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Review Article

Fred Vlès – Early Holistic Biophysicist and Pioneer of "Earthing"

Marco Bischof*

Institute for Future Science and Medicine, Dreetz, Brandenburg, Germany

***Correspondence:** Marco Bischof, Institute for Future Science and Medicine, Dreetz, Brandenburg, Germany, Email: mb@marcobischof.com

Abstract

The paper reports on the life and works of Fred Vlès (1885-1944) and Paul Reiss (1901-1944), and Charles Laville (1877-1959) who worked in a similar field. Vlès was the founder of the first institute of biophysics in France at the University of Strasbourg, and Reiss was his pupil and associate. They worked in the time of 1910 to 1944 on the acid-alkaline balance and the reduction-oxidation (redox) potentials of the body fluids and tissues and their influence on the proteins and colloids of the "terrain", along the lines given by the "milieu interne" (internal environment) or homeostasis concept by Claude Bernard. Vlès and Reiss were also electrobiologists and were some of the first scientists to investigate the physiological effects of electrical grounding where also the work of Charles Laville is relevant. In the conclusion we link this historical narrative to contemporary research.

Introduction

A major French tradition in biophysics has its origin in the approach and the works of Claude Bernard (1813-1877) and Jacques Arsène d'Arsonval (1851-1940) [1]. The physiologist Bernard proposed the concept of the "milieu interne" (internal environment) in 1859, i.e. the blood plasma, the lymph and all the body fluids were maintained constant in order to protect the "vital activity" of the organism.

"It is the constancy of the internal environment which enables a free and independent life, and all vital mechanisms, as varied they may be, have only one goal, namely the constancy of the life conditions in the internal environment".

The disturbances of these "protective functions" (regulation mechanisms), writes Bernard, causes initially only pathological changes in the fluid "terrain" (soil) in which cells and organs are embedded, but can later lead to illness and death. This mechanism was later called "homeostasis" by Walter B. Cannon. Bernard's concept of the "terrain" is one of the most important and fruitful contributions to a holistic physiology and medicine.

Arsonval was since 1873 until Bernard's death in 1877 a close colleague of Bernard at the College de France, and complemented Bernard's physiological approach with a bioelectrical one. He was a many-sided scientist, but he is especially known for the introduction of electrical waves of high-frequency and their application in medicine – therefore some time ago this area of biophysics was known as "d'Arsonvalization". He invented electro-surgery and in 1895 investigated discharges from electric rays [2,3].

However, Bernard's concept of homeostasis didn't win recognition in his lifetime [1,4]. Not before 1900 it attracted attention in connection with investigations on the mineral composition of blood when it was found that the internal environment of organisms is as in physical as well as in chemical respect quite similar to ocean water. The concept of the "terrain" was resuscitated especially by physiologists who on the basis of the new findings of physical chemistry began to investigate the regulation of the interior environment of the body fluids by hormones and electrolytes. Among them were Joseph Barcroft, Ernest H. Starling, Lawrence J. Henderson, Walter B. Cannon and Edward F. Adolph. Their colleagues William M. Clark, Leonor Michaelis, Heinrich Schade, Charles Laville, Fred Vlès and Wladislas Kopaczewski were engaged in the time of 1913 to 1928 in the investigation of the acid-alkaline balance and the reduction-oxidation (redox) potentials of the body fluids and their influence on the proteins and colloids of the terrain. The pH measurement of the body fluids as a "terrain diagnostics" was later

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picked up by Louis-Claude Vincent, Ernst Ziegler, Werner Kollath, and the contemporaries Zbigniew William Wolkowski, Jeanne Rousseau and Joszef Orszagh.

Fred Vlès (1885-1944)

Born on 22 January 1885 at Le Havre, Fred-Manuel-Raoul Vlès showed early in his life a tendency to study and to observation [5,6]. At the age of 8 years he attempted to write and illustrate a work on animals. He began his research career in zoology; at the age of 20 years he was a pupil and preparator of Yves Delage (1854-1920) in the Laboratory of Marine Biology at Roscoff in Brittany, France, who was at the same time professor of zoology at the Sorbonne in Paris. His first works were devoted to marine organisms, especially the mye (Mya Arenaria), the Soft-Shelled Clam, and the sea urchin [7-10]. He got in 1911 the title of Doctor of Natural Sciences with a work devoted to the "Optical Properties of Muscles" [11].

He took part in World War I as a corporal, then adjutant, and he was awarded the "Croix de Guerre" because of bravery. After World War I, Vlès went to Strasbourg in Alsace where the main part of his career took place. He was commissioned in 1919 to teach the course of biological physics and introduced a new perspective to it. Then he became professor without chair and professor of Physical Chemistry at the Institute de Pétrole.

This discipline was taught in no other place in France. Vlès was a biologist, but a solid knowledge in mathematics and physics allowed him to life and later illness with the methodology of physics. This course at the Science Faculty was a great success. *"His teaching was very original, rich in possibilities of all sorts. Among his listeners, many felt the necessity to come to work with him. He built from these people a lively group of scientists of diverse tendencies and aspirations: chemists, biologists, physicians"* [12].

It was at the biological station of Roscoff that Vlès encountered Paul Reiss (1901-1944) at the beginning of the 1920's. This encounter was decisive for the development of biophysics. In 1921, Vlès founded the journal *"Archives de physique biologique et de chimie-physique des corps organisés"* which appeared until 1945 under his direction at the publisher Vigot Fréres in Paris.

In 1923 against a deep scepticism and misconception from the part of the professors of medicine against the new discipline, the dean of the Medical Faculty charged Fred Vlès with the course of Biological Physics at the Medical Faculty. Vlès held that a physician not only must be aware of the physical disciplines specialized in a direct utilization in medicine, like radiology and ophthalmology, but also of the physical foundations of life. In 1929, he got his medical degree with a scientific paper on the problem of cancer tumors with the title of *"Introduction à une physico-chimie pathologique"* (Introduction to a pathological physical chemistry).

In 1930 he was appointed professor and chair of biophysics which position until then the dean Georges Weiss had occupied. In 1931 he founded the "Société de physique biologique de Strasbourg" which became, in 1937, the "Société de physique biologique de France". This society organized monthly sessions open to the works and communications of different laboratories.

Vlès created a research center of international reputation. In the time of World War II, Fred Vlès was nominated in 1934 for the Nobel Prize in Physiology or Medicine by the well known physiologist and biochemist Louis Camille Maillard, known for the Maillard reaction. Among the researchers who worked under his direction, Paul Reiss was the most remarkable. But also André de Coulon must be mentioned, director of the laboratory of the Anti-Cancer Center in Lausanne (Switzerland) who devoted himself to the study of the physical chemistry of cancer and published many papers together with Fred Vlès. Vlès had also a number of further collaborators like the lady researchers G. Achard and M. Gex, as well as students and researchers of all disciplines and nationalities who frequented his laboratory to make a thesis or a research investigation.

Vlès' laboratory was not only well known in France, but also beyond its frontiers. Its works were known in all of Europe, in the United States and Japan, and thus the laboratory received many visitors and foreign researchers. According to G. Achard, *"the school of Prof. Vlès was an entity characterized by a great diversity of tendencies, a great thirst of knowledge, and a lack of conformism thanks to which it could move in uncharted water"* [12]. Vlès was a scholar avid for new knowledge and animated by an insatiable thirst to understand the mysteries he had the gift to unravel in the course of his experiments [5].

He joined in May 1940 the University of Strasbourg which had fled from the hostilities of war to Clermont-Ferrand in Central France. He resumed work and tried to reorganize the work of the Society of Biological Physics in France. Denunciated to the Gestapo after an assassination attempt, he had the possibility to flee. But he chose to deliver himself in full awareness of the consequences on the 10th of March 1944, in order to prevent reprisals on his colleagues and staff. On the 15th of June he was transferred to Compiègne and consigned to a convoy due to the concentration camp at Dachau. It is in this convoy that he died on the 2nd of July 1944 from exhaustion.

Vlès was a pioneer biophysicist of the cell and its environment, the so-called "milieu intérieur" – the seat of subtle balances and guarantor of the interchange with the external environment. The Strasbourg professor was called *"the greatest biophysicist in Europe"* by the author of his obituary in *"Science"* [13].

Paul Reiss (1901-1944)

The work of the Institute de Physique Biologique in Strasbourg was unthinkable without Vlès' asscociate Paul Reiss. Reiss was born in 1901 [5,6]. He studied medicine at the faculty of Strasbourg. With studies in histology he began his career in research. He was a pupil of André Pol Bouin (1870-1962), French cytologist and histologist who was professor of histology at the University of Strasbourg. He studied the Golgi apparatus and the secondary sexual characteristics of the male lizard. In parallel, he studied the natural sciences and received a degree in 1924. At the end of his medical formation he spent three years at the Anti-Cancer Centre of Strasbourg. There he was first preparator, then assistant from 1924-1927; he studied the stimulation of the cellular multiplication by weak doses of X-rays. He showed that some doses of X- or gamma-rays killed the cell nucleus, but left the cell nucleus intact.

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He was a pupil of Fred Vlès at the Laboratory of Marine Biology in Roscoff and became in 1927 preparator at the Institute de Physique Biologique in Strasbourg under Fred Vlès and in 1930 associate professor of Vlès. Vlès assigned to him the study of the pH in the cell, which formed the subject of his medical thesis in 1926 ("Le pH intérieur cellulaire") [14]. Later he dedicated himself especially to the reduction-oxidation balance in the cell. His Ph.D. thesis in Natural Sciences that he defended in 1942 before the faculty of Strasbourg relocated to Clermont-Ferrand was concerned with "The action of the oxidation-reduction potential of the environment on the activity of various proteinases: Hydrolysis and condensation". He established that the proteolytic enzymes could cause lysis or synthesis according to their rH: lysis in a reductive environment, synthesis in oxidative environment. With Dr. Achard, he studied the variations of the enzymatic activity and of the rH during the metamorphosis of the insects. Later he authored the books "Action des agents physiques sur les organisms" [15], "L'action biologique des rayons X et gamma" [16] and "Interpretation physico-chimique du mécanisme de la mitose" [17].

Vlès and Reiss were both convinced of the benefit they could derive from physical methods of investigation. They developed novel electrometric and spectroscopic techniques which permitted a study of the fine structures of muscular fibers, the transparent media of the eye and the embryonic cells.

The work of Fred Vlès

Teaching was especially important for Vlès. He asserted that the goal of biophysics is not yet known, because it is often treated not enough exactly and in incomplete form [6]. He saw himself as a pioneer in a new science. Since the end of the 19th century, it was known under the name of "medical physics". It must develop, Vlès was convinced, into a science on its own and generate its own methods and theories. Biophysics is a science that should investigate life from the viewpoint of physics. It must be *"basically biological in tendency, even when its means are physical"*.

"Every branch of research", he wrote, *"presents itself in a double way: one direction of research deeply biological, treating the unknown in the environment where it occurs, and one direction purely physical, that in a second approximation, discusses and pursues the physical facts, explaining the initial unknown – in this second regard the results of the purely physical investigation could also have implications on the biological level which permits a fruitful pursuit of researches on this level"* [18].

Therefore he authored a number of textbooks and manuals for students and fellow biologists and physicians. Among them were "Travaux pratiques de physique biologique et de chimie-physique" [19], "Précis de Chimie-Physique à l'Usage des Étudiants en Médicine" [20], "Cours de Physique Biologique" [21], "Introduction à la photochimie biologique, à l' usage des médecins et des biologists" [22]. Then he wrote a number of textbooks, among them "La cinématographie astronomique" [23], "Cours sur la physico-chimie des pétroles" [24], "Physique Biologique" [25], and "La spectroscopie en biologie" [26]. Furthermore, he wrote a number of papers on his electrophysiological studies, among them "Revue des Notions Actuelles sur un Problème de Physico-Chimie Pathologique: Les propriétés des points isoélectriques et du terrain physico-chimique dans l'organisme normal ou pathologique; leur applications à l'étude des tumeurs" (Review of the Actual Ideas on a Problem of Pathological Physical Chemistry: The Properties of Isolectric Points and of the Physico-Chemical "Terrain" in the normal and the Pathological Organism; Their Application on the Study of Tumors", 1929) [27], "Notes sur la lyse électrique de l'oeuf d'oursin" [28]. And "Documents pour servir à l'étude du role des facteurs électriques dans l'évolution des embryons d'oursin [28]. Finally, he published a number of articles in series where he made known from time to time the results of his investigations, such as "Recherches sur les propriétés physico-chimiques des tissus en relation avec l'ètât normal ou pathologique de l'organisme" (Researches on the Physico-Chemical Properties of Tissues Related to the Normal or Pathological State of the Organism), "Notes sur les propriétés physico-chimiques des électrolytes" (Remarks on the Physico-Chemical Properties of Electrolytes), and finally the papers and books on his experiments about earthing which will be the subject of last paragraph in this paper.

About 1910-1940 biophysics (medical physics) was concerned mainly with physical chemistry. It is in the tradition of humoral physiology and of the concept of homeostasis, that the concept of dilute ionic solutions, developed by Jacobus H. van't Hoff and Svante Arrhenius, was used. The regulation of the internal environment of the body fluids by the control of hormones and electrolytes characterized the work of pioneers like René Quinton, Léon Frédérick, Joseph Barcroft, Ernest H. Starling, Lawrence J. Henderson and Walter B. Cannon [4]. After the introduction of the concept of the "colloid" by Thomas Graham in 1861 many biologists, physiologists and biophysicists have conceived of the protoplasm as a hydrated polyphasic colloidal system [29-32].

In the tradition of Claude Bernard, the biophysical school of Fred Vlès continued the humoral-physiologic approach with physico-chemical studies of the acid-alkaline balance and reduction-oxidation (redox) potentials and their influence on proteins and colloids of the "terrain" of the organism. Vlès held that water was the basis of biology because its properties determined many of the properties of living substance. *"La biologie est pour la grande part la science de l'eau"* (biology is for the most part the science of water"). He also was one of the first to recognize the biological significance of water structure [33,34]. Vlès and his pupils perfected the pH and redox measurements of the blood and other body fluids, established by Leonor Michaelis (1914, 1933) and William Clark (1926, 1928) and later taken up by and popularized by Louis-Claude Vincent, Ernst Ziegler and Werner Kollath. Vlès used and justified the parameter invented by Clark in 1920 and used by Louis-Claude Vincent, rH_2, that stands for the electronic charge of a given pH. He also investigated the isoelectric point of solutions, proteins, and colloids, the point where the electric charges of all components of a system, negative and positive, counterbalance each other.

Early investigations of "Earthing"

Recently, a book and some papers were published about the physiological effect of electrical grounding by a number of American authors [35-38]. But the American authors were not the first

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to observe this phenomenon. Fred Vlès has already made some experiments in this field in the 1930`s.

Charles Laville (1877-1959), precursor of Vlès

There was even a precursor of Vlès in this area: Charles Laville (1877-1959), electrical engineer from the "École Supérieure de l'Électricité", who was a disciple of d'Arsonval in the year 1882 in the Laboratorium of Biological Physics at the "École Pratique des Hautes Études" in Paris. Laville's father-in-law was Professor Raoul Baron who occupied the chair of zootechnics at the "École Nationale Vétérinaire d'Alfort (near Paris). He continued his education at the school of his father-in-law in physiology and pathology; it was as an electrobiologist he became known after his period of education.

Laville was the editor-in-chief of a scientific journal that dealt with physical chemistry, biology and medicine, named "pH", where eminent personalities of medicine and pharmacy established a link between physical chemistry and clinical physiology. His work was as well practically as theoretically oriented; among his books are "Électrodynamique du muscle" [39], "Cancer, derangement électrique" [40], "Mécanismes biologiques" [41], "L'homme, son origine, ses moyens et ses fins" (Man, His Origins, his Means and his Destinations, 1951), "Nos défenses naturelles contre le cancer" (Our Natural Defenses against Cancer), and "Introduction à l'étude de l'anthropotechnie" [42]. In "Mécanismes biologiques" [41] he wrote that all elements of life are of vibratory nature, that life is a resonance phenomenon, and everything in the universe moves in vortexes.

Charles Laville wrote in "Cancer, dérangement électrique" [40]: *"The balance and condition of organic tissues depends on the maintenance of the electronegativity of the blood"*. In 1922 Laville had found that the cancer cell had a positive electrical overcharge, in contrast to the healthy cell that was negatively charged. Laville assigned the responsibility of the electrical disturbance (of the cancer cell) to a reversion of the electrical polarity between the cell nucleus and the cytoplasm, the nucleus experiencing positive charges in abundance [43]. He had also developed an apparatus with name of "Electro-pulsator" which operated with electric microcurrents in order to repolarize the cells. The apparatus was tried out in Maison-Alfort by the scientists G. Lesbouyriés, P. Goret and J. Guilhon on laboratory animals and at the Hospital Beaujon in Paris by Dr. Paul Aubourg on patients.

Laville's reference to the significance of electronegativity has been corroborated by new findings. Because of their strong electronegativity – the strongest of all biological materials – the proteoglycans and the glycosaminoglycans of the Extracellular Matrix possess the strongest water-binding and electron-and-ion-exchanging ability of all tissue substances [44]. Because of their electronegativity, these substances, who form the main component of the Extracellular Matrix, establish the electrostatic tonus of the organism and have a strong ability to catch and neutralize free radicals [45]. They are an almost inexhaustible source of electrons for the organism.

Earthing experiments of Vlès

In 1930 Fred Vlès presented results of experiments that showed that certain phenomena in physics and chemistry developed differently if their systems were in electrical contact with the ground or isolated from it [46]. For instance, a container which evaporates water into the atmosphere could show a difference in weight of 7 decigrams when a mass of water of 15 grams is evaporated, that is a difference of 4 percent. The same is shown in biological experiments; the phenomenon happens probably under the influence of an electrical loss in the field of the atmosphere, and is therefore linked to the electrical conductivity of the air. However, mercury coulometers or voltameters which are placed on the connecting circuit on the bottom of the evaporating container didn't show any noticeable difference in spite of evaporations of several weeks and the electrical loss must therefore be considered very minimal and non-measurable.

"And since that time", Vlès writes in a paper five years later, *"we have had the occasion to examine several other physico-chemical phenomena which can also depend on the isolation or the connection to the ground, and from which this time a rough estimate of the loss can be attempted"* [47].

Interesting information was provided by the "Philippson reaction" [48]. This Belgian researcher had found that when one puts in some colloidal silver a metallic plate of copper or zinc, then one observes after some weeks that the colloidal silver begins to precipitate, in which the Tyndall – a measure of scattering light – of the colloid is strongly diminished. Vlès and his team took up the observation of the Philippson reaction, but under conditions that were not identical to those of Maurice Philippson, especially as they were performed under open air. It led to the observation that the colloidal silver went through a whole series of transformations in the first hours, some even in the first instants. The colloid changed its color from the original yellow to brown-rosé (sometimes to pure rosé under certain conditions), then turned violet, discolored gradually and showed finally a powder-like residue that represents the definitive precipitation.

Vlès concluded from his experiments the following:

"When a pair of colloidal silver lots with metallic electrodes (Philippson reaction) is mounted in an electrically isolated way, wherof one has the electrode connected to an electrical grounding and the other not, it can be observed in a majority of cases (about 80%) that the curve of the isolated lots precedes the one of those that are grounded.

Everything happens as if the grounding was capable of braking the Philippson reaction and if a counter-electromotive force came to oppose the normal release of cations by the metallic electrode. Everything induces us to think that this counter-electromotive force is the result of the intervention of exchanges with the atmosphere; as a matter of fact, the closure of the containers accelerates the reaction. We can observe the influence of the relationship of the electrical conductivity of the atmosphere λ + / λ -.

When capacitors in series are introduced on the grounding, it can be observed that the speed of the reaction can vary with the capacitance. We register a characteristic variation of the absorption equivalent to the increase of the capacitance on the spectrometer.

Another reaction that is sensible to the connection to the ground

has been experimentally proven: that variations of the pH happen as a result of grounding, observable in the chart by colored indicators – but the reaction is less sensitive than that of the colloidal silver.

We have attempted to calibrate the reaction (Ag) by producing it by electrolysis and measuring the number of Coulombs which are necessary in order to arrive at the characteristic curve. The measurement has given values of the magnitude of 6 to 7 x 10^{-2} Coulombs. If we compare the time differences that result between isolated containers and containers connected to the ground, the calculation indicates that the counter-electromotive force considered could reach values up to 5 x 10^{-5} Coulomb per second.

The introduction of a capacitance into the appliance gives rise to examine if the appliance cannot be the seat of resonance phenomena under the influence of an exterior high-frequency field. A summary calculation gives the high-frequency wave range which could correspond to the properties of the appliance; but putting the reaction in a Faraday cage gives results that are not favorable to the hypothesis of the action of an external field. Contrariwise the determination that the application of high-frequency waves seems not to slow down the reaction in a noticeable way. Therefore, the interpretation of the phenomena made in a former paper [49] that they are a result of a loss of charge in the atmosphere seems for the moment more probable" [47].

In the book publication on the Earthing experiments [50] he wrote in a first chapter on the facts known in his time on the electrical field of the earth, the ions in the atmosphere, and the conditions in a system that is isolated from the earth. In a second chapter he wrote on the biological processes in a system in connection with or isolated from the earth. Here he reports on the experiments he made on grasses in 1928-30, other experiments he made on other plants and bacteria in 1934, and investigations on animals (eggs and embryonic developments, young mammals, and pathological processes, mainly experimental and spontaneous cancers). Experiments with seeds of grasses in germination showed that the speed of growth was different depending on whether the grains were planted in electrically isolated pots or in pots connected to the soil.

"On the occasion of an epidemic of poliomyelitis in 1930, Vlès made a connection between the frequency of declared cases and the conductivity of the atmosphere. Working for Paul Rohmer (1876-1977), professor of pediatrics at Strasbourg he found that the growth of the babies varied according to their electrical isolation or their connection to the ground" [12].

In chapter three of the book he discusses the physico-chemical processes of systems in connection with the soil or isolated from it, and finally in chapter four he deals with the biological interpretation of the actions of insulation and grounding. In this last chapter he notes first that the organisms living in the atmosphere are not inert solid bodies: they often take up spontaneously an electrical charge that is negative. Already the famous French physicist Claude Pouillet (1790-1868) in 1827 let grow seedlings of wheat on an electroscope and found they take a negative charge. The physician and photobiologist Jean Saidman (1897-1949) indicated in 1929 that humans are subject to a constant loss of negative electricity that is even accelerated through photochemical action by ultraviolet light.

In his own experiments with mice Fred Vlès could show that the mice after a quarter of an hour on an isolating support presented themselves to the electroscope as spontaneously negatively charged, probably due to the respiratory intake of oxygen of which a part exists in the form of small negative ions. On the other hand, mice connected to an electroscope and charged by positive or negative ions, Vlès could specify the conditions of the loss of charge: for either of the charges, the loss is not symmetrical; the loss of negative charge went on much faster. On the other hand, the living mice charged negatively discharged faster than the dead mice charged at the same potential. Contrariwise the living mice charged positively showed no difference to the dead mice charged the same way.

To interpret these facts, Vlès remarks, it must not be forgotten that compensatory processes are possible and a mixed origin of the electrification is likely – it is possible that the animal through negatively charging by the uptake of ions – by the respiration –, must also take up positively charged ions through the evaporation of water. An exogenous charge of the animal has therefore an independent impact on both phenomena whereof you see only the summing-up: a positive charge which blocks the general loss of negative charges, speeds up those of the positive ions, but amplifies the absorption of negative ions. A negative charge of the organism facilitates the emission of negative ions, brakes their capture as well as the emission of positive ions.

Therefore a living mammal in normal state ingests negative charges bound to respiratory oxygen and eliminates the excess of these negative charges by a general loss of charge: there is effectively a metabolism of electricity – the respiratory uptake and its elimination through the skin. This metabolism is marked by a series of oxidation-reduction reactions, since the supply of an electron corresponds to a reduction and its removal to an oxidation.

Conclusion

The pioneering work of Charles Laville, Fred Vlès and Paul Reiss is again highly relevant today [51]. I has become highly topical through the work on redox regulation / redox signaling [52-54]. The concept of redox regulation, and the complementary roles of Reactive Oxygen Species (ROS) and antioxidants in an electron-driven regulation system attract growing attention [55-57]. Additionally, the work on water research by the scientists assembled each year at the International Scientific Conferences on the Physics, Chemistry and Biology of Water led by Gerald Pollack, and especially the work of my colleagues Emilio Del Giudice and Vladimir L. Voeikov (for instance Voeikov, "Biological Oxidation: Over a Century of Hardship for the Concept of Active Oxygen" [58], Voeikov, "Reactive Oxygen Species (ROS) – Pathogens or Sources of Vital Energy?" Part 1 and 2. [55,56], and Voeikov & Del Giudice, "Water Respiration – The Basis of the Living State" [59] make the work of Laville, Vlès and Reiss again significant. The work of Laville and Vlès on electrical grounding has become relevant through the rediscovery of electrical grounding by Chevalier, Ober, Sinatra, Zucker, and Oschman.

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