Views of Vilnius University biologists in the 18th–19th centuries

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...The God's spirit penetrates everything: the entrails of the earth and the deepest seas, and the boundless sky...everything comes back here, there is no death, and life is soaring among the constellations high under the blue vaults of heaven.

Vergilius, The Georgics IV, 221–227

The report presents the development of the chairs of natural sciences, chemistry, physics and others after the Vilnius Academy – (University) had been reformed into the Head School of the Grand Principality of Lithuania. Since the 1781–1782 academic year the Department of Physical Sciences of the School rejected the scholastic presentation of natural phenomena. At the Vilnius University the principles of biological evolution were developing in the period when it was unknown that life cannot appear by itself and before the evolutional mechanisms were revealed by Ch. Darwin in 1859 and L. Pasteur in 1860–1861.

The end of the 18th – beginning of the 19th century were noted for the development of physics and especially of chemistry, and improvement of methods of laboratory studies. Chemical and physical methods used in biology brought the latter closer to the former. This was the atmosphere in which the professorate of the University began to form and to do the teaching and research work. Here the names of professors Georg Forster, Andrzej Sniadecki, Stanislaw Jundzill, Ludwig Bojannus and Edward Eichwald deserve special note.

The development of the idea of biological evolution at the University is given a broad discussion: gradually, after the Earth and the necessary conditions had been formed, lower aquatic plants and animals began to develop; then the higher classes of plants and animals gradually developed. In the course of time, alongside the evolution of terrestrial animals, the human race appeared. Nature is supposed to have embodied in man the highest step of organization of the animals' world.

There are data enough to maintain that at the Head School of the Grand Principality of Lithuania (Vilnius University) formed a school of biological evolution, which had a positive influence on science and society.

The Vilnius Academy – University was founded in 1579. The scientific and cultural development of Lithuania and the neighbouring countries, to the East in particular, was related with the activities of this university. One can boast that the Vilnius University was established only 87 years after the discovery of America. But it is not the old age that makes the University important; it is its scientific developments as they exert a positive influence on both the economics and culture of society. Nevertheless, it is worth mentioning that both at the Vilnius and at other European universities in the flow of centuries the knowledge of natural sciences and philosophy did not always give a proper reflection of reality.

In natural sciences, biology in particular, senseless became the theory of flogiston which had survived up to the end of the 18th c. The followers of vitalism survived even longer. The term "vitalism" originates from *vis vitalis* (force of life). Up to the middle of the 19th c. it had been understood as a doctrine which maintained that the metabolism, i.e. the physical and chemical processes in the organisms, are governed by the force of life, or entelechy according to Aristotle. The synthesis of organic compounds found in plant and animal bodies in laboratory conditions was considered impossible without this force. Organic compounds of this type were first synthesized in the first half of the 19th c. Since then the vitalism doctrine began to fade out, and attempts to improve it failed.

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The end of the 18th c. is the period when Vilnius University was reformed into the Head School of the Grand Principality of Lithuania. The Educational Committee entitled the Head School to administer schools in all educational districts: Lithuanian with the centre in Grodno, Samogittian with the centre in Kražiai, Naugardukas with the centre in Naugardukas, and Polessye with the centre in Brest. The Vilnius Educational District was soon (in 1802) reorganized. It was authorized to control the educational process in the schools of Vilnius, Grodno, Kiev, Minsk, Mogilev, Podol, Vitebsk and Volyn provinces [1, 2].

Did the professorate of Vilnius University stick to a vitalistic or any other outdated approach while evaluating the very process of citizens' education?

The Chairs of Natural Sciences, Chemistry, Physics and other related sciences were founded in 1781. At this period the University was headed by the Rector, His Magnificence Martin Poczobut – Doctor of Theology, Royal Astronomer, Member of London Royal Scientific Society, Corespondent of Paris Royal Academy of Sciences. He maintained that for the Slate, of vital importance is to establish schools and academies to offer young people the possibilities to study all branches of science. He believed that the state's foundations would be ruined it there were no room for justice, wise solutions, intelligence and abilities, when true philosophy and other sciences that form the citizens' spirit are not developed [3]. His words suit best our epoch, but do those who regulate science nowadays know them?

The University's activities were divided into two faculties–collegia: of physical and of moral sciences. The first comprised chairs related to natural sciences, thus it is here that we should search for the professors that sticked to the vitalism doctrine, the more as late in the 18th and early in the 19th c. such views were advocated in many higher schools. We will discuss the activities of Chairs of Chemistry, of Natural Sciences (Historia naturalis) and others. While evaluating their work we will concentrate on two aspects: are right those who maintain that there were vitalists in these chairs [4]? If there were none, then how the physical and chemical processes in the organisms were explained?

It should be noted that at the period under discussion at the universities of Europe it was chemical and physical sciences, theoretical chemistry in particular, that gained most accelerated rates of development. It was the period when biological science came into a close contact with chemical and physical sciences, analytical methods were improving, new problems in experimental subjects of biology were realized.

These were the surroundings in which the professors of Vilnius University Chairs of Natural Sciences worked. Of them, most outstanding were Andrzej Sniadecki, Georg Forster, Stanislaw Jundzill, Ludwig Heinrich Bojannus and Edward Eichwald. Their activities developed in the period under discussion.

From separate phenomena they had to derive a scientific answer to the question: What is it that predetermines the course of biological processes in the organisms? The plant and animal systems compiled in the mid 18th c. by K. Linnaeus were quite enough to understand that each species of plants and animals is different. Is it the vital force – entelechy – that determines these differences? If it is entelechy that governs the organism's activities, then there is no room for chemical and physical rules in the process of perceiving their chemical and physical regularities.

Advances in chemistry exerted an effect on the other branches of sciences. A great impetus for the development of biological science was provided by P. A. Lavoisier in 1772–1782. He determined the composition of air gas and, rejecting the theory of flogiston, introduced a new theory of oxidation and respiration which explains respiration as a process of oxidation. Such a conclusion was enough to reject the flogiston theory which served as the theoretical basis of alchemy. Moreover, the late 18th and early 19th c. was a period very favorable for chemistry to develop, which in turn induced revision of the theories that had been used since long in biology. Professor of chemistry A. Sniadecki maintained that the organism's life is determined not by the vital forces, but by the chemical and physical processes peculiar to plants and animals, which differ even among the species. His work "A Theory of Organic Bodies" was published in Warsaw in 1804 and in 1811, 1838 and 1861 in Vilnius, and in 1925 it was published in German and French. Thus it was available for European scientific society of the time. A. Sniadecki singles out two classes of organic bodies – plants and animals. They possess a common life organization. Nutrition in plants and animals has the common traits such as accumulation of solar light energy in the form of the energy of organic compounds synthesized from carbon dioxide and water. Then, solar energy is necessary for being accumulated as chemical energy in plants in the process of photosynthesis [5].

What did the other outstanding investigators of photosynthesis think on the subject at that time?

The last N. Th. Saussure's conclusion presented in 1804 can be expressed by the formula:

carbon dioxide + water + light $\xrightarrow{\text{plant}}$ organic matter + oxygen.

In N. Saussure's formula there is no notion of energy, while A. Sniadecki in 1804 maintained that the core point of photosynthesis is the transformation of solar light energy into chemical energy in organic compounds. He maintains:

carbon dioxide + water + light (energy) $\xrightarrow{\text{plant}}$ organic matter and energy + oxygen.

Light energy is necessary for decomposing the water molecule whose hydrogen is used for carbon dioxide reduction. This idea was brand new for the time and, what is most important, it was correct. As long as 150 years attempts were made to explain how carbon dioxide is reduced in the process of photosynthesis; several theories on the subject were advanced. A. Sniadecki's teory was not considered in them. The problem was solved by two independent groups of scientists: 1) A. Vinogradov and R. Teiss, and 2) the American S. Ruben with colleagues in 1941, with the aid of oxygen isotope O^{18} as part of CO_2^{18} or H_2O^{18}, found that during photosynthesis the oxygen isotope O^{18} present in water is isolated [6, 7]. Only in our times it has been proved that A. Sniadecki was right: during photosynthesis oxygen is isolated from water. According to A. Sniadecki, all living organisms use the portion of solar energy accumulated by plants through photosynthesis. Animals are unable to provide themselves with energy. A. Sniadecki considers respiration, *i. e.* oxidation of organic compounds as one of the most important biochemical processes according to scheme:

organic matter and its energy + oxygen $\xrightarrow{\text{animals}}$ carbon dioxide + water.

The animal's life is determined by its ability to use solar energy accumulated as organic compounds from nutrition. Thus, solar light energy is the common source of energy for both plants and animals. I dare say that A. Sniadecki's thesis about the use of solar energy in biological systems – plants and animals – has substantiated the principle of energy preservation in living organisms. By saying so I by no means belittle the wisdom of R. Meyer who found the law of universal energy stability and proclaimed it in 1845 [8].

Without knowing the principles of evolution of the living organisms it is impossible to explain how the peculiarities of physical and chemical regularities have formed. According to A. Sniadecki, such regularities were established by the Creator of the world: "All living organisms are part of the created world and as part belong to the whole" [5; p. 12]. His thesis about the common physical and chemical traits of vital activity in plants and animals is correct. Then he says: "Hence we learn that this force which during the initial creation of organic bodies for the first time transferred matter into the organic state still survives and is unchanged. Further I'll call it the organizing or organic force. It may be called the organic force of a genus or of a species, therefore I'll call it the organic individual force; eventually it is proper to a separate individual" [5]. Such an organizing force, according to him, is the chemical and physical transformations that occur in living organisms.

It would be not correct to identify with vital force the individual force considered by A. Sniadecki as the regularities of physico-chemical transformations in the organisms of different classes, families and even species. Only a similar term – live force (kinetic energy) – survived up to the beginning of the 20th c. Maybe it is such terms that arose suspicions, even in our times, that here the vitalistic approach was meant [9].

Other biologists of that time also deserve mentioning. The second half of the 18th c. marked the beginning of the science of plant physiology. J. E. Gilibert, professor of Vilnius University, in 1786 wrote: "Plant anatomy and physiology are not well elaborated; they are, frankly speaking, the truths ascribed to botany" [10, 11]. This is a new branch of botanical science, although the official opinion still survives that the term "plant physiology" was first used in 1800 by J. Senebier [12].

J. E. Gilibert should be also mentioned as one of the first botanists who considered the K. Linnaeus's system not natural, therefore in his work "Outline of the Lithuanian Flora" (1781) he tried to group the species according to their affinity: in each systemic "group we brought together the species that have been drawn together by nature" [10].

Let's return to experimental botany. The founder of plant physiology in Lithuania was S. Jundzill. He did not substantiate the idea of evolution, however, like A. Sniadecki, he was convinced that the species had been created by the hand of the almighty Creator, and the physiological transformations in living organisms depend on the physico-chemical transformations in them. In the manual "Elements of Botany" (published in 1804 in Warsaw, in 1818 and 1829 in Vilnius) he directly says that "the goal of physiology, or plant physics, is to cognize all the parts of the organic system which form a plant, and the influence of these parts (organs – A. M.) on the whole organism, eventually on the life of the plant itself, its growth, reproduction and life continuation" [13]. The manual presents also the general knowledge of the time in plant physiology, with fundamentals of chemistry.

S. Jundzill paid due attention to the environmental factors, or ecology, as we would put it nowadays. They affect both plants and animals, without singling out man from the other Primates, but considering him a separate species of them [14]. This was his idea expressed in "A Concise Zoology" (Vilnius, 1807). Who knows what was the reflection of his idea of man belonging to the Primates, *i. e.* of his being close to apes? We can guess the then mood upon recollecting how 52 years later, when Ch. Darwin ascribed man to the same evolutionary line to which not only the Primates, but also all other mammals belong, just a storm of the protests was evoked because of Darwin's having unforgivably insulted the human race.

S. Jundzill was on the verge of understanding from his observations that the species in K. Linnaeus's system are not stable, they undergo evolution. It would be injustice if nowadays, 200 years later, we started boasting of the supremacy of the heights attained in biology by our contemporary scientists. Each period of time has its own heights, with their own beauty and visions. We cannot accept either A. Sniadecki's or somebody else's idea that the bodies the moment of appearance were endowed by the supreme force the unchanging biological-physical and chemical motion, each species its own, once and forever.

Such an idea was not contrived by the professorate of Vilnius University. It was inherited from the earlier ages. The outstanding physicist I. Newton in the 17th c. maintained that the initial impetus to celestial bodies had been given by the Creator. In the middle of the 18th c. the University of Sorbonne warned, as a negation of J. L. Buffon's ideas, that no idea should be advanced about the species having appeared without the Creator's mercy. Works of J. L. Buffon were known at Vilnius University, and S. Jundzill pointed them out in his lectures on zoology [15]. Even J. B. Lamarck, the famous pillar of biological evolution, in the early 19th c. seemed to believe that the evolution of the living organisms started upon the Supreme Creature given them biological motion. Still I would like to say that the panorama of the then botanical science led A. Sniadecki's and S. Jundzill's works and mentality to the dawn of biological evolution. The science of plant and animal evolution began to flourish later, changing not only the contents of biology, but also the philosophical understanding of nature's evolution. But this was already the second half of the 19th c.

We should not be too strict, for as early as the 18 c. ideas of biological evolution had been already declared at the Vilnius University – the Head School of the Grand Principality of Lithuania. For example, G. Forster, the precursor of A. Sniadecki and S. Jundzill, professor of natural sciences, doctor of philosophy and medicine, member of numerous scientific societies of Europe, believed that the living organisms evolutionize, therefore in 1784–1787 he concluded his lectures on botany and zoology by saying that "the science of the year will be crowned by the theory of the generative origin of organic bodies, as well as their interrelations" [16].

Interrelations of the living organisms are revealed by comparing them with those extinct and those that came into being before. Man is allied with other animals, and such a conception doesn't allow the science of zoology to occupy a place it deserves. The human race changes the environment. Accepting the variability of living organisms, G. Forster, at least formally, maintains that it was the world's Creator that has established the harmonious initial order of the sum total of the organisms [16, 17].

In the University environment, the approach to the state of living nature underwent gradual changes. Thirty years following the University reform, the doctrine of biological evolution was formed in it. All biological professors, L. H. Bojannus (1776–1876) and E. Eichwald (1795–1876) in particular, should be considered its authors.

L. H. Bojannus since 1806 was professor of Animal Treatment Chair at Medical Faculty, till 1823 he was giving lectures on comparative anatomy. His splendid education resulted from two factors: (1) progress in biological (natural) sciences and (2) his teachers. Among the latter we should mention the famous French researcher, zoologist and paleontologist J. Cuvier (1769–1832), whose merits in science cannot be overestimated: results of his studies were used by J. B. Lamarck, Ch. Darwin and other scientists.

However, even J. Cuvier was not always right. H. Bojannus argued with J. Cuvier's theory that species change not through the evolution. He considered them stable. On the other hand, he saw palaeontological studies to indicate clearly that animals underwent considerable changes in the course of time. J. Cuvier explained these changes as follows: at definite periods on the Earth occurred catastrophes – cataclysms, when life on the Earth would be destroyed. Later on the Creator would create new species. Moreover, J. Cuvier harshly attacked J. B. Lamarck, because the latter explained the evolutionary processes in nature. His ideas on the biological evolution are explicitly developed in his work "Philosophy of Zoology" (1809). The term "biology" was coined by J. B. Lamarck.

L. H. Bojannus was J. Cuvier's contemporary. His vews on the biological processes differ from those of J. Cuvier. The core of his theory is as follows: the organisms develop through evolution. He says: "Material nature, according to its laws and order, in some way smoothly passes from simpler to more complicated and perfect forms; most diverse natural phenomena are not separated from one another by a strict limit or impenetrable wall" [18]. Then he says that the nature's efforts are most perfect creation. Everywhere the same common life is manifested according to its eternal laws, and the mind strives to overview the battle of the forces and to add to disclosing the nature's mysteries, because nature develops from the kingdom of plants up to the very man.

Moreover, L. H. Bojannus, as an expert in comparative anatomy, substantiated the evolutionary theory by both renowned biological studies and his own works. At that time he was acknowledged by the most outstanding researchers in the field. Here are some examples of his works. The famous poet J. W. Goethe believed that the animals' skull has developed from the upper vertebra. L. Oken in the journal "Isis" started a discussion on the origin of the skull, and L. H. Bojannus in 1818–1821 published several papers on the subject, in which he as a fostered of evolution maintained that the analysis of the problem should be started from the fish to determine from which elements their skull had been formed, and then to extend the analysis up to the mammals. His most significant work (in tortoise anatomy) was published in 1819–1821 in Vilnius. This work has retained its scientific value up to now. J. Cuvier wrote that this book was wonderful, as no other animal had been given such an exhaustive study.

L. H. Bojannus was recognized in Europe. His fame was high. While visiting the J. W. Geothe's House–Museum in Weimar, I saw in the poet's study a portrait of L. H. Bojannus.

Among other cherishers of evolutionary ideas, Edward Eichwald (1795–1876) should be mentioned. He arrived to Vilnius in 1829 from the Kazan University to occupy the vacancy of professor in comparative anatomy and zoology. His arrival to Vilnius was probably induced by two incentives: by the invitation to occupy the chair of the famous scientific man L. H. Bojannus and by the proximity of Vilnius to his native town Jelgava. He worked at the Vilnius University up to its closing in 1832. From E. Eichwald's manual of zoology and his other works we can see that his views in biology were consistently evolutionary. Such views were induced by several factors: he had a good background in geology, paleontology and zoology, and the evolutionary approach to biological processes which predominated at the Vilnius University encouraged him to go deeper into the laws of natural development. Besides, I believe that he was also given an impetus by his acquaintance with most outstanding naturalists of Europe: five years after graduating from the Berlin University he visited J. Cuvier, A. Humboldt, listened to J. B. Lamarck's lectures, attended the British Museum in London, in Vienna visited the botanist V. J. Jackin, etc.

His main works are "Traits of Natural History of Lithuania, Volyn and Podol" [19, 20] and "Special Zoology" (vol. 1, 1829, vol. 2, 1830 in Vilnius).

They reveal the author's views on the evolution of live nature which is related to the ecological conditions of the globe and their evolution. He believed that primitive plants and animals have common traits, and he considered the evolutionary development of the fauna as a uniform stream from simpler organisms up to most complicated species, up to man [19, 21].

According to E. Eichwald, the biological evolution took the following way:

Liquid earth → earth crust → conditions for plants and animals to develop.

Appearance of lower aquatic plants and animals marks the beginning of the first epoch on the earth. In the second epoch gradually appear higher terrestrial animals, however, aquatic animals still prevail. The earth's surface changes: ranges of mountains now subside, now the new appear. The subsidences are occupied by lakes; rivers and rivulets begin to flow. The land surface increases up to the area able to give food to land animals, so the aquatic animals become of secondary importance. The third epoch on the earth is characterized by a sudden change of temperature. In the north the zone of frost appears, and glaciers form around the poles. This epoch is still going on. At last, alongside terrestrial animals, the human race has appeared. "Thus we observe how nature gradually developed from the lower forms, and at last in man it has embodied the highest step of organization of the animal world".

These words of E. Eichwald conclude our relation about the theory of biological evolution at the Vilnius University. It will be not too much to say that professors-biologists of Vilnius University have founded the Vilnius School of evolutionary biology.

The professorate of the higher school of Vilnius – Vilnius University late in the 18th c. and early in the 19th c. substantiated a thesis that the organisms' activity depends on the physico-chemical processes, that the organisms in the long course of evolution underwent changes – they have been improving up to man, the most perfectly developed form.

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Neither the representatives of the Vilnius School of evolutionary biology nor their precursors (J. Buffon, J. B. Lamarck et al.) knew that the primitive organisms, even their simplest forms, cannot appear by themselves in any medium; this was later proved by L. Pasteur in 1860–1861. According to the present understanding, the initial organisms – prokaryote predecessors were created by nature through a long chain of physico-chemical processes. From it the biological evolution started.

At the time under discussion nobody knew it for sure what are the mechanisms that induce evolutionary changes in plants and animals. The answer was given later by Ch. Darwin in his work "The Origin of Species" published in 1859. He pointed out that the new species appear because of a struggle for existence in the changing conditions of life: the individuals that fail to accommodate to the environment perish without leaving offspring, and those best fitted survive unchanged in the new environment, because the organisms are characterized not only by changeability, but also by inheritance of the acquired features.

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XVIII–XIX A. VILNIAUS UNIVERSITETO BIOLOGŲ PAŽIŪROS

S a n t r a u k a

Pranešime aptariama, kaip reformavus Vilniaus akademiją-universitetą į Lietuvos Didžiosios Kunigaikštystės Vyriausiąją mokyklą fizikos mokslų skyriuje nuo 1781–1782 mokslo metų pradėjo veikti Gamtos mokslų, chemijos, fizikos ir kitos gamtamokslinės katedros. Atsisakyta scholastinio gamtos reiškinių supratimo.

XVIII a. pabaiga – XIX a. pradžia pasižymėjo fizikos ir ypač chemijos mokslo plėtra, laboratorinių tyrimo metodų tobulėjimu. Biologijos srityje naudojami chemijos bei fizikos metodai ją ypač suartino su šiais mokslais. Tokioje aplinkoje universitete mokomąjį ir mokslinį darbą dirbo universiteto profesoriai. Iš jų paminėtina Georgo Forsterio, Andriaus Sniadeckio, Stanislovo Jundzillo, Liudviko Bojanaus ir Edvardo Eichwaldo mokslinė veikla.

Aptariama biologinės evoliucijos minties plėtra Universitete: palaipsniui susiformavus žemei ir atsiradus sąlygoms gyvybei vystosi žemesnieji vandens augalai ir gyvūnai, atsiranda aukštesnių klasių gyvūnų ir augalų. Ilgainiui greta sausumos gyvūnų evoliucijos atsiranda žmonių giminė. Buvo sakoma, kad „gamta žmoguje įkūnijo aukščiausią gyvūnų pasaulio organizacijos pakopą".

Biologinės evoliucijos principai formavosi laikmečiu, kai nežinota, kad gyvybė savaime neatsiranda ir kas skatina augalų ir gyvūnų kintamumą. Į šiuos klausimus atsakė L. Pasteras 1860–1861 m. ir Č. Darvinas 1859 metais.

Galima teigti, kad Lietuvos Didžiosios Kunigaikštystės Vyriausioje mokykloje – Vilniaus universitete – susiformavo biologinės evoliucijos mokykla, turėjusi teigiamą įtaką mokslui ir visuomenės pažiūroms.