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Ukrainian Naturalist and Economist Serhii Podolinsky and His Role in the Formation of the Noosphere Concept

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Abstract: Based on the analysis of 'Human labour and its relation to the distribution of energy' by the Ukrainian natural scientist and economist Serhii Podolinsky, the authors support the opinion of modern researchers that Podolinsky's ideas, published in this work in 1880, have foreseen some moments from Vladimir Vernadsky's noosphere concept. Podolinsky also underlined that there are countries which formerly had been rich but later almost fell into poverty. He believed, and this has proved correct from a modern point of view, that such a situation is connected with mistakes in economic management. Despite some critical comments against the concept of Podolinsky, its consideration is of interest today.

Keywords: *noosphere concept, Serhii Podolinsky, social economics, Vladimir Vernadsky*

The works of Serhii Podolinsky, a Ukrainian naturalist, economist and physician, were not widely known for almost 100 years after his death. However, the scientific principles he worked on, though recognized by few, laid the foundations for a new worldview, based on the objective laws of historical development. Misunderstanding of the meaning of these laws can be quite tragic for the fate of mankind, inevitably approaching the catastrophic environmental consequences.

Serhii Podolinsky was born on 19 (31, according to N.S.) July 1850 in Yaroslavka village, Zvenigorodsky District of Kyiv Province (now Shpola District of Cherkasy region, Ukraine) in a wealthy noble family. Serhii's maternal great-great-grandfather Marie-Gabrielle-Florant-August de Choiseule-Gouffier (1752–1817) came from an ancient French family, from which a number of prominent people in the military and diplomatic history of France have born. His eldest son, Earl Octavius de Choiseul-Gouffier, Serhii's great-grandfather, was born in 1773, at the dawn of the French Revolution, and together with his father he emigrated to Russia, where he joined the army. Octavius's daughter Matilda-Josephine, Princess Kudasheva (1806–1867), was Serhii's grandmother, and her daughter Maria (1827–1901) the mother of the future scientist. Serhii's paternal grandfather Ivan Podolinsky (1777–1852), Kyiv squire, served as Chairman of the Kyiv Chamber of the Criminal Court. His son Andrii, Serhii's father, born in Kyiv in 1806, was a pupil of the Nobles' Boarding School at St. Petersburg University, and wrote poems which earned the warm appreciation of his contemporary, Alexander Pushkin.

In 1867, Podolinsky entered the Department of Natural Sciences of the Faculty of Physics and Mathematics of the Imperial University of St. Vladimir in Kyiv. During the studies, he attended the lectures of Professor Vladimir Tomsa, a student of the famous German physiologist Carl Ludwig, and became interested in physiology. While studying at the university, Serhii started to collect information about diseases and epidemics, the influence of natural and living conditions on the health of the population. After graduating, in 1871, from a university course with a degree of the Candidate of Natural Sciences, he decided to specialize in medicine to become a doctor. With this purpose he left for Zurich, where the revolutionary youth of Russia acquired professions allowing them to be closer to the common people. Taking active part in all the activities of the Russian diaspora, Serhii Podolinsky played an important role in the organization of the magazine *Forward*. In 1872, he went to Paris to listen to the lectures of Claude Bernard. In 1873–1876 he was in Breslau (now Wroclaw, Poland), where he studied and worked at Rudolf Heidenhain's Physiological Institute at the Breslau University. He presented the results of his research in a thesis, for which he received the Diploma of Doctor of Medicine from Breslau and Degree of Doctor from the Kyiv University. Five years later, he finished the course of the Medical Faculty of the Wroclaw University. During this time he also thoroughly studied political economy, history and philosophy.

While in Kyiv, Podolinsky married Natalia Andreeva, and together they moved abroad and settled in Montpellier, South of France. There they had three children,

but the family life failed, because his wife chose the revolutionary activities and left her family. The death of two children from meningitis, excessive work, and difficult financial situation worsened his already instable mental health. Over the following three years, his mother tried to cure him in Clamart, near Paris, but in May 1885 she brought him to Kyiv, where he was slowly dying in a state of dementia. Podolinsky died on June 30, 1891 and was buried in Zverinetsky cemetery (Chesnokov, 2006).

Podolinsky authored more than 50 scientific works, published in Russia and abroad. The range of his scientific interests is very wide: economic theory, sociology, ecology, geography, medicine. The most famous of his works is 'Human labour and its relation to distribution of energy', published in 1880 in St. Petersburg journal *Slovo* (Podolinsky, 1880a). During the same period of time, he published fragments of this work in German, French, and Italian journals. The abridged German version was called 'Menschliche Arbeit und die Einheit der Kraft' ('Human labour and unity of force') (Podolinsky, 1883; it was translated into Ukrainian by M. Grushevsky). This work by Podolinsky was reprinted in 1990 and 2000 in Ukrainian and in 1991 and 2006 in Russian (Podolinsky, 1990; 1991; 2000; Chesnokov, 2006).

Using philosophical and socio-economic approaches of Karl Marx, he tried to answer the question: Is there such a type of natural processes which has an efficiency of over a hundred per cent? And he came to the conclusion that it is possible.

How did Podolinsky substantiate his conclusion?

In Chapter 5 of his article, entitled 'The value of animals and man in the distribution of energy. The concept of labour,' he wrote (using the terminology of his time) that higher forms of energy, produced by plants and animals, always end up uselessly wasted in space. They are never directed to the only useful work (in the sense of increasing the energy of the earth), that is to its transformation into higher forms of energy. As an example, he calls the transformation of the energy of sunlight into mechanical work. In Chapter 9 he focused specifically on the differences of individual types of labour activity in connection with the distribution of energy.

Looking around ourselves, he says, we see that at the present time the amount of solar energy, more convertible on the earth's surface, is gradually increasing. Now the number of plants, animals and peoples is certainly greater than it was at the

time of appearance of mankind. Many infertile places are cultivated and covered with luxuriant vegetation. The yields in all civilized countries have increased. The number of domesticated animals and the number of people have evidently grown. Whatever may be said about the large herds of wild animals, there is no doubt that domesticated animals and people in total are greater living matter and consume more nutritious material, accumulated by plants, than wild animals only.

Podolinsky stresses (and this is a very significant observation from a modern point of view) that there are countries which formerly used to be rich, but have now transformed almost into desert, but such facts, he writes, have obviously depended on errors in management. Thus his conclusion is that we should recognize the fact of increase (from the time of the appearance of mankind) in the production of nutritious materials, which in itself includes the stock of transformed energy on the earth's surface.

Podolinsky ponders on what is the source for the excess of energy that is required to generate the feed and fuel material? What is labour in such case? Labour is such consumption of mechanical and mental work which results in an increase in the number of transformed energy on the earth's surface. This growth can occur either directly, through the transformation of new quantities of solar energy in a more convertible form, or by saving from scattering the number of transformed energy that already exists on the earth's surface, which is inescapable without the interference of labour.

The next question Podolinsky raised was how the ability to labour is being created and realized.

According to him, it can be done only in case the energy accumulated in plants raises its stock to a new level, at which this energy is either used for the nutrition of animal or man, producing work, or this reserve is fuel for machine, built and controlled through man's efforts. In other words, labour is either carried out by man who takes care of the animal and manages its work or he is a designer of this machine. The concept of labour involves the consumption of mechanical and mental work, having as a mandatory result an increase in transformed energy or the prevention of its scattering, and this will have the effect of increasing the level of energy.

As long as man has existed among other animals, obeying the general laws of the struggle for existence and receiving from the environment all that he needed

without exerting any impact on it, he does not cause any noticeable effect on the energy budget of the earth's surface. Podolinsky stresses that standard muscle tension should not be confused with useful labour. The first useful labour (in the sense of transformation of energy), he believes, was the domestication of animals, their breeding and protection, systematic extermination of predators as enemies of livestock, etc.

These actions violated the initial balance that had been established under the influence of the struggle for existence in the energy metabolism on the earth's surface. Of course, breeding and protection of herds together with extermination of predatory animals increased to a certain extent the number of the highest forms of energy, expressed partly in mechanical work of many domesticated animals, partly as an accelerated reproduction of peoples themselves. But this increase occurs only at the expense of further transformation of solar energy which has already been saved by plants, and therefore this reserve soon proves insufficient. Pastures can no longer feed the far too numerous mass of nomadic peoples. This is easily understandable if one takes into account that the labour put into breeding of domesticated animals only facilitates the transition of energy, saved by plants, in the highest form, but the labour itself has not been accompanied by preservation of new, additional quantities of solar energy. Nevertheless, the role of nomadic life and cattle-breeding in the development of labour is beneficial to the highest degree. The abundance of domestic animals, saving people at a time from extreme poverty, provided them with pastime, enterprise and development, necessary for successful implementation of the many observations and more or less successful experiments, which preceded the spread of agriculture.

So this was an answer Podolinsky gave to his own question. At the same time he stressed the point that extra amount of energy, added in the metabolism by man, is the reason for his advantage over animals. But labour spent on hunting and fishing increased, albeit indirectly, the exchange of energy on the earth's surface and therefore can also be attributed either to the category of useful labour or labour in general, in the true sense of this word.

The invention of weapons and work tools changed the relationship between the saving or increasing of energy. This had moved to the new level compared to primitive hunting and fishing. The following idea is quite important: scarce food was replaced by abundance and due to this prosperity people discovered the ability to increase the efficiency of mechanical work. Podolinsky applies similar reasoning to the appreciation of the first crude pottery. Labour that went into making pottery was generously rewarded with the preservation of transformed

energy in human body and adds to the exchange a new volume of solar energy, saving by plants, which without the intervention of labour would not be part of the energy exchange or would be wasted (for example, by decaying), mostly unproductively. The man, investing his own energy reserves, creates the environment in which energy conservation begins to occur as though of itself, or at least creates the opportunity to save from waste the share of transforming energy which already exists at his disposal.

Comments to the essential positions developed by Podolinsky may be as follows. In his opinion, human labour is a phenomenon of nature which increases energy power. If plants absorb solar energy and accumulate it without transforming into mechanical work, and animals use the energy saved by plants for realization of movement necessary for their survival but waste it in the environment, then in human being it is quantitatively different. The man in the early stages of his development receives energy by eating plants and animals, fully converting it into mechanical work, which he carries out. But already the conversion of people from gathering and hunting to settled agriculture, and then man's creation of more complex devices and mechanisms by means of muscular and mental labour to facilitate work changes the situation. This process leads to the accumulation of surplus energy that increases the efficiency of useful human activity to a level greater than a hundred per cent. Thus, the man finds the ability to obtain and use free energy.

Foreseeing that natural resources of energy (oil, peat, coal, and wood) have been steadily reduced and in time will become insufficient to provide for the growing needs of people, Podolinsky proposes to develop ways of accumulating the sun's inexhaustible energy by means of further rationalization of human labour. While the political economy of capitalism defines that additional product, obtained as a result of escalating energy, becomes a profit in the interests of capital, the so-called social economy, one of the founders of which was Podolinsky, considers benefit from the excess of energy in the interests of a man.

In addition to energy costs, necessary for the maintenance of life, a man must satisfy the requirements of mental activity, the specific weight of which in the total budget of energy grows in the course of society's development. Podolinsky wrote that the higher the human development, the harder its intellectual life is, and the more labour it must spend on satisfying its needs. He stressed that addressing the needs of knowledge caused the emergence of university education, the organization of research laboratories, scientific expeditions and many other actions that require the additional labour. He said that the teachers convey the

knowledge to students, who would later use this knowledge to increase the amount of accumulated energy. Also art, which stimulates humans to activity and provides an increase in the budget of energy, proves useful for this activity.

In general, the most important conclusions that Podolinsky arrived at in his work are as follows (if presented in modern language):

- The total amount of energy received by the earth's surface from its depths, and from the sun, is gradually decreasing. At the same time, the total amount of energy, accumulated on the earth's surface and available for people, is steadily increasing. This growth is the result of human labour and the use of domestic animals and mechanisms.
- Human being has a certain economic equivalent which is reduced proportionally to the increase of human needs.
- The existence of human beings and their reproduction is ensured until each person can use the totality of energy potential, exceeding its own by the number equal to the ratio of his economic equivalent divided by consumption. This can be explained by the fact that mechanical work can be always expressed in nutrients and other means of satisfying human needs. This supply is limited only by the absolute amount of energy received from the sun, and the set of non-organic materials on the earth.
- The main issue that will allow to continue the process of accumulation of energy on the earth with the greatest efficiency is the use of solar energy as a main engine to produce nutrients from inorganic raw materials.

Thus, Podolinsky substantiates from the scientific point of view the creation of the energy base by mankind to meet its social and cultural needs and at the same time gives an optimistic forecast of its further development. He was the first to define the expediency of rational environmental-and-economic activity of mankind in contrast to the irrational energy dissipation and laid the foundation for the future ecology-and-energy concept in the development of society.

Podolinsky sent his work, published in French (Podolinsky, 1880b), to Karl Marx. Marx read it and wrote an abstract of it, but, unfortunately, his answer to Podolinsky has not been preserved. However, there are two letters by Friedrich Engels to Karl Marx, in which he spoke about Podolinsky (Marx & Engels, 1954). In the first, Engels writes: "the history of Podolinsky I imagine as follows: his real discovery consists in the fact that human labour is able to

keep solar energy on the surface of the earth and make it work for a much longer time than it would be possible without human intervention" (Marx & Engels, 1954, p. 109). But then Engels writes that this effect can be observed only in agriculture and cattle-breeding, but that in all industries energy is only consumed. In addition, labour spent in industry, for the most part, cannot be expressed in units of heat. And he concludes with the following: "He leaned away from his very valuable discovery, because he wanted to find new scientific validation to socialism and therefore mixed the physical and the economical" (Marx & Engels, 1954, p. 111). However, according to some modern scientists, Podolinsky is well worth investigating today, because a closer study of his work is important for understanding the formation of Marxist theory and ecological economy (Burkett & Foster, 2008).

Vernadsky repeatedly turned back to the works of Podolinsky. On 3 July 1923 he noted in his diary: "Podolinsky is very interesting. He has been of interest to me for a long time. His energy conception, even though not understood by Marx and Engels, is largely new. He is one of the predecessors and innovators" (Vernadsky, 1998, p. 114). In the first edition of *Geochemistry*, published in French, Vernadsky (1924, p. 335) gave an assessment of Podolinsky's creativity: "The young Ukrainian scientist, Sergei Podolinsky, understood the significance of his ideas and tried to apply them in the study of economical phenomena".

Creating his biosphere-noosphere conception, Vernadsky turned to the developments of Podolinsky, as well as of his other predecessors. In particular, one of the main terms of the theory of biosphere—'living matter'—was coined in 1749 by Georges-Louis Buffon, who realized that the processes of the animate and inanimate nature are internally interconnected. At the turn of 18th and 19th centuries, Buffon's student Jean-Baptist Lamarck, considering nature as a unity of abiotic and biotic components, pointed out that in forming the earth's crust, animals and plants play a decisive role (Levit, 2001, p. 53). Vernadsky began to develop the issue of living matter in 1908, understanding this term as the totality of all organisms, plants and animals, including humans. In his works, the doctrine of living matter became one of the central components of the concept of biosphere.

In his work on the living matter, Vernadsky considers the natural mechanism of the accumulation of free energy in biosphere: "Living matter is not only a source of nutrients for geochemical processes, but also a source of free energy that supports them… It also appears in the earth's crust where the living matter is concentrated, in biosphere" (Vernadsky, 1978, p. 99). But more than a quarter

of a century earlier, similar thoughts, though using different terminology, were expressed by Podolinsky: "before the appearance of organic life on the earth's surface the reserve of convertible energy was generally small. The origin of organic life on the earth has changed considerably not only in its form and properties, but also in the amount and the manner of distribution of energy" (Chesnokov, 2006, p. 235).

In biology, the concept of biosphere, an 'area of life', was introduced in the early 19th century by Lamarck, and in geology in 1875 by Eduard Suess. However, this notion was perceived as a living population of the planet, without realizing its geological role. Vernadsky was the first to describe biosphere as a superficial geological envelope of the earth, configuring its surface. Giving lectures at the Sorbonne in 1922 and 1923, he stated that biosphere evolves because of the biogenic migration of chemical elements. Eduard le Roy in his lectures at Collège de France in 1927 introduced the notion according to biogeochemical principles postulated by Vernadsky, defining 'noosphere' as a modern stage, geologically experienced by biosphere, and stressed that he had come to such conclusions with Pierre Teilhard de Charden. But Teilhard's noosphere is not the next stage in evolution: it is "the ultimate phase of the phenomenon of man" which leads to the end of life on the earth (Kotov & Kull, 2011, p. 188). Vernadsky first described his conception of noosphere in a brief article, published in 1944. Stating that noosphere is the final stage of evolution in geological history of life, he claimed that at this stage "the man first becomes a tremendous geological power" (Vernadsky, 1944, p. 492).

In his doctrine on noosphere, Vernadsky outlined the process of active functioning of the concentrated energy under the influence of labour activity of human, stressing that the ability of man to intensify energy flows is associated with his spiritual development:

> Looking at the changes introduced by a new geological force—by the force of cultural mankind, created by changes of living matter over millions of years, you can see that the agent which sets it in motion is the conscience, the mind, the new power on our planet. Inevitably it will get also the conditions of its appearance, which will give it the maximum of possible action. (Vernadsky, 1989, p. 210)

Podolinsky's thoughts developed in the same area, as he claimed that we cannot consider the distribution of the converted energy on the earth's surface as the most profitable and quite satisfactory for human life. "On the contrary, we are

thinking that the opportunity for a more favorable distribution of this energy is to a certain extent in the hands of man" (Chesnokov, 2006, p. 228).

After the publication of Vernadsky's works, the name of Podolinsky began to appear in literature about the role of energy in living matter. The common ground between these two scientists was also manifested in the development of the problem of autotrophy—the production of food without participation of living matter. Vernadsky started thinking about this problem since 1918. On 11 February 1919 he wrote in his diary: "It is clear to me that the transmission of man to an autotrophic organism through the development of scientific work is a natural process, entirely falling within the scope of other geochemical processes" (Vernadsky, 1994, p. 129). On 16 December the same year, he makes the following entry in his diary: "Now I am serious about considering the questions of autotrophy of organisms, in particular of the autotrophy of humanity. Thus, autotrophy is one of the mysteries of life" (Vernadsky, 1994, p. 192). In 1925, Vernadsky's work *Autotrophy of Humanity* was published in France; later it was published also in Russian. According to Vernadsky, developing a chemical synthesis of food "could remove humans from dependence on other living matter. From a socio-heterotrophic being he would transform into socially autotrophic" (Vernadsky, 1885, p. 73).

Vernadsky wondered whether his predecessors thought about autotrophy. As it turned out, Podolinsky proved one of the first among Russian scientists to address this problem. He considered implementation of direct synthesis of food from inorganic substances very important for the purpose of meeting the needs of a growing population on the earth, as he posted in the conclusions to his book (Podolinsky, 1880a, p. 211). Humanity must be free from the intermediate stage in the use of solar energy, carried out by plants, and use it directly.

All of the above allows us to consider Serhii Podolinsky as one of the predecessors of Vladimir Vernadsky, who had hoped that his concept of noosphere would have an important role in strengthening the humanistic tendencies of modern civilization.

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