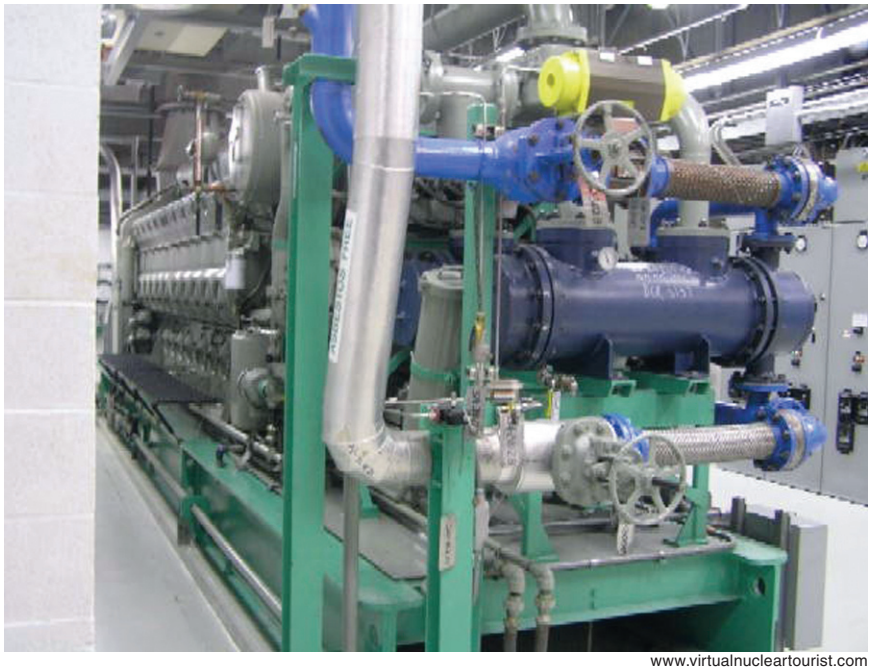
Now, what happens in an accident like Three Mile Island? The TMI accident is analogous to what I believe happened in Japan. You have an accident, and you have a power failure. It turns out that some of the power that some utilities use to run the plant—I think we're trying to get away from it in the United States—comes from off-site. Here in the Northwest, we get power from our hydroelectric facilities coming into the power plant to run back-up. Now, suppose we lose the off-site power, as they did in Japan. This means that the circulation pumps in the reactors shut down.

In the United States we have anticipated that by installing huge diesel generators. And these diesel generators are quite capable of running a minimum supply of electricity, including instrumentation, circulation pumps, and so forth. They are huge—big enough to run small ships.

And part of the inspection process in our reactor in Richland is to inspect and start up these back-up systems without the use of off-site power. Now the way they do that is, that these diesel engines can be started with large batteries. And they do that; on a regular basis they fire them up and start them, just to make sure they are operable.

Now in Japan—and this is fragmentary information that I've gotten—they had back-up diesel generators, and they were capable of generating onsite power from them, but the diesel fuel was located outside the reactor building, and these got broken. I don't know whether it was the earthquake that broke them, or the tidal wave that broke them, but the back-up diesel lost power because it couldn't get fuel.

And so—I don't know what the euphe-

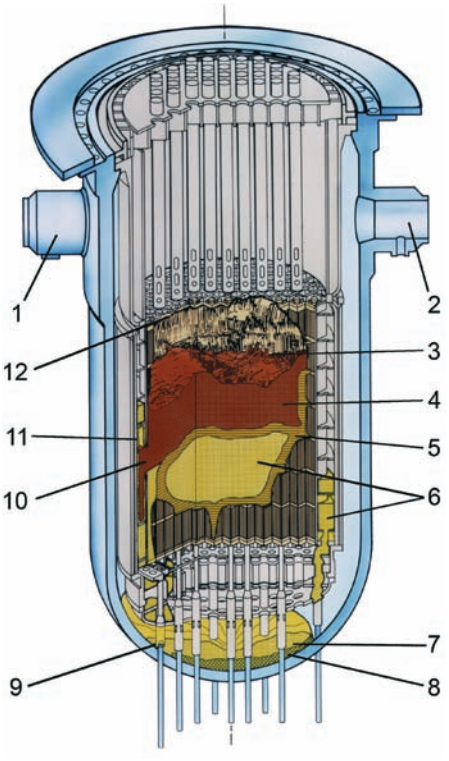


www.virtualnucleartourist.com

Nuclear plants have a back-up power supply to keep the emergency systems (water cooling pumps) operating if there is a power loss to the grid. At the three damaged Fukushima plants, the back-up diesel generators lost power in the flood waters of the tsunami, leaving reactor fuel assemblies uncovered. Here, a back-up diesel generator.

NRC DIAGRAM OF TMI CORE WITH MELTED FUEL

This Nuclear Regulatory Commission diagram depicts what happened in the 1979 Three Mile Island accident where reactor fuel slumped to the bottom of the boiling water reactor pressure vessel. Dr. Fox notes (based on what was known just two days after the accident) that this might be the case with the damaged Fukushima reactors.



Key

1. 2B inlet
2. 1A inlet
3. Cavity
4. Loose core debris
5. Crust
6. Previously molten material
7. Lower plenum debris
8. Possible region depleted in uranium
9. Ablated incore instrument guide
10. Hole in baffle plate
11. Coating of previously molten material on bypass region interior surfaces
12. Upper grid damage

mism is—but Tokyo Electric Power Company was screwed, because it couldn't pump water. Then the reactor starts heating up and driving off the cooling water that is in the core, in the pressure vessel. As it drives off steam, the reactor top, the tube assemblies, become uncovered, bare, and exposed to air and steam. . . .

Then a sequence of events happens that is very helpful to understand what you see on television today.

Once these fuel rods become uncovered, they are still hot. I mean very, very hot—hundreds of degrees—and a chemical reaction occurs that we learned in high school. The fuel rods become uncovered and hot, and their zirconium fuel cladding then has a hot metal/water reaction.

Anytime you heat a metal to very high temperatures and throw steam around it, what happens is that oxidation takes place. The zirconium is converted to zirconium oxide, and the by-product is hydrogen.

One talk show guest I heard, a so-called "expert," said that hydrogen and oxygen are generated by that process. That's not true. Oxygen is consumed by oxidizing the metal. So you get zirconium oxide plus hydrogen.

Now the zirc oxide is now not a metal, but it's a brittle ceramic oxide . . . and it begins to slough off the reactor fuel buttons that are loaded into the fuel rods. All that becomes free, and the fuel slumps to the bottom of the pressure vessel.

So that's what happens with the zirconium-clad fuel; it goes to the bottom of the pressure vessel.

The hydrogen, on the other hand, is vented and it was caught—collected—in the exterior building in Japan, where it built up in constant pressure. And with hydrogen concentration, I know, the flammability in air is about 4 percent. The explosion limit is 6 or 8 percent. So it doesn't require an entire room of hydrogen to create a problem.

Once it gets up to that 8 percent. . . . When dealing with hydrogen, you always assume that there is an ignition source around—anything from a match to a light switch, which can ignite the mixture. And kaboom! Away we go. And the utility loses the reactor. It's destroyed.

So, what upsets me more about the media coverage is that it is almost making a parody of it. They have zero concept of relative risk. The big problem facing the Japanese now is not the reactors, it's the 80,000 people that are missing from the tidal wave and other damage caused by the earthquake.

There is essentially no health risk involved from the reactors.

Another thing that drives me nuts, is that we are not told what kind of radiation is involved. It's a big, big, big difference, whether it's tritium or whether it's strontium, cesium, or whatever. Because these come from different sources in the reactor system, and would tell me what kind of damage is likely to have occurred.

But all the news media think they have a nuclear "expert" on nuclear power, but they are coming from groups like the Center for American Progress, the far left-wing group in Washington, and others that I've never heard of.

I'm a member of the American Nuclear Society, and I've never heard of these people. I'm also, as I said, familiar with the failures at Chernobyl. And these guys, the so-called experts, so far as I know, have never been involved with doing health studies or environmental studies at Chernobyl. They are not experts in failure-mode analysis or risk analysis for reactors, but they are obviously very good at self-promotion and very pleased with themselves to get on television.

I have nothing but contempt for these people, who are reciting 25-year-old scare stories for their own self aggrandizement and doing a dreadful job of informing the public. How's that for candor?

Question: That's why they picked them, and that's why they're "experts." Not because they know anything about the disaster.

Fox: They're certainly experts in self-promotion, and they know some of the lingo. And most of the lingo that they use is old lingo from the TMI accident, but essentially the health effects of TMI are zero, and I expect that the health effects of the Japanese reactors to be essentially zero too.

I've worked in the nuclear industry for

Report of The President's Commission on the Accident at Three Mile Island: The Need for Change: The Legacy of TMI

Three Mile Island personnel in protective clothing cleaning up the contaminated auxiliary building in October 1979.

40 years, and I've operated and managed radio-chemistry labs and plutonium labs, and I know what I'm talking about. And, since I have people whose health and safety are important to me, and are friends, I never took my radiation advice from people like this, or Greenpeace, or John Gofman, or any of the other opportunists, because they are invariably wrong—whether it's plutonium chemistry, or the health effects of radiation, or whatever.

And the Japanese: I see them monitoring children and adults, but they are doing it in a proper, very, very, very conservative way. And that's the way we do things.

It probably aggravates the situation to see a guy in what we call SWP clothing—safe work permit clothing—monitoring a child who is in street clothes, but that's how you do it.

Sensitive Instrumentation

Another problem involved with this, by the way, in communicating, is that our instrumentation in 2011 is hugely sensitive in the measurement of radioactivity. There is a false presumption that if the radiation is detectable, it creates cancer, it creates death. That's absolutely not the truth.

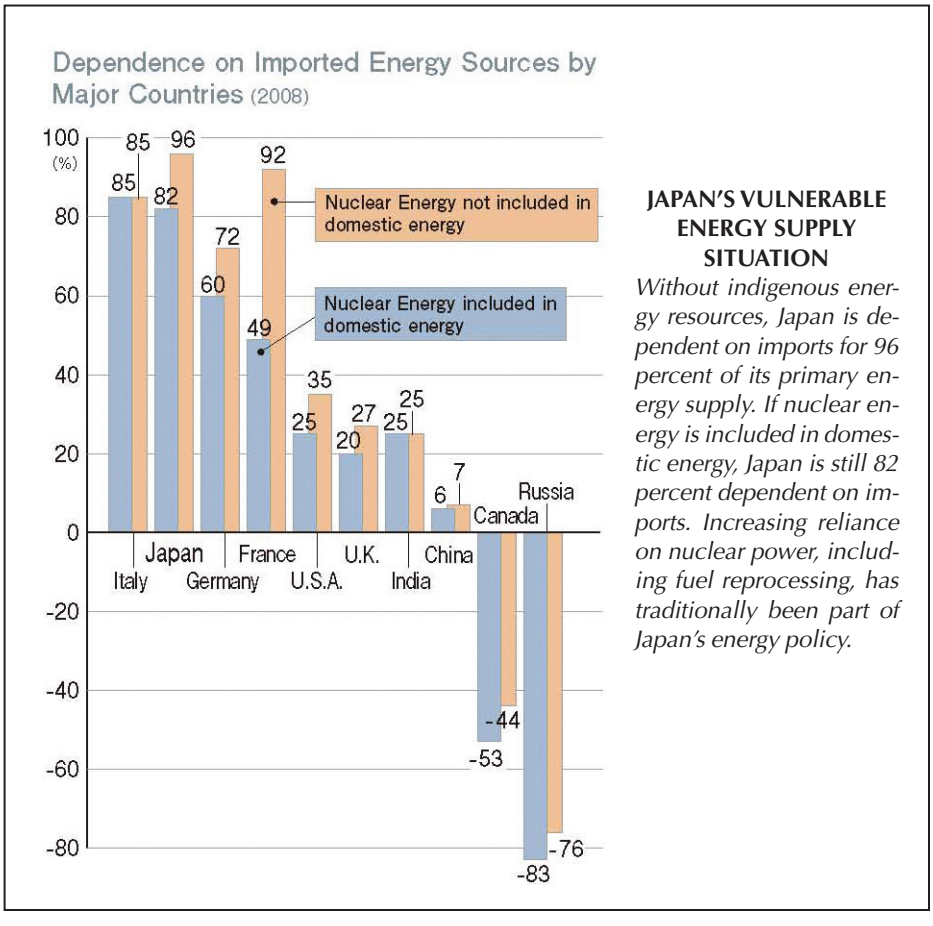
We have detection equipment now that can detect chemical elements off the periodic chart at the parts-per-million level. When I took quantitative analysis, we were happy with parts per thousand! Now the detection limits are parts per trillion, and the detection of radioactive materials is even lower than that—another factor of 1,000 to 10,000 times lower than that.

So a scientist can stand up and say "Yep, we detected it, it's there," but if you don't have any sense of perspective and the magnitudes of what their detection equipment is telling them, why you can easily paint a scary story, and a lot of the reality is left out of the discussion. It's one of my pet peeves, since I've operated some of those pieces of equipment.

It's a big financial hit for sure, but they're making a parody out of it. Because Japan has to have electricity, and most people in the United States don't appreciate what electricity has done for them as a nation. It provides entertainment, it provides highly productive workers, it provides help in our national security defense systems.

Electrical energy is a substitute for human backs, or for slavery. Now, we have a rather terrible choice here, and if we want to go down the road here to more reliable, low-cost electricity, we can either have it or we can not have it. And I grow weary of people who think that we can get abundant energy from sunbeams and gentle breezes. That's just not the case. That's one thing I learned in teaching thermodynamics.

There are some things about energy that are inviolate. For these people to be scaring people about nuclear power plants, especially when they have the history of the TMI incident, is dishonest. The Japanese have much, much, much bigger problems to solve right now. . . .



JAPAN'S VULNERABLE ENERGY SUPPLY SITUATION

Without indigenous energy resources, Japan is dependent on imports for 96 percent of its primary energy supply. If nuclear energy is included in domestic energy, Japan is still 82 percent dependent on imports. Increasing reliance on nuclear power, including fuel reprocessing, has traditionally been part of Japan's energy policy.

Question: It's reported now that not only the Fukushima nuclear plants were damaged, but other reactors were demolished, including coal-fired plants and an oil refinery that went up in smoke. What are you looking at in terms of actual plant damage?

Fox: This morning's news is reporting that there may be a possibility of three reactors undergoing this process of the fuel becoming uncovered and slumping to the bottom of the pressure vessels. So there is going to be a lot of damage there. The damage is being contained both by the pressure vessel and the first containment building, which is robust concrete.

You won't be able to tell how much damage unless you get very close to it. I imagine that they will follow that TMI clean-up pretty closely in Japan. We certainly got a lot of experience doing that.

I hadn't heard that Japan had lost coal plants. I do know that one of the oil refineries is burning. But, Japan is in a tough situation. They don't have any indigenous supplies of coal or oil. And they are very smart and great people, so they went down the road to build domestic nuclear power plants. Regrettably, Japan itself is on a geologic fault and so they have to engineer around that. . . .

Defense in Depth

Question: What you said about electricity is key, and I haven't surveyed a lot of the other damage to the infrastructure. But if you juxtapose the situation in Japan, with what happened, say, in Haiti: Haiti never had that kind of infrastructure, the way Japan has built theirs up, so the damage done to Haiti was much more severe, because they didn't have this higher energy flux dense capability that the Japanese do. In Japan, we may be talking about three reactors that are down, but is it the case that the infrastructural integrity granted by the power plants, and the power plant itself, actually fared better than other infrastructure that was involved in the earthquake and the tsunami?

Fox: Yes, what we call defense-in-depth, how to contain the fission products, has worked very well. The pressure vessel is intact, the first containment building is intact, and it's very unlikely that they will be breached.

There are additional safety measures that they could take. I don't know why they are not pouring in borated water into the reactors, but they apparently are not. Boron is a wonderful element that absorbs neutrons and stops nuclear fission reactions. That's one way to stop it.

But, yes, the infrastructure at the power plants is pretty much intact in terms of anticipating the kind of accident that occurred. The problem is that they engineered for—it's called the design basis accident—and that was, I think, somewhere around a 7.0 magnitude earthquake. Well, this was a 9.0, so the plants were not designed for a 9.0. Something gave, and in this case it was the fuel supply to the diesel generators that was terminated. . . .

Especially given the hardship that the Japanese people face now with water shortages, food shortages, and loss of infrastructure, just in living in communities there. I don't know what the Japanese are going to do—are they going to bring in floating nuclear reactors?

Question: They could; Russia's not too far away. The Russians have a design for small floating reactors. I know the Russians are bringing in natural gas.

But let me ask you this: What do you think we could learn from this situation? You mentioned that we learn the best, sometimes, from the failures. So what do you think we can learn from the earthquake and tsunami in Japan?

Fox: Well, it's conjectural, but we can learn how to build more robust cooling systems, and more robust back-up diesel systems. And the Japanese, at least, are going to have to build more robust reactors to withstand a 9.0 earthquake. So the guys who are expert in risk analysis and failure-mode analysis are going to be going through this with a fine tooth comb, and making observations that we haven't even thought of.

Chernobyl was a different thing. They were almost begging for an accident there. They had a design flaw, which is called a positive void coefficient: At low power, the cooling lines in the reactor could flash to steam. Now that's a problem that was recognized 40 or 50 years ago. But the Soviets designed the Chernobyl reactor in such a way that as the liquid water in the cooling system flashed to steam, it *increased* the power output of the reactor. That's where the word "positive" in positive void coefficient comes from—it increased power as the liquid water flashed to steam. In all other reactor types, there is a *negative* void coefficient, so they have a tendency to shut themselves down.

I have a friend in Tri-Cities [Washington] who was involved in the design of reactors, and he personally told the Russians—and I know this happened in a number of cases—he personally told the Russians in the 1970s that their RBMK-1000 had a major flaw in it, its positive void coefficient. But the Russians just pressed on and built these things, knowing that the reactors had a design flaw that was waiting to happen. And it did.

There's a whole bunch of other things that the Russians did or did not do, in terms of violating their own safety rules, but the design flaw was a showstopper. . . .

Notes

* Zbigniew Jaworowski's most recent article on Chernobyl, "Observations on Chernobyl after 25 Years of Radiophobia," can be found here.

Articles by Michael R. Fox In 21st CENTURY

Let's Tell the Truth About Plutonium and Hanford
Winter 2010

Why Hanford's Nuclear Waste Cleanup Wastes Your Money
Summer 2004

Nuclear Is Not Inherently Costly
Summer 1994

Hanford Workers' Health and the Decline of Scientific Debate
Spring 1993

Interview with Michael Fox: Don't Bury Nuclear Waste: Recycle and Reprocess It!
Summer 1990

The Truth About Solar Energy: It Costs Too Much
July-August 1989

American Trailblazer, Mentor, and Friend

by Mary Claire Birdsong
Nov. 15, 2011

The author is one of the high school students who founded the Go Nuclear! blog (http://gonuclear.net/). Her essay is reprinted with permission.

* * *

One summer ago, I backpacked 40 miles of the Appalachian trail with my dad, sister, and dog. One of the first things I learned on this family adventure, even before a single step down the trail, was that others had gone before me. Kind, thoughtful, more knowledgeable others set packages of dried food and other necessities at the trailhead. They left notes about the condition of the trail. Mildly surprised, I proceeded down the trail, only thinking of these helpful gifts now, over a year later.

Dr. Michael Fox was born some 10 miles and 60 years separated from my birth at Fort Lewis, Washington in 1994. As a youngster, I attempted to climb the steep stone steps of Saint Martin's college, which Dr. Fox ascended many times during his years studying math and chemistry. Our paths would nearly cross in 2005, as Dr. Fox moved to Honolulu and I departed Hawaii for Georgia.

Finally, in 2010, Drs. John Shanahan and Bob Schenter introduced us, as I researched medical isotopes and nuclear energy. At the time, I did not realize Dr. Fox and I shared so much in common. I eagerly anticipated our meeting for the Go Nuclear! scientist interview project.

Because Dr. Fox's correspondence reflects such a tremendous intellect and a sharp wit, I felt optimistic that his disease that recently resurfaced would be beaten. I realize that a sharp mind, even one keenly aware of the best medical treatments, has little to do with conquering such an illness. I now understand the gravity, the impatience at times, embedded in the messages Dr. Fox shared. He offered to help me continue to tell compelling stories of people whose lives were cut short due to the lack of a medical isotope treatment. Sadly, I am reminded of the truth in the title of my keynote nuclear energy presentation last year, "Time Waits for No Man."

Mary Claire Birdsong

Dr. Fox mentioned his personal battle a few times, in the context of responding to requests for information about varied isotope treatment options or a history lesson on the isotope shortage. The dominant tone of his numerous messages to me and to others reflected compassion and perseverance, knowledge and leadership. Fox bubbled with information. The right information. Clever insight. His unique combination of professional and personal experience helped the isotope issue come alive to me, personally. Dr. Fox inspired the Go Nuclear! team because of his passion to assist others in need, even through his illness.

I hoped Dr. Fox would continue with the nuclear isotope campaign alongside Go Nuclear! for some time. With the news of Dr. Fox's passing, Go Nuclear! is profoundly disappointed by our loss.

Dr. Fox's efforts to produce domestic radioisotopes and to educate the public can continue. I am starting to learn just how. As the students of the Go Nuclear! team examine the experiences of a mentor and friend, we realize the treasures we possess.

We can still learn from advice. We can echo heartfelt words. Dr. Fox's favorite, often-repeated phrase, "Everybody is entitled to his own opinion: no one is entitled to his own facts" will live. The published papers, interviews, and numerous articles and emails remain—strategically placed at the trailhead of a nuclear medicine renaissance. Those who follow in the footsteps of Michael Fox celebrate this life of accomplishment and service.

climateconference.heartland.org/michael-r-fox/

Dr. Fox speaking at the Heartland Institute International Conference on Climate Change in July 2011 on "Global Warming Politics and the Lessons from the Nuclear Industry."

Dr. Fox was a friend and inspiration to Go Nuclear! Inc. students working to promote public understanding of nuclear energy and nuclear medicine. He assisted the students and management in learning about the many benefits of nuclear energy for electric power and nuclear medicine. Michael was one of the first seven nuclear experts the students were going to interview for professional documentary purposes and education of other students and the general public nationwide. The Board of Directors and students at Go Nuclear!, Inc. will miss Michael and send our deepest condolences to his wife, Jennifer.

Iran Has a Nuclear Power, Not a Weapons Program

Clinton Bastin was responsible for the U.S. Atomic Energy Commission (AEC)'s reprocessing of plutonium, and plutonium scrap operations, plutonium-238 production, transuranic materials processing, tritium and deuterium production for weapons programs, radioactive waste management, and related activities at the Department of Energy's Savannah River Plant in South Carolina. He was also involved in the diplomatic side of U.S. international nuclear efforts, and he was president of the Federal Employees Union at the Department of Energy headquarters.

Upon his retirement, Bastin was recognized by the DOE in a Distinguished Career Service Award, as the U.S. authority on reprocessing and initiator of total quality management and partnering agreements. Bastin served as a Marine in World War II and was an instructor in chemistry for the Marine Corps Institute.

He was interviewed on Nov. 18, 2011, by managing editor Marjorie Mazel Hecht, and this is a shortened transcript of the interview.

* * *

21st Century: As a nuclear scientist and chemical engineer, who for decades directed U.S. programs for production and processing of nuclear materials and components for weapons, you have asserted that there is no weapons threat from Iran. What is your assessment of Iran's nuclear program?

Bastin: It's a nuclear *power* program. Iran made a commitment to full use of nuclear power in 1970, ordered five nuclear plants from the United States, which promised, but later denied, reprocessing technology. This resulted in Iran's cancelling the U.S. plants and ordering them from others, which were cancelled during the revolution. But Iran has stayed committed to nuclear power. Russia is building Iran's nuclear plant, which is ready to start operation.

Because of the denial of reprocessing, Iran is reluctant to rely on others, so they wanted to enrich their own uranium, which is essential for nuclear power. That's what they're doing. Their reactor is a U.S.-type light water reactor. The Russians started building them successfully, and I think it's fine.

I believe Pakistan provided the gas centrifuges, which have had problems. I was a member of the Atomic Energy Commission's steering committee for gas centrifuge development, and I know that they are very sensitive, run at high power, and often crash. I suspect problems are related to that, and not computer hacking. Iran also has a research reactor, Osiris, which was built by the French and uses 20 percent enriched uranium, which they've been getting from others and would like to

A model of the Bushehr Nuclear Power Plant, exhibited in the Iranian pavilion of EXPO 2010 in Shanghai. The map shows the location of Bushehr.

Iran made a commitment to full use of nuclear power in 1970. The German firm Kraftwerk Union AG signed an agreement to build two nuclear plants at Bushehr in 1975, and withdrew in 1979, when both plants were partly completed. Reportedly, Germany was pressured by the United States to withdraw. During the Iran-Iraq war, 1984-1988, the Iraqis damaged the plant site in air strikes. Bushehr I was completed with Russian assistance in September 2011.

make themselves. Twenty percent is not weapons material. Weapons material is about 90 percent. David Albright has been claiming that you can make a weapon with it, but it would be incredibly difficult, and it's not a rational thing to try.

Iran Cannot Make A Nuclear Weapon

21st Century: You mean he's claiming that you can make a weapon with 20 percent enriched uranium?

Bastin: He said theoretically you could—but you could not. A gun-type weapon would require several tons of highly enriched uranium, and wouldn't make sense. Anyway, that's not a real concern under these circumstances. To make a bomb, Iran would not only have to further enrich the uranium in its existing facilities—which would be difficult to do—but after they complete further enrichment, they would have to convert the gas to metal. Iran doesn't have the facilities or experience to do that. It would take years. The most important thing to realize is that any diversion of uranium for further enrichment or anything else would be immediately detected. It's very easy to detect diversion from a gas centrifuge facility.

21st Century: Do you mean detection by the IAEA inspectors?

Bastin: Yes, they are good at it, and it's appropriate for them to do it. That's the only thing that you can count on to make sure that nobody's building weapons. The nonsense of drawings of this, or drawings of that—it's really just nonsense. ElBaradei, the former IAEA director general, recognized this and he said, during our conversation, that no, there was no threat from Iran's nuclear power program.

21st Century: You've criticized the IAEA report's claim on Iran's nuclear program as incompetent. Can you give some examples of this?

Bastin: Yes, that's what's going on right now. The IAEA director general now—I guess he's a political person, I don't really know. I've looked at some things about him, and it sounds like he's been more like a political person. I think some people come in, as in the Department of Energy, and they accept everything that people tell them. And I think he's come in, and believes all those inspectors that have seen things, have found things, that they shouldn't really—they have long trigger lists of things to look for, and it misleads them. The inspectors don't really know anything about nuclear weapons production, but they have this long list of items that are mostly normal chemical engineering-type processes, used in operations, or similar things that they'll run into.

Now, on the drawings: I'm sure in Iran that there are people who are upset about everything—you know, they have lots of problems as a country. The drawings, I'm sure, are made by people that are sort of ticked off, here, there, and yonder. Drawings for a weapons program: I had all the drawings in the Atomic Energy Commission for all weapons. Nobody ever sees those except people I want to see them. The drawings the inspectors have seen are something that somebody has played with.


یک‌چهارم گروه دانشمندان اتمی ایران خانمها هستند!

✶ چگونه میتوان‌شوهر را با آتم آشتی داد؟
✶ زنان آتم‌شناس ایران خیاطی و آشپزی را نیز باندازه‌کارخویش دوست میدارند.

✶ استاد «آزاد» بنیانگذار راکتور اتمی ایران میگوید: زنان دانشمند از پایه‌های دانش‌اتمی در ایران هستند.

Iran's nuclear program began during the Atoms for Peace program, in collaboration with the United States. In 1967, the Tehran Nuclear Research Center was established by the Atomic Energy Organization of Iran, which operated a 5-megawatt research reactor supplied by the United States.

Here, an Iranian newspaper clipping from 1968 with a photo of Iranian Ph.D. scientists in front of the research reactor. The caption reads: "A quarter of Iran's Nuclear Energy scientists are women."

21st Century: So you think that inside Iran, some people have produced drawings that these inspectors find, and the drawings are just manufactured.

Bastin: Yes. I think some scientists might have played around, but in a realistic manner. Drawings of assembling a hypothetical nuclear weapon with a missile are particularly unrealistic. I've watched U.S. nuclear warheads being attached on missiles for the U.S. weapons. You have to know what the weapon looks like. You can't build a hypothetical weapon in a meaningful way, and put it on a hypothetical missile, or even a real missile, if you don't know what everything looks like. The whole thing is stupid. It's sort of stupid, and when I say they're ignorant, it's really worse than that.

'Nobody Knew Anything'

21st Century: Is it different now in the IAEA than it used to be? Are inspectors less trained now than they used to be?

Bastin: They are trained to detect the diversion of nuclear material, and that's what they do. But they're also given a list of things to look for, that suggest weapons activities. *But the IAEA doesn't have people who know about nuclear weapons. They don't build nuclear weapons. I've never met anybody—and I've been to the IAEA many, many times—and I've never met anybody who knows anything about nuclear weapons.*

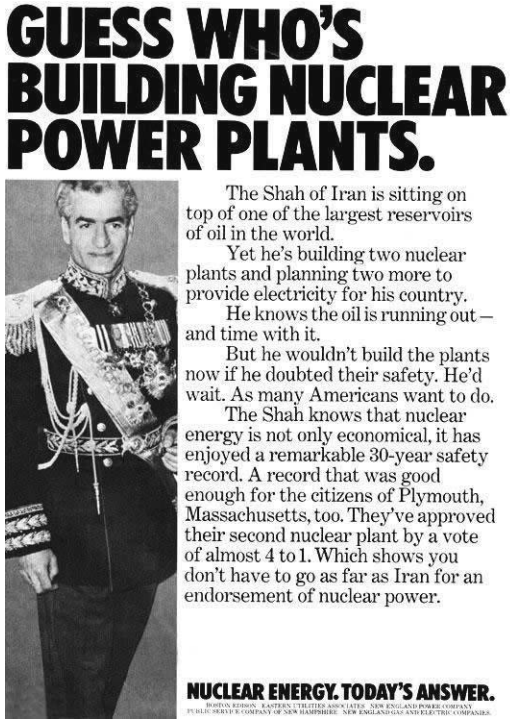
That's also the problem in Washington, D.C. For the 25 years I was there, when involved with nuclear weapons business, with interagency and other committees, nobody knew anything about what I was telling them. It was interesting at times. Once I met at the Department of State with a group involved with concerns about nuclear programs in India. I was asked to go to India and take a look and made a report. The representative from the Arms Control and Disarmament Agency said, "We've been looking at this

problem for four years, and it looks like we now finally know what we're talking about."

That's the reality in the U.S., the reality in the U.N., and the reality almost everywhere—except perhaps Russia and China. I spent a week with the Minister of Nuclear Energy in Russia and a lot of other leaders, and I think they know more about what they're dealing with. And I imagine that China does too. But our system is dysfunctional. You know, the Department of Energy has lost the ability to produce nuclear materials, because they didn't really know about things. It's really awful.

21st Century: That's not comforting—

Bastin: Yes! Iran is just one of many that I've focussed on, and I'm very much interested in it because it has awful potential consequences if somebody attacks them.



The Shah planned to build 23 nuclear plants. This is a newspaper ad from the 1970s by American nuclear-energy companies.

21st Century: Absolutely. I know that you wrote a detailed letter to the Israeli Prime Minister, Netanyahu, about Iran's nuclear weapons, or lack of such. Have you had a response?

Bastin: Yes, let me elaborate on this: I started three years ago with the Consul-General of Israel in Atlanta. I sent e-mail messages, and in March 2009, we had detailed discussions. I'm sure everything I said was sent to Tel Aviv, and I feel 100 percent certain that he knew I knew what I was talking about.

I sent some of the information to President Obama, and I got a call from the FBI office in Atlanta saying that they wanted to meet with me. The White House referred me to the FBI weapons of mass destruction unit, and they asked to meet with me to verify that this information was valuable. After my meeting with the Consul-General, there was an article about a statement made by Netanyahu to Ahmadinejad of Iran that Iran's nuclear programs for weapons are meant to kill Jews, just like Hitler's in World War II.

I sent an e-mail message to Netanyahu that Germany didn't have a nuclear weapons program in World War II; they had a nuclear program, but their scientists never focussed on the idea of a nuclear explosion. That's from the book *Alsos* by Samuel Goudsmit, who was the principal scientist for the Alsos (Greek word for Groves), the project that looked into nuclear work that Germany was doing. When German scientists found out about the U.S. nuclear weapons, they went into shock because they couldn't believe that the U.S. scientists could do something that they had never been able to figure out at all. Fascinating book!

"We acknowledge receipt of your e-mail to Prime Minister Benjamin Netanyahu, the contents of which have been duly noted"—was the response to my information to Prime Minister Netanyahu. They didn't say they were going to do anything, but I remember, after one particular message, the next thing I heard from the White House, was that Israel had stopped making threats. The White House information said that it was because of trouble with the gas centrifuges, but my feeling is that they knew that the information that I was providing is sound. And so did the FBI.

I've written to the Senators from Georgia, and all I get is the rhetoric and folderol and so forth, which doesn't have a damn thing to do with whether Iran can make a nuclear weapon. They cite all the things the inspectors say. The IAEA inspectors were saying the same things that they were saying when ElBaradei was there, but ElBaradei recognized that they were not valid concerns. They were not then, and they are not now.

Don't Listen to Know-Nothings

21st Century: So you think ElBaradei had more sense about the situation?

Bastin: He had more sense about the reality of things in this situation. I enjoyed him and liked his approach. He got the Nobel Peace Prize. I was union president at Department of Energy headquarters, and had interaction with secretaries of energy. Most of them would get information from the know-nothings and go with the flow. But I could sense with a few that they were interested in getting really good information. And I think ElBaradei was one of those.

21st Century: Well, it's a good quality not to listen to the know-nothings. One of the things you noted in the various things you've written is that most of the so-called scientific experts quoted by the press are not nuclear weapons experts at all, but ideologues with an agenda, like David Albright whose scare statements—

Bastin: David Albright and his Institute for Science and International Security. I know him and I know he has an agenda. I'm interested in taking care of this business, and it's got to be done by people who know what they are doing. Dave does not. I met Dave for the first time after I had testified and shot down something that Representative Markey of Massachusetts was trying to do. But then when I was active in the nuclear weapons freeze campaign, I commended Markey for his support for this campaign.

21st Century: This must have been in the '80s.

Bastin: Yes, '87, '88—I'm not sure exactly. The session was about a GAO

[Government Accountability Office] review of a report that I had determined was non-valuable to the Japanese for reprocessing. The GAO review and testimony to Markey was by a nuclear engineer who said that it was valuable for reprocessing.

I was in Japan a couple of months after it was provided to the Japanese, who said it was worthless. It was done by Bechtel, and right after the testimony, I was on an elevator with a vice president of Bechtel and apologized for assaulting the quality of Bechtel work. He said: "Apologize nothing. You did a great thing. You got us off a real nasty hook." And they offered me a job after that. I didn't take it.

21st Century: What are some of the specific technical areas that you think people are being misled on by the so-called experts?

Bastin: The one I most emphasize is the failure to recognize that a nuclear weapon cannot be made of gas. The gas must be converted to metal, a difficult and very dangerous process because of the high potential for a critical accident (like a nuclear reactor without shielding) that would kill anyone in the room or nearby.

Iran has no experience with this process, and no facilities to carry it out. Assembly of metal components with high explosives is even more dangerous, because a nuclear explosion would kill those within half a mile. Because of the difficulties, Iran would need 10 to 15 years to make a weapon, after diversion of low-enriched uranium, which would be immediately detected by IAEA inspectors. Iran's leaders know that their facilities would be attacked following a diversion. So they not only wouldn't be able to build a weapon—

21st Century: They'd lose a lot of their country—

Bastin: Okay, so if nobody bombs, and 15 years later, Iran has a nuclear weapon. Israel has 400 nuclear weapons, tested and deliverable. What kind of idiots would make weapons under those circumstances? It is absolute stupidity to believe that they are that idiotic. They are not.

Iran is interested in nuclear power, and nobody seems to appreciate that, because Iran has oil. Iran knows its oil is not going to last forever.

IAEA

Former IAEA Director General Mohamed ElBaradei addressing a press conference in Tehran at the Atomic Energy Organization of Iran in October 2009.

21st Century: And that decision was made way back in 1970, with the U.S. support at that time.

Bastin: That's right. The U.S. State Department promised Iran all the technology needed. But the reprocessing technology promised to Iran had failed in U.S. programs. I'd been transferred to Atomic Energy Commission headquarters to deal with those failures, and was given the staff paper to review for the transfer of technology that would be provided to Iran.

I recommended that the reprocessing technology not be provided, and the AEC denied the transfer. That led, partially, to an early breakdown of relations between the U.S. and Iran, and—in my opinion—the oil embargo of 1973. I remember reading about Iranian oil ships that were at sea during long periods of time during that embargo.

21st Century: You've mentioned in your writings that similar unfounded claims about Iraq led to the U.S. decision to invade Iraq, which cost hundreds of thousands of lives and a trillion dollars plus, and now, instead of us repeating that situation, you've called for negotiations based on mutual interest and an end to foolish rhetoric and hostile actions. What are the prospects for this, and what kind of support have you gotten from the nuclear community for your campaign?

Bastin: Good question. After U.S. officials determined there was a weapon threat in Iran, *Nuclear News*, the monthly magazine of the American Nuclear Society, published my letter that the idea that Iran was a nuclear weapon threat belongs on the same shelf as the notion that 1 rad of radiation to 1,000 people would mean the death of one of those people—the linear no-threshold hypothesis.

The *New York Times* published two of my letters, and the *American Legion Magazine* published my letter, but I really have not had much support from the nuclear community, nor from U.S. officials. I've given talks to community groups in this area, and I've sent the text out, but once things start going out of control, it's hard to get them back.

21st Century: It's true, but you have to keep it up.

Bastin: Yes, I'm going to keep working on it. I do what I can, I hope. And I was really overjoyed with my efforts with Israel, which, in my opinion, resulted in Israel ending their threats to Iran's nuclear facility. But that's picked back up again. People in Israel don't understand the situ-

ation. And there are few people who understand it here, or anywhere.

21st Century: Let's try and get your interview out to more people on the LPAC-TV.

Bastin: That would be great. I appreciate your doing this, and I hope it is of value.

21st Century: I think so, and for the reason that all of the so-called experts in the press, as you have pointed out, are really not experts in this technical area. You are.

Bastin: I mentioned to David Albright that Pakistan's gun-type weapons require about 50 kilograms of highly enriched uranium, and that the numbers that appear in the newspaper are probably high. He said Pakistan's weapons are implosion-type, not gun-type, and have solid metal components. I said, "Wait a minute, David, you know better than that." I laughed. He got mad and cut me off, and we are no longer colleagues.

An implosion-type weapon is a hollow sphere of plutonium or uranium metal, surrounded by high explosives with detonators on the outside. The explosion squeezes the nuclear material into a tiny ball, which becomes supercritical and explodes with great force. But explosives will not squeeze solid metal. David's comment wasn't just technically invalid, it was stupid.

A gun-type weapon consists of two solid chunks of metal, one a cylinder, the other with a hole the size of the cylinder. The cylinder is driven into the other chunk, and boom!

21st Century: But it takes a lot more of the enriched uranium.

Bastin: The implosion weapon is a hollow sphere or spheroid, surrounded by explosives, with detonators on the outside, all contained within a strong structure. So all the force squeezes the hollow sphere into a tiny ball, a very small and very highly critical mass, and it makes a big explosion. And you can't do it with solid metal, because it won't squeeze.

21st Century: Was your point with Albright that Pakistan did not have the technology to do an implosion-type weapon?

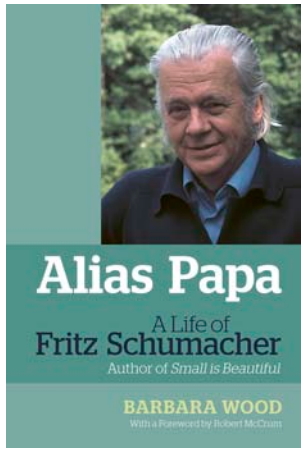
Bastin: Yes. They are much more difficult to make, have to be tested prior to use. The Manhattan Project had to test the implosion weapon at Alamogordo, before it could be declared usable, whereas the gun-type weapon was used at Hiroshima without any testing. The implosion-type is a much more sophisticated, complex weapon.

The Israeli weapons are the implosion type, but are of French design. The French helped the Israelis with their weapons program. India's is also an implosion type, but it took them a long time, and they've got an awful lot of very, very smart physicists and others in India. It took a long time, and I understand that they had some failed tests before they were successful.

Now, North Korea—I'm not sure what they have. Because they have a plutonium system. The first test was a dud, the second test apparently was successful. Whether they actually had a plutonium implosion weapon, I don't really know. Maybe Pakistan loaned them something. It's hard to know.

Small and Deadly: The Empire's Green Guru

by Marjorie Mazel Hecht



Alias Papa: A Life of Fritz Schumacher, Author of Small Is Beautiful
by Barbara Wood
Dartington Hall: Green Books, 2011
Paperback, 299 pp., $22.95

Fritz Schumacher was a crucial force in shaping the post-war ideology that has almost destroyed the United States and has chained the Third World to poverty. He developed the post-World War II monetary system, attributed to John M. Keynes, which was a subversion of the ideas fought for by Franklin Delano Roosevelt and Harry Dexter White. He introduced a corporatist, actually fascist, conception of "worker control" for Britain's coal industry, and championed the zero-growth, small-is-beautiful ideology, with which the oligarchy has continued its world dominance by denial of science and technology and by population reduction.

How did Schumacher (1911-1977) come up with these ideas? What forces shaped him into such a destructive figure for the Third World?

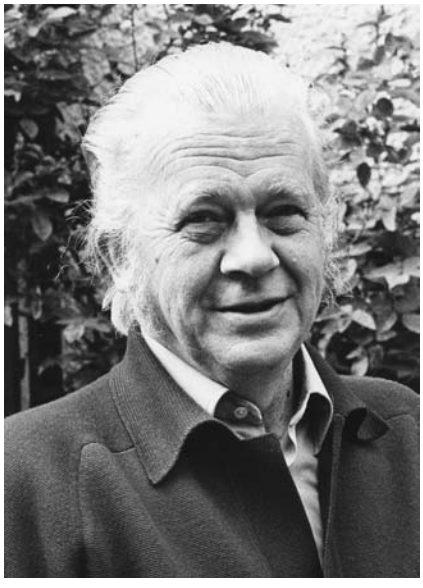
This biography, written by his eldest daughter in 1984 and newly reissued for the centenary of her father's birth, answers these questions. The author, Barbara Schumacher Wood, tells the story of her father's life, using his own words and those of family, friends, and political associates, in an engaging manner, so that the reader can follow his bizarre philosophical twists and turns and get a sense of the man's descent into smallness.

Elements of Schumacher's philosophical journey were familiar to me, having observed such transformations during the countercultural shift of the 1960s. Schumacher successively embraces atheism, Marxism, socialism, organic farming, Buddhism, mysticism, psychical research, astrology, meditation, and, finally, Roman Catholicism.

Early Years

Ernst Friedrich Schumacher, known as Fritz, was born in Bonn, Germany, into a cultured and well-known family. His father taught economics, and was an advisor to the Crown Prince. The Schumacher's moved to Berlin in 1917, where his father became Professor of Economics at Berlin University. Times were hard in Germany in the aftermath of the Versailles Treaty and even the relatively well-to-do Schumachers went hungry.

In school, Fritz was bored at the slow pace, and played tricks on teachers he looked down upon. After a year at Bonn University, he went to England for a semester and met the economist J.M. Keynes, whom he admired greatly. He returned to England in 1930 on a Rhodes scholarship to study at Oxford University, and there met many of the influential people who were to help him in later years. He made many English friends, although he didn't much like student life, and was criticized, quite rightly, as a supercilious know-it-all.



Fritz Schumacher: The man whose mind composted, as it descended into smallness.

His thesis topic was on the London gold market, and after two years at Oxford, he decided to go to Columbia University to study the New York banking system. He loved New York, and the "intellectual freedom from Europe." In addition to Columbia academics, he worked at Chase bank as a "rotator," spending time in every department to learn every aspect of the business. (He had spent a summer at M.M. Warburg in Berlin, doing the same rotator job.) His outlook was that practical field experience was more important than the academic side.

In both England and New York, the self-confident Fritz was often called upon to speak about Germany's political situation. At first, he defended German nationalism, explaining that the hardships of the Versailles Treaty had led to support for National Socialism, and rationalizing why Germans resented Jews. But by March 1933, he wrote to a family member, "We no longer have right on our side."

The news from Germany was deeply troubling to him, but he decided to return home in 1934. There he had a well-paying job with friends in a trading syndicate, but he found life with Hitler's National Socialism to be more and more intolerable, as he saw his Jewish friends forced to flee for their lives, and police state measures restricting thought in general. Against the wishes of his father, he chose to return to England with his new

wife, and was fortunate to have a job offer, managing the investments of the Unilever CEO in London. His daughter writes that the main reason he left was his opposition to the Nazis' "abandonment of truth."

A Smallness of Mind

When did Schumacher come to think that small was beautiful? It was early in his career as an economist, in 1934, when he proposed to solve the devastating unemployment in Germany, by having the state subsidize employers to get rid of machinery and technology and thus employ more workers, at a state-supported salary, to produce manually. This was dubbed "Fritz's World Improvement Plan," and it met little support. However, it shows his way of thinking about people, technology, and progress. Progress, in the form of technology, was seen as the enemy. Science—so well developed in his homeland—was not part of his education or his mindset.

Fritz settled in London with his new bride, Muschi (Anna Maria Petersen), who was reluctant to leave her extended family, but deferred to the wishes of her new husband.

As an enemy alien in Britain, Fritz had to move out of the London area. His publishing friend David Astor[1] installed the Schumachers in a country cottage on a family estate as a farm laborer, but in 1940, Fritz was interned with 1,400 other enemy aliens at Prees Heath in Wales, under difficult conditions. At first he was sick and depressed, but he and his Marxist tent-mate, journalist Kurt Naumann, soon organized the camp into a more hygienic, ordered place.

His first real "education," his daughter says, came from Naumann, and Fritz came out of the camp (through the lobbying of his friends in high places, like Lord and Lady Astor) "invigorated" and a Marxist.

He was released back to his farm, and its hard manual labor. Meantime, the new Marxist continued his intense study of Marxism and worked out a peace plan, centered on an international balance of trade. He advocated a multilateral, as opposed to bilateral, world trade organization, with a central bank and clearing house. Fritz sent his proposal to Keynes, whom he idolized.

The Rhodes Trust

Schumacher as a Rhodes Scholar, 1930. His reputation at Oxford was as a supercilious know-it-all.

The Schumacher Society

The author, Barbara Schumacher Wood, Fritz's eldest daughter. Schumacher had eight children, four with each wife.

The centenary logo of Practical Action, the group Fritz founded. It still pursues appropriate technology, as do the myriad United Nations and non-governmental organizations who copied the poverty-sustaining Schumacher philosophy.

Keynes told him that he was thinking along the same lines. But when Fritz wanted to publish his proposal, Keynes urged him to hold off, writing: "I must leave the matter to you. But what would help me most is that you should simply let me see your ideas on this matter and have a talk next time you are in London, but put off actual publication for the time being."

When the Oxford Institute of Statistics, where some of his former internment friends now worked, had an opening, Fritz applied, and got the job, moving to Oxford in March 1942, and leaving his wife and children behind on the farm. At Oxford, his elite connections expanded. He had met the head of the Chatham House Royal Institute of International Affairs at Keynes's house, and he entered into these high-level circles, putting forward his trade proposal.

Fritz's plan was widely discussed. The Chancellor of the Exchequer liked it, so Fritz thought it was time to publish in the May edition of an economic magazine—but it was too late. Keynes published his proposal in April as "Proposals for an International Clearing Union." Noting that his proposals "lay no claim to originality" was the closest Keynes came to acknowledging Schumacher's ideas. The Keynes plan could have been called the Schumacher plan.

In this period, Fritz joined a Marxist book club and became a socialist, supporting state-run enterprise. He completely rejected religion, in particular Western Christianity, identifying with the views of Nietzsche. He moved into social-fascist Fabian circles, and into journalism (His old Oxford friend, David Astor, was the editor of *The Observer.*

He wrote easily on a variety of subjects to supplement his meager income, and became well known and sought after as an author, speaker, and advisor, including to the government and Parliament. The self-confident Fritz could compellingly discuss his current view, no matter how contradictory it was with his previous views, or how bizarre.

'Invisible Hand' Morality

At this point, Fritz argued that morality didn't exist—everyone has his own view. His daughter describes the emotional change in Fritz, as he grappled with the problem of unemployment, working with Lord Beveridge on a plan for Britain after the war. For Fritz, his daughter writes, it was necessary to resort to Adam Smith's "invisible hand," but this time as a way to make the workers think that they had a role in running the industries that they were toiling in, by participating in committees and councils. State-run industries would require that workers believe that there was some equity in income distribution.

As Fritz wrote about this concept: "the worker's loyal support can be obtained only if he can feel that a more moral principle governs distribution than the principle of ownership. I have the feeling that the necessary measures will be adopted only if justified by reference to more than temporary expedience: if justified by reference to a moral principle."

Fritz became a British citizen in 1946,

1 David Astor's infamous, super-wealthy parents, Lord and Lady Astor, were members of the Hitler-supporting "Cliveden set" in Britain during the War. (Cliveden was the name of the Astor estate.) His mother, Nancy Astor, was a American from the South and a racist. David, well known as a liberal champion of the underdog, however, claimed that his parents had protested to Hitler about his treatment of the Jews.

Videograb of David Astor (left), editor of The Observer*, and one of the many elite friends who aided Fritz in his journey inward to smallness.*

and then became a member of the team of the American Bombing Survey of Germany, returning to his homeland in the uniform of an American Army colonel, with the task of figuring out why the bombing of industries had not damaged Germany's military strength.

After a few months, his wife and family joined him, and he worked full-time on economic recovery plans. His socialist plan for Germany involved the nationalization of major industries. He put coal at the center of his plan, for he correctly saw that energy was key to recovery, and that Germany had plentiful coal. His plan was not adopted, and in later years, his daughter writes, he became disgusted with Germany's "fat cat" industrialists.

His other economic plans (for European cooperation and a payments system) were also rejected, and when he was offered a job with the British National Coal Board as economic advisor, he happily returned to England in 1950, where he and his family settled down in a Surrey house with a four-acre garden.

Compost

Here, Fritz became immersed (literally) in compost, and an active member of the Soil Association, led by Lady Eve Balfour, a pioneer of organic farming. He passionately gardened, milled flour, and baked his own bread.

At the same time, Fritz threw himself into the problems of the nationalized coal system, and into deeper questions of the spiritual nature of man. As he delved into Indian and Chinese philosophy and religion, he underwent a fundamental change in thinking, viewing intellectual strength and expert learning as an impediment to the primitive inner life. He was transformed.

He joined the Society for Psychical Research, and, as his daughter describes it, "From saying that no intelligent man should believe anything that could not be proved, he now took the opposite view that nothing should be dismissed because it could not be proved."

The transformed Fritz joined a G.I. Gurdjieff mystic spiritual group, studied flying saucerology, began yoga, and very seriously investigated his and his family's horoscopes. He threw off his "intellectual baggage," as he put it. His daughter attributes some of this abrupt change in Fritz to the emotional shocks of the postwar years spent in Germany, and to his immersion in the soil. In truth, his mind composted.

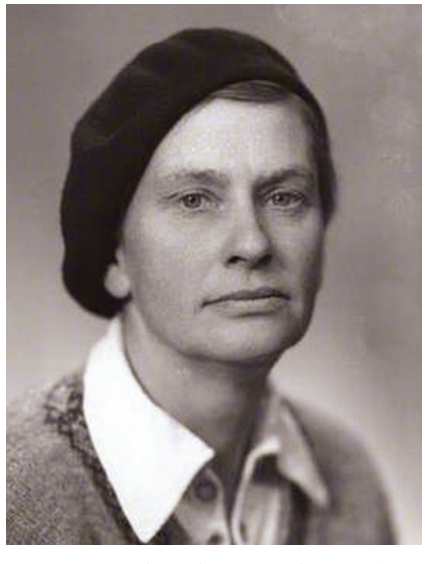
Fritz's transformation continued. His coal work led him to avow that energy was key, and that man was depleting non-renewable energy resources, "nature's larder," at "breathtaking speed." Instead of looking outward and upward to new breakthroughs based on man's creativity, Fritz continued his journey inward, to the small, studying the smallness in Gandhi and Buddhism, at the expense of the broader views.

The Burma Road Inward

His journey inward picked up speed, when in 1955, Fritz was given a three-month unpaid leave from the Coal Board to go to Burma as an economic advisor, financed by the United Nations. There he was enthralled by the "happy," colorful, and simple life of the poor in Burma, and he saw Western civilization as a destructive force. He described his economic team mates as "American Materialists" who have done "a lot of damage," which he strove to counter with his own form of Buddhist economics, a "middle way."

Fritz's economic plan for Burma recommended that the government ditch its development plans and its Western advisors, and stick with the renewable resources of forest and agriculture—no industry, chemicals, or metals. "It is already certain beyond the possibility of doubt," he wrote, "that the 'oil, coal, metal economies' cannot be anything else but a short abnormality in the history of mankind—because they are based on non-renewable resources and because, being purely materialistic, they recognise no limits. The new economics would be a veritable 'Statute of Limitation'—and that means a Statute of 'Liberation.' "

Fortunately, the Burmese government ignored Fritz's economic reports. Meanwhile, Fritz immersed himself in Buddhist meditation, spending weekends at



Lady Eve Balfour, founder of the Soil Association, whom Fritz greatly admired. Through the Soil Association, Fritz immersed himself in compost.

a monastery. He returned to England as a Buddhist, and began an intensive study of Buddhist history for four years. His newfound insights were promoted in a series of lectures on "what is man,"(perhaps a more accurate title would be "Fritz as man") which included many of the ideas made infamous in his later book, *Small Is Beautiful.*

Coal, Statistics, and Serpents

By 1960, as oil from the Mideast became available, the continued existence of the coal industry was under threat. Fritz argued that it was wrong to become dependent on oil from such an unstable region of the world, that coal was of continued importance for Britain's economy, and that once shrunk down, the industry would not be able to gear up again.[2] But he lost this fight with the Coal Board.

He thought about leaving the job, but his wife's illness and subsequent death from cancer postponed any decision. And then, within a few months, Fritz remarried, this time to the young Swiss "mother's helper," Verena Rosenberger, Vreni, who had been taking care of the children and later nursing Fritz, who was injured in an auto accident.

The appointment of a new Coal Board chairman, Alf Robens, who agreed with Fritz and was willing to fight for a coal policy, was also decisive in keeping him on the job. Both he and Robens expected that the newly elected Labour government of Harold Wilson in 1964 would follow its pledge to keep the coal industry at its 200 million ton/year target. That didn't happen. Wilson continued to expand oil imports, shut down coal mines, and, a worse crime in Fritz's view, Wilson pursued a vigorous nuclear program.

Nuclear was anathema to Fritz, not just because it threatened the coal industry, but because it exemplified to him what was wrong with modern society. Already in his 1955 work on Buddhist economics, he had written of the "violence against nature" of nuclear: "Atomic energy for 'peaceful purposes' on a scale calculated to replace coal and oil, is a prospect even more appalling than the Atomic or Hydrogen bomb. For here unregenerate man is entering a territory which, to all those who have eyes to see, bears the warning sign 'Keep Out.' "

Fritz was enamored of Burma (now Myanmar) in 1955, idolizing its poverty as true happiness. Here a 2007 street scene in Yangon, from flickr.com.

In 1965, Fritz came under government attack when he expanded on this view in a public lecture before the Clean Air Society, calling nuclear the ultimate and dangerous pollution. Like most of today's anti-nukes, he had no understanding of atomic science, and a hatred of the technological advances that make human progress possible.

At the Coal Board, Fritz was given charge of the Statistics Department, and from that position he used statistics to back up his policy proposals. To his credit, he figured out that the pits with the most accidents, above and below ground, were not those with geologic faults, as commonly assumed, but those where safety standards were lax.

(One personal application of this knowledge, as described by his daughter, was selfish. In Japan, where he and other Coal Board members were visiting, he sat in a Japanese garden, while the rest of the group went underground. When later asked why he didn't go with them, he replied that he had looked at the safety statistics and concluded that it was "not a risk I ought to take." Why not tell his friends of this before they descended? One of the men came up with a bandaged head—and two weeks later an explosion at that mine killed 450 miners.)

Fritz also proposed a reorganization of the mining industry, giving local decision-making power to lower levels of the bureaucracy, with the rationale that this would increase performance. This was not a bad idea, but behind it was Fritz's idea of "the Middle Axiom." Boiled down to its essential, this Buddhist bowdlerization involved telling people what to do without appearing to command them to do it—an updated version of the invisible hand.

To his family, his daughter writes, he put it this way, "You must be as cunning as a serpent and as innocent as a dove."

Small Talk Goes Big

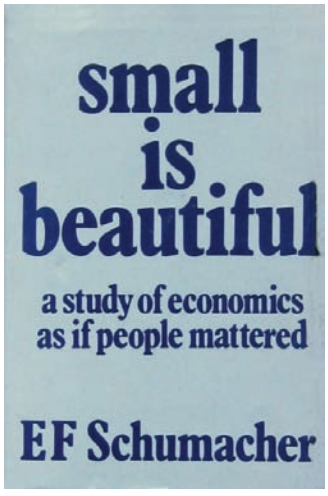
In the last chapters of her biography, Barbara Schumacher Wood briefly reviews her father's fascination with the smallness "solution" to poverty in the developing sector. He worked with India's Bhoodan movement and J. Narayan, advising them to eschew the Western concept of economic growth and to develop local crafts and agriculture. Factories were to be avoided, he said, because they would ultimately drive the population into more poverty by mass-producing goods and putting local craftsmen out of work.

His was Marx's view of English capitalism. How different from the successful American System of Political Economy, of the 19th Century, which promoted a "Harmony of Interests," where labor

2. The irony of Fritz's ardent support of full coal power, while attacking the use of non-renewable resources is not discussed by his daughter.

and capital would dramatically raise general living standards in the United States (and also in Germany, Japan, and elsewhere, where it was adopted).

It was on a 1962 extended visit to India that Fritz came up with the idea of "intermediate technology," what later was institutionalized as "appropriate technology." This meant a simpler, non-capital-intensive technology that would *slightly* improve on the primitive technology being used. In Britain, he teamed up with the willing African Development Trust, to spread his "appropriate technology" throughout Africa as well.



"As if people mattered?" The 1973 edition of the book whose prescriptions are still killing people.

But officialdom had not yet recognized his intermediate technology as a solution, as Fritz found out when he presented a paper on his plans to an economic conference at Cambridge University in 1964 to much criticism. The Minister of Overseas Development also received his idea coolly.

The break came in August 1965, when David Astor's *Observer* featured Fritz's article on intermediate technology, titled "How to Help Them Help Themselves." This was the spark that fired up support for Fritz, and his new organization, the Intermediate Technology Development Group, which later changed its name to "Practical Action." All sorts of subgroups were set up to devise "modern" but simple technologies, suitable for developing countries, which were to be denied access to advanced technologies because of the ideology of Fritz et al. that held Western materialism to be bad.

As his daughter notes, this was the "first world improvement plan" of Fritz to spread like wildfire internationally.

Fritz, now a very public intellectual, was deluged with speaking requests and began travelling extensively, having been given the freedom of a three-day work week at the Coal Board. At this point, his wife, Vreni, realized that she needed to fill the hole left in her life when Fritz was travelling, and she began attending Mass and taking instruction at the local Catholic Church, subsequently becoming a Catholic. Around the same time, the author says, she (Barbara) also investigated Catholicism and joined the Catholic Church. Fritz supported both of them, but was not yet ready for this move, he said, because it would shock his mother.

At the invitation of their respective Presidents, Fritz visited Tanzania and Zambia to give development advice—intermediate technology and limited cultural "uplifting" of the rural population. Then he was invited to South Africa, where his advice was to give the black homelands separate development. He did not like Apartheid, but he thought that any other system of development would have the whites in charge and the blacks oppressed.

Fritz was unprepared for the blowback of his "separate development" remarks, both in Africa and in London. His daughter writes that he wasn't thinking of the political implications, but only of how to help the most people.

In 1970, Fritz formally retired from the Coal Board, staying on as a paid consultant, and he began to write and to tend his neglected garden. For his 60th birthday, he refused a gift from the family of a small tractor, calling it too high a technology for his garden, and instead he bought a battery-operated wheelbarrow. He also became president of the influential Soil Association, and, in the middle of writing *Small Is Beautiful,* he joined the Catholic Church. He wrote of this:

"[I]t has taken me a long time to discover why religion has split up into so many different religions: it's so you can choose the one that is most practical for you. The most practical to me was the Roman Catholic version of Christianity, and now I am relieved of such totally off-

beat questions as: How could something incredible, like the human being, have come about by an accidental combination of atoms?"

By 1973, *Small Is Beautiful: A Study of Economics as If People Mattered* was at the publisher. Fritz's comment when the book was finished, his daughter writes, was "Brilliant" and "It comes as a complete surprise to me that I have written this marvellous stuff." His audience agreed—book sales took off exponentially, as did speaking invitations. The next year, the Queen awarded him the CBE, Commander of the Most Excellent Order of the British Empire, and honored him with a private dinner with Prince Philip and a luncheon with her.

Rex Miller/Full Belly

From solar cookers and compost privies to double-pot "refrigerators": These are the limits of technology that Fritz and friends allow in the Third World. Shown are the hand-cranked nut sheller, the solar cooker, and Practical Action's "zeer pot fridge" (two clay pots with sand in between and a damp cloth on top).

Gurudom

Amid the many further honors and accolades, his daughter says, her father was transformed into a "guru figure." This was especially true in the United States, where California Gov. Jerry Brown used Fritz's philosophy in his election campaign, and where the youth, battered by the counterculture assault and disillusioned with the Vietnam War, found solace in Fritz's "back to nature" anti-technology ideas. On a later tour of the United States in 1977, crowds of thousands attended his lectures, and President Jimmy Carter, a co-small-thinker, invited him to the White House.

Later that year, Fritz Schumacher died of a heart attack on a train in Switzerland. His legacy lives on in the treadle pumps, clay pot "refrigerators," and other so-called appropriate technologies still being peddled in the developing sector, and in the destructive mindset that believes it is helping humanity by stopping science and technology. His life journey, as presented by his daughter, who works to continue her father's mission, is essentially one devoid of the beauty of science, as well as of classical art and music.

A gifted man, profoundly self-absorbed, takes a wrong philosophical turn early in life, ignoring the creative ability that is mankind's birthright, and instead choosing the small and practical. Rather than moving society to new and higher platforms of development and extending man's potential, Fritz devises new ways to make poverty in the Third World more acceptable to the West. His international economic plans involve centralized international bodies to manage trade and finances; but he proposes decentralization for everything else. He advocates divesting the West of advanced technology for sustainability; and he wants to divvy up the inevitable austerity, by reducing wages (equitably, of course), and redefining happiness as the simple life.

And so, this successful motivational speaker does the practical work for the Malthusian Prince Philip, Lord Bertrand Russell, and the rest of the oligarchy, promoting limits to growth and anti-technology policies that are proven to spread starvation, disease, and death—all the while claiming to help the people whose deaths will be caused by his policies.

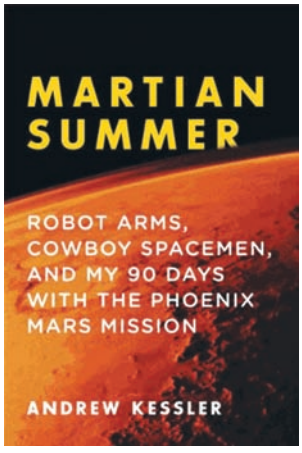
It is therefore no surprise that Britain's present Cameron government is avidly pursuing Schumacher's ideas, which are so well suited to a decentralized, deindustrialized, despondent population and top-down dictatorship—fascism with a human face.[3] One senior policy advisor to Prime Minister Cameron, Rohan Silva, told a reporter for *The Observer* in March 2011, that the government was seeking to "break-up large-scale institutions into smaller elements. Smaller elements will enable people to choose a human scale—with an emphasis on the environment and well-being. There is more to progress than narrow economics, and more to life than GDP. We will be the first government to implement a measurement of well-being."[4]

3. "Fascism with a human face" and fascism with a democratic face" were the terms used by David Rockefeller's Trilateral Commission in the 1970s to describe its corporatist policies for the United States. Trilateral members made up most of President Carter's cabinet in 1976.

4. "E.F. Schumacher: Cameron's Choice," by Robert McCrum, *The Observer*, March 27, 2011.

Keep a Sense of Humor, While Exploring Mars

Martian Summer
by Andrew Kessler
New York: Pegasus Books, 2011
Hardcover, 352 pp., $27.95



Sending a spacecraft to Mars is hard. Landing it safely is even harder. Keeping the spacecraft's instruments working through bone-chilling temperatures and dust storms, and returning data to anxious scientists back on Earth, is harder, still.

Planetary scientists are serious people. They spend years, if not decades, designing a mission that will answer critical questions, writing proposals, designing and developing the scientific instruments, testing and retesting, and waiting to launch. There's nothing funny about Mars.

When NASA launched the Phoenix mission to Mars, on Aug. 4, 2007, as its name implies, it was the resurrection of a previous mission to Mars, which had failed. No one on the Phoenix team had to be reminded that two thirds of all of the U.S. and Soviet/Russian missions that have been sent to Mars have failed.

Phoenix was the first spacecraft successfully deployed to the arctic north polar region of Mars. It was expected to last only 90 days, before Martian weather would freeze the lander for eternity. And, as an added experiment, the Mars Phoenix mission team decided to allow a reporter—an outsider—access to the mission from the inside. For author Andrew Kessler it was a dream come true—to spend the Summer of 2008 on Mars.

Inside the Mars Mission

Throughout the 90-day primary mission of the Mars Phoenix polar lander, Kessler reported every (Martian) day (24 hours, 37 minutes) to Mission Control at the University of Arizona. He sat in on science debriefing and planning meetings, and talked and schmoozed with the scientists.

Kessler's book describes the trials and tribulations and frustration of managing a spacecraft tens of millions of miles away. Invariably, some equipment does not function as designed. Mars, itself, comes up with surprises, such as sticky soil that would not budge from a scoop, or be dropped into an oven for chemical analysis. And just because they all see the same data, it does not mean the 130 scientists on the mission agree on what the data mean.

Then, there are the pressures from the space agency, which has expectations for mission results, and is paying the bills. And, if things go wrong, a Congress, which holds the purse strings, and expects accountability.

In retelling his experience through this densely packed summer on Mars, Kessler shares his sense of humor. So while the reader is learning about Mars, about why it is important that Phoenix found perchlorate, about how scientific pursuits such as these long-distance planetary missions are done, every few pages produces a chuckle.

One should not be discouraged by the numerous acronyms, or try to remember what each scientific instrument does. This is a story about the scientists, not the spacecraft.

This book would make a great gift for those excited about not only the results, but the challenges, of space exploration.

Near East Artifacts in Ecuador

by Charles Hughes

Atlantis in the Amazon
by Richard Wingate
Rochester, Vt.: Bear & Company, 2011
Paperback, 168 pp., $16.00

This book is a controversial account of the discovery of ancient artifacts of Near Eastern origins, in South America. The author claims that the described artifacts are proof of the existence of a colony of the lost civilization of Atlantis, located in Ecuador, in western South America.

Reader beware: Author Richard Wingate is strongly opposed to nuclear energy technology, a belief he presents throughout the book. He also states that high-technology civilizations existed in the remote past, and became extinct because of nuclear warfare. Therefore, his ideas have a pronounced green tinge, bordering on the flaky. That said, his description and photos of the artifacts are most interesting.

Wingate tells the story of a Catholic priest from Italy, of the Salesian order, who migrated in the 1920s to the Ecuadorian city of Cuenca. Father Carlo Crespi was deeply interested in science, and held degrees in archaeology, engineering, and other disciplines. He used his personal fortune to build a high school and museum in Cuenca.

Cuenca is historically significant, as it was the capital of the northernmost extension of the Inca Empire. The city has extensive building ruins from that period, and possibly older, predating the Incas. One such building possesses a true arch with a keystone.

Throughout his life and ministry (Crespi died in 1983), the priest purchased unusual artifacts brought to him by local inhabitants. Eventually he collected thousands of items, many obvious fakes of modern manufacture.

Genuine Artifacts

Barry Fell, the great epigrapher who successfully deciphered many ancient scripts,* heard about the Crespi collection of artifacts and investigated a square bronze artifact covered with what appeared to be letters of an alphabet. Fell declared that the script was similar to a script discovered in Cyprus and he produced a tentative translation. This artifact, found in Ecuador, has a high probability of being genuine, since no knowledge of this script existed prior to Fell's work.

One of the Crespi gold plates with writing.

When Crespi died in 1983, his collection was dispersed. The most interesting pieces were purchased by the state of Ecuador for the Cuenca Museum, for the equivalent of half a million dollars.

Wingate's point here is that Crespi's artifacts may indicate contact between the Middle East and South America in ancient times. The book is illustrated profusely, including color photos of the controversial metal plates which Fell deciphered. Although not quite Atlantis, as Wingate desires, this discovery may prove important.

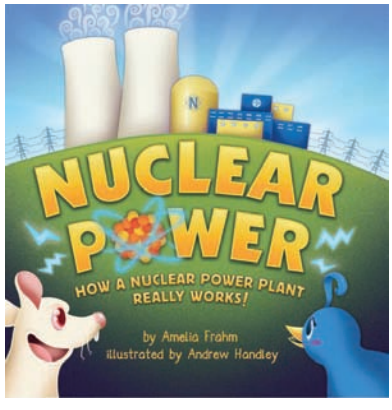
* See "Barry Fell, Epigrapher: Biography of a Renaissance Man" by Julian Fell, *21st Century,* Winter 1999-2000 and Summer 2001.

BOOK NOTES *by Marjorie Mazel Hecht*

The Cat Who Designed A Nuclear Plant

Nuclear Power: How a Nuclear Power Plant Really Works
by Amelia Frahm
Apex North Carolina: Nutcracker Publishing Company, 2011
Paperback, 36 pp., $9.95

Move over "Cat in the Hat." Here comes Penelope the cat, who, according to a chubby rat and pretty blue bird, must be responsible for designing the Nukie Nuclear Power Plant. Why? Because nuclear electricity powers the female feline's house so that she can laze around in the air-conditioned cool. With charming illustrations, this little book in rhyme, presents the basics of nuclear power for a young audience.



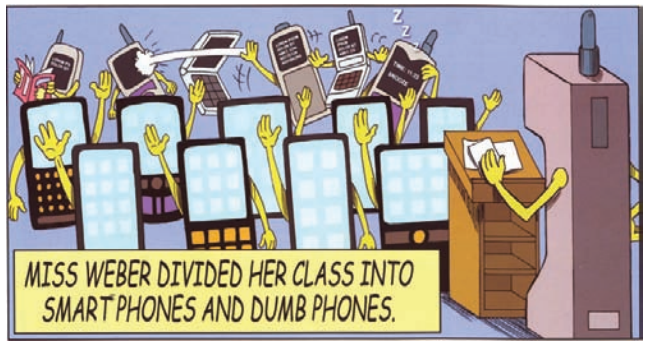
Refreshingly, there are no politically correct caveats, just simple rhymes that cover the basics of how a reactor works. The book is designed for ages 4-9, but there are probably people of all ages on your gift list who are in need of this non-scary introduction to nuclear power.

Seriously Funny

Future Shock Comics
by Jim and Pat McGreal
Paperback, 105 pp., $10.00
www.futureshockcomics.com

This little book of cartoons arrived with a note saying that "science could use some humor." We concur, and we thank the authors for providing us with some high-tech and scifi laughs!

It was hard to select just one illustration to give readers a sense of the McGreal brothers' style. If you want someone to laugh at your gift, this book is a good choice.



Medicine As an Art

A Lost Art: Reflections of a Dermatologist
by Dr. Eyal K. Levit
New York, 2011
Paperback, 132 pp., $15.00
Purchase at advanced.
dermatology1220@gmail.com (718)375-7546

Medicine is an art, but in these days of cost cutting, euthanasia, and insurance paperwork, human life is not valued and medical diagnosis too often is reduced to a computer check list without individualized attention and deliberation. Thus, the title of this little book caught my eye, and I requested a review copy.

The book is a series of short essays by a young dermatologist reflecting on life in general and on some of his patients and the problems he had to solve. Some of the problems are cosmetic, others are very serious; but in each case Dr. Levit takes whatever time is needed to assess the problem and talk with the patient. It is clear that if all medicine were practiced this way, we would have a happier, healthier nation (and world).

One memorable image is a lecture he gives to 100 or so dermatologists at Columbia University. He describes the case of a woman who comes in for some cosmetic surgery on veins on her face, for which purpose he has invested in a very costly new special laser, and he is ecstatic at the prospect of putting it to use. But upon examining her, he realizes that more important than the cosmetic treatment, he needed to rule out Hereditary Hemorrhagic Telangiectasia. And, then, he dramatically unveils a human skeleton hidden behind him, to remind the doctors present of the importance of looking behind the surface for hidden causes.

Dr. Levit is Director of Cosmetic and Dermatological Surgery at St. Luke's Hospital, Columbia University, and practices dermatology in Brooklyn.

The Sad State of Science 'Success'

Whiz Kids
Tom Shepard, Director
Waterville, Me.: Shadow Distribution, 2010
Documentary Film, 82 min.
(Check local PBS stations for 2011 showings, beginning in April)

This is a fast-paced look at high-school students who submitted science projects to the premier science competition, the Intel Science Talent Search, formerly sponsored by Westinghouse. The three projects focussed on in depth are a fossil discovery, a botany experiment in plant growth, and a system for detecting and removing a contaminant from water.

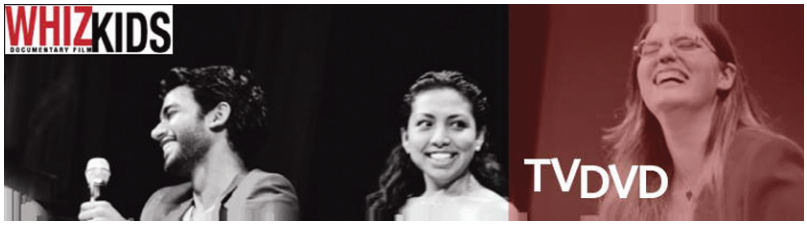
The students pursuing those projects are diverse—an Hispanic young woman from a Uniondale, N.Y. mostly minority school, a Pakistani young man from a single parent family in Staten Island, and a young woman from West Virginia who lives near a DuPont plant that has released chemicals into a local river.

What the youth have in common is that they are all self-driven to "succeed," so much so that the science is overwhelmed by the competition, and by their measuring of success as getting into an Ivy League college.

The film begins by noting that American students rank 26th in science and math compared to the youth of other countries. The narrator then announces that the film will look at those American youth who are the "best and the brightest."

One can only feel pity and horror at what American science has become, and the pressure today's students are under to perform. Lost is the joy of discovery and the love of learning. The mentors involved with the youth obviously love their work, but the scientific enterprise, not intentionally, comes across as cutthroat and competitive. And like most of science today, the hint of a purpose in helping mankind move forward is tied to cleaning up the environment.

The three youth are obviously very bright and likeable, as are the other youth portrayed only in passing. But the most striking lesson one takes away from the documentary is the failed state of American science today.

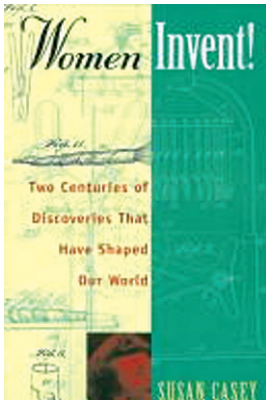


Not Just for Girls

Women Invent! Two Centuries of Discoveries That Have Shaped Our World
by Susan Casey
Chicago Review Press, 1997
Paperback, $16.95
Now available in electronic formats; Ages 9+

This is an engaging book for young people, which colorfully conveys the idea that human beings create all sorts of things to make life better. And since women are human, women invent!

Most readers have probably thought of a few things that should be invented to solve everyday problems. But few people pursue these ideas to the design and patent stage. This book tells you about wom-



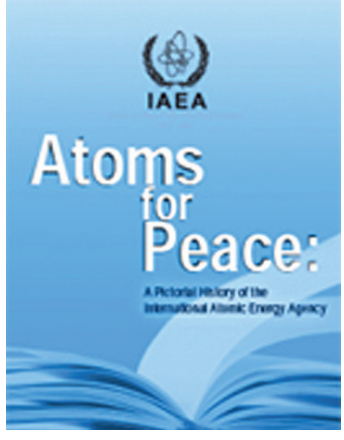
en who had a good idea *and* patented it. From the ironing board and life preserver to frozen pizza and a system of ore recovery, author Susan Casey describes 50 women inventors. They come from city and farm, and are black and white; some are educated, others are not. Some became millionaires.

Youngsters who want to pursue their potential inventions might also be interested in Susan Casey's other book, *Kids Inventing: A Handbook for Young Inventors*.

For the Coffee Table

Atoms for Peace: A Pictorial History of the International Atomic Energy Agency
Vienna: IAEA, 2007
Hardcover (11 X 13), 200 pp., $ 50 Euro

This handsome, large-format book is a 50-year history of the IAEA and has many fine photographs including some surprises, even for a nuclear-literate person.



PRODUCT REVIEW

A New Technology for the Refrigerator

The Ozonator
$29.25
www.ozonator.com

We don't usually review new products, but this one seemed worth making an exception. The Ozonator is a small (6" X 5"), battery-operated device that sits on the top shelf of your refrigerator and produces enough ozone to purify the air inside the refrigerator, thus protecting perishables from mold and decay. The FDA-approved machine is advertised as saving families up to $500 a year, the estimated amount of produce that a household throws out because of spoilage.

We did not do a scientific experiment, but anecdotally, here's what we found: The refrigerator smelled cleaner almost immediately after installing the device. The Ozonator eliminated odors from fresh fish or other usually discernible smelly items.

Produce lasted longer. In particular, lettuce and fresh herbs, berries, and many fruits and vegetables (including especially those bought at a local farmers' market) stayed fresh longer.

Ozone, O_3, works by oxidizing some chemicals and by neutralizing ammonia and ethylene, thus delaying the onset of mold and decay. Again, anecdotally, the Ozonator seemed to keep meat fresher also.

Four "D" batteries keep the Ozonator operating on a cycle that maintains an adequate level of ozone to do the job. There is no perceptible ozone smell (as there sometimes is from an ozone air cleaner). The supplied batteries lasted a little more than three months. We replaced them with alkaline "D" batteries, which have a longer lifespan. A small red light indicates when it's time.

In sum, this is a worthwhile product, and perhaps will be standard equipment in the refrigerators of the future.

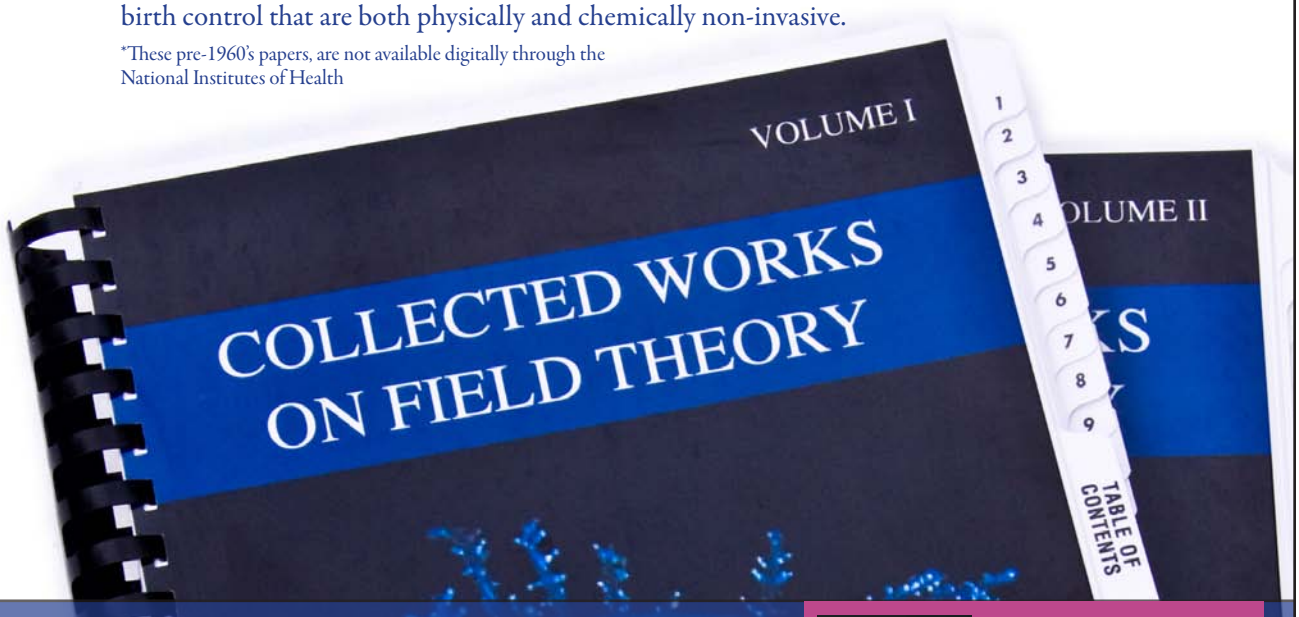
—Marjorie Mazel Hecht

Found! A verified electrical technique for the early detection of cancer and human ovulation.

The Collected Works on Field Theory includes studies that were previously lost, forgotten and ignored by the academic community. They reveal scientific secrets that will stand the pharmaceutical and medical industries on their ears.

Several of the articles republished in this collection were retrieved from dusty Yale University archives dating back to the 1930's*. They contain ground breaking research that could only truly be appreciated now 90 years later, revealing methods of early cancer detection and effective birth control that are both physically and chemically non-invasive.

*These pre-1960's papers, are not available digitally through the National Institutes of Health



Volume I

- The Electro-Dynamic Theory of Life, H.S. Burr and F.S.C. Northrop (1935)
- A Vacuum Tube Microvoltmeter for the Measurement of Bioelectric Phenomena, H.S. Burr, C.T. Lane, L.F. Nims (1936-1937)
- Experimental Findings Concerning the Electro-Dynamic Theory of Life and an Analysis of Their Physical Meaning, F.S.C. Northrop and H.S. Burr (1939) (submitted 1936)
- fifteen additional, related journal papers

Volume II

- Electrodynamic Field Theory in Psychiatry, Leonard J. Ravitz (1950)
- History, Measurement, and Applicability of Periodic Changes in the Electromagnetic Field in Health and Disease, Leonard J. Ravitz (1962)
- five additional related journal papers
- six papers relating field theory to human physiology
- two papers of Einstein's work on cosmology and the energy associated with elementary particles
- one paper linking Northrop's work on field theory to Pierre Teilhard's hypothesis of radial energy

Author Darden Dickson edited this compilation of important philosophical and scientific papers that attest to "The Electro-Dynamic Theory of Life".

The two volume set is $160.
One volume is $80.

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