

L.A. Orbeli - Outstanding Physiologist and Science Leader of the Twentieth Century

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L.A. Orbeli and his school developed new directions in physiology: evolutionary physiology, the theory of adaptational-trophic functions of the sympathetic nervous system, the theory of coordination of functions, and neuroendocrine regulations in the body. Orbeli enriched the study of the physiology of the cerebellum, the sensory organs, the kidneys, and the study of pain. His name is associated with the development of the foundation of physiology of extreme states (the physiology of deep-sea exploration, high altitude, and high velocity flight).

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Introduction

Leon (Levon) Abgarovich Orbeli may be considered an outstanding physiologist and scientist, methodologist, and scientific heir of I.P. Pavlov. He is the founder of a large scientific school. Orbeli and his school developed new directions in physiology: evolutionary physiology, the theory of adaptational-trophic function of sympathetic nervous system, the theory of coordination of functions, and neuroendocrine regulation in the body. He promoted the development of the physiology of the cerebellum and sensory organs, the physiology of the kidneys, the physiology of pain and extreme states (deep-sea diving, high altitude, and high velocity flights).

Orbeli was born on July 7th, 1882, in one of the most beautiful corners of Armenia and given the poetic name Tsahkadzor (valley of the flowers). He was born in the family of the renowned legal scholar of Transcaucasia Abgar Iosivovich Orbeli, who was a graduate of St. Petersburg University. His childhood and youth were spent in Georgia. He graduated from the 3rd Classic Gymnasium in Tiflis (Tbilisi). Since the age of 17 until the end of his life (almost 60 years from 1899 to 1958) he lived and worked in St. Petersburg (Leningrad), Russia.

Leon Orbeli together with his brothers Ruben (one of the founders of the underwater archeology) and Iosif (well-known historian of the East and of Armenia, archeologist, art historian, director of the State Hermitage museum) were raised in a family with old traditions. There was an atmosphere of respect toward the ancient culture of Armenia, adoration of beauty, high moral ideals, and spiritual values. Uncompromising truthfulness, generosity of the soul, honesty, and high principles were characteristic for all Orbelis.

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Figure 1. Orbeli (left) and Pavlov.

These family traditions defined the future of Leon Orbeli, a man of high personal courage and dignity, encyclopedic education and profound knowledge of natural and humanitarian sciences, music, and theater.

Orbeli studied in one of the best medical schools of Russia — the Military Medical Academy (MMA) in St. Petersburg (1899–1904), where he was taught by famous scientists such as the histologist M.D. Lavdovski, the zoologist N.A. Holodkovski (a translator of *Faust*), and the physiologist I.P. Pavlov. He advanced his knowledge in the laboratories of Western Europe, including Ewald Hering in Leipzig, John Newport Langley in Cambridge, and at the Biology Station in Naples (1909–1911). He became a university teacher in 1913 and professor of MMA from 1925 to 1950; he was professor of Physiology at the First Leningrad Medical Institute between 1920 and 1931. He was elected member of the Academy of Sciences of the USSR (consider AS of the USSR) in 1935 and acting member of the Academy of Sciences of Armenia Socialist Republic in 1943. His brother Iosif was a first president of the Academy of the Sciences of Armenia. L.A Orbeli was an honorable and foreign member of many Academies of Sciences of the Western Europe and of the United States. He saw sources of his spiritual, moral, and intellectual development his “luck” in life and in science in the constellation of beneficial conditions and factors: his belonging to one of the oldest nations in the world, upbringing in a family of intelligentsia, education at an elite Medical School, and in being educated by famous physiologists.

Main Scientific Achievements of Orbeli and his School

Theory of adaptational-trophic function of the sympathetic nervous system. Orbeli started his research on the role of the sympathetic nervous system (SNS) and the life function of

animals at the Physiology Laboratory of the Leningrad Medical Institute in the early 1920s. According to the classic theory of John Newport Langley, sympathetic nerves of the autonomic nervous system innervate everything in the body except skeletal muscles. The first experiments conducted by the student A.G. Ginetsinski, under the guidance of Orbeli in 1922–1923, showed that stimulation of the sympathetic nerves gradually restores the work capacity of the exhausted skeletal muscle (Orbeli, 1923, 1932; Ginetsinski, 1923). The muscle exhibits the ability to perform stronger and more prolonged contractions. In the international physiology literature, this phenomenon — the increase in excitability, contractility, and strength of contractions — carries the name of “Orbeli-Ginetsinski phenomenon” (Brücke, 1927). Further experiments in this direction lead Orbeli to conclude that the SNS causes profound physical and chemical changes in the striated muscle, leading to functional changes in the muscle. Orbeli saw sympathetic innervation of the striated muscle as an adaptational-trophic innervation. Orbeli and his school “developed a direction of extreme importance by resolving a question that resisted resolution by physiologists for more than half a century — the question of trophic innervation” as was written by Pavlov in 1931 (Pavlov, 1975). The study of the role of the cerebellum in the body was a new phase in the work of Orbeli’s school. This research represents a logical extension of his study of the adaptational-trophic role of the SNS, significantly extending the views of classic physiology of the cerebellum as a center of movement coordination. The school of Orbeli established several facts, observed during the stimulation of the cerebellum: changes in the arterial pressure, changes in pressure reflexes, sudden shifts in the excitability of the SNS, and decrease of peristalsis. This allowed discussing the influence of the cerebellum on all of these functions, animalistic as well as vegetative. A complex interaction between the cerebellum and the SNS, between cerebellum and hypothalamus, and between cerebellum and the cortex was established. The circular feedback pathway of cerebellum-SNS-cerebellum was established as well. Convincing data, provided by Orbeli’s school, about the existence of these feedback loops between the peripheral and central structures of the SNS, between the latter, and the cerebellum and the cortex acquired a new meaning in light of the discoveries in the physiology of the reticular formation (Tonkih, 1965).

In 1948, following more than 25 years of research on the role of the SNS and cerebellum in light of the evolutionary theory, Orbeli proposed a theory of adaptational-trophic function of the SNS in the body. The adaptational-trophic function of the SNS is defined by regulation and stabilization of functional qualities. Orbeli proposed that adaptational-trophic innervation is a certain transitional step in the evolutionary process of the influence of the nerve on the innervated organ; he distinguished further transitional forms of innervation as imitation, adaptation, and trophic forms.

Study of the coordinational relationships. In his article “On the Mechanism of the Development of Spinal-Cerebral Coordination” (1923) data were provided proving the legitimacy of the evolutionary approach toward the study of the coordinational relationships (Orbeli, 1961). This study of the formation of reflexes allowed to follow the increase in the complexity of the coordinational relationship in the processes of onto- and phylogenesis. The variability in the course of onto- and phylogenesis is an important factor in allowing the possibility of progress in the animal kingdom. Many years of research of functions of the nervous system from its lower levels up to the cortex allowed Orbeli to formulate the theory of functional evolution of the nervous system. The essence of the

theory is that in its development every function passes through three phases (Orbeli, 1961):

1. A period of autonomic activity when the organ or the tissue is fully dependent on the local conditions for its function (chemical, thermal, etc.);
2. A period of coexistence of two forms of activity — an autonomic and a central in which the initial stage of development is characterized by suppression by the central nervous system of local automatisms;
3. A period of complete suppression of automatisms; suppression of the mechanism of coordination of lower levels of the nervous system by higher levels.

According to Orbeli, in the process of the development of functions, old functional relationships do not disappear completely; they coexist with the later developed forms, but in a “displaced” state; they become inhibited, suppressed, and “hidden” only to appear during disorders of the physiology of the body. The important quality of the functional evolution is progressive suppression by the nervous system of the functions of the organs and tissues as they develop and advance.

Problems of the Evolution of Behavior in the Works of Orbeli

Orbeli’s concept of the functional reorganizations during the onto- and phylogenesis is a significant contribution in the behavioral sciences and creative achievements of the physiology of functions of the central nervous system. The research program to study the evolution of behavior included a significant range of the comparative-physiologic studies including groups of animals selected from the point of view of potential possibilities of their nervous system. Orbeli concentrated his attention on the study of the central nervous systems of insects, birds, mammals, and humans. The selection criterion was the correlation of the congenital (hereditary) and acquired forms of behavior.

In his presentation “The Application of Evolutionary Principles to the Study of the Physiology of the Central Nervous System” (1942) (Orbeli, 1961), Orbeli proposed the idea of the importance of certain early stages of ontogenesis on all of the future development of behavior. Since birth, the human organism being “not completely mature” and “not having completely realized” its hereditary inclinations comes under the influence of various conditions — physical and social, which serve as a beneficial condition in its further development. Orbeli’s idea of the “maturation” of a number of hereditary inclinations after birth under the influence of forming conditional reflexes in the process of their interaction agrees with a number of the postulates of ethology.

In the early 1950s, Orbeli began to study the formation of human behavior in ontogenesis with the purpose of describing the basic stages of the maturation. The article “On Some Ways of Studying the Higher Nervous System Activity of the Child” (1955) describes a wide range of ages from the moment of birth including mature and premature children up to the age of 14–15 years (Orbeli, 1961). During his whole career Orbeli consistently developed the idea of necessity of supplementation of the Pavlovian objective method of research with the research of the subjective manifestations of the psyche. This idea, first offered in his doctoral dissertation *Conditional Reflexes in the Eyes of the Dog* (1908) was further developed in the course of the lectures on the physiology of the nervous system in the 1930s (Orbeli, 1961).

In *Lectures on Physiology of the Nervous System* (1934) the encyclopedia of neurophysiology of the beginning of 1930s, the eighth lecture is especially dedicated to psychophysiological problems. Orbeli emphasized: “it would be a severe and profound

methodological error to accept a point of view of negating the subjective world anywhere except oneself, not only in relationship to humans, but also in relation to other members of the animal kingdom.” Orbeli thought that the methodological approach and devices of research applied to dogs by Pavlov became insufficient at a certain phase when applied to the various species on the various levels of development. The subjective method is clearly necessary in the study of the brain function of man.

In the lecture “Physiology and Psychology” (1945) Orbeli raised the question about the interrelationship between physiology and psychology. Physiology, according to Orbeli, is poised at the threshold of a new phase where the results of the previous work of physiologists of the whole world has to be tied with general biology and psychology in order to create a unified and integrated knowledge about the life of man and human behavior. Accepting the predetermination of all forms of action and deeds does not contradict the acceptance of independence of active behavior. Man ceased to be a passive “responder” to the influences of external environment.

In his program speech “The Main Goals and Methods of Evolutionary Physiology” (1956) Orbeli stressed that for evolutionary physiology a specific historic period of human existence is of significant interest. Orbeli foresaw success in understanding the whole of human behavior including his emotional and spiritual world in the correct interaction of three fundamental sciences: biology, physiology, and psychology. These three sciences study biological, neurophysiological, and social-psychological bases of the human behavior.

Physiology of the Extreme States

Orbeli’s school started and successfully developed a new direction of physiology research — the physiology of extreme states associated with the research of human well-being in unusual states. The first works that founded the beginning of the new direction were conducted at the Department of Physiology of the Military Medical Academy. These studies looked into the influence of increased muscle activity on the function of the alimentary glands (A.P. Brestkin, C.P. Prikladovitsky) and blood chemistry (E.M. Kreps, V.V. Streltsov). As a result of this research, recommendations on a rational regime of labor and food rations for soldiers were worked out. Simultaneously, there was ongoing research of the influences of the various physical factors on the body: increased and decreased atmospheric pressure, electric current, electromagnetic field of various frequencies.

In his presentation at the conference dedicated to the problems of stratospheric travel (1935), Orbeli stressed that stratospheric travel represents a shift to completely new conditions of existence. Following the program developed by Orbeli, the research was concentrated on the study of the influence on the body of ultraviolet and space radiation, ozone, and high acceleration. Combined efforts by physiologists, biochemists, biophysicists, physicists, and technicians were necessary.

Professions associated with diving (physiology of the deep-sea diving and underwater swimming) and to high altitude and high velocity flights (aviation and space physiology) required scientific substantiation. The physiology of the deep-sea diving, first studied by Claude Bernard’s student Paul Bert, is a child of twentieth-century science. The systematic and concentrated research developing a theoretical basis of the deepwater diving, started at the Department of Physiology of the Military Medical Academy in the beginning of the 1930s, led to the States Prize in 1950s. Orbeli and his students achieved record successes: submerging down to 200 meters, increase in length of staying on the bottom, and the decrease of the ascent time of the divers. It is accepted that the credit for the use of helium instead of nitrogen belongs to Jacques Yves Cousteau. However, this idea was

realized by Orbeli's school by working out helium-oxygen tables before Cousteau (Orbeli et al., 1944; Kreps, 1975). Special studies were conducted under experimental conditions in the baro-laboratory at the department and subsequently on the Black Sea to check the safety of the practical implementation of the results of the deep-sea research. All who worked in the Safety and Rescue Commission noted that Orbeli participated personally in the research at the baro-chamber as well as in the sea. The works of Orbeli's school created a physiological foundation for further achievements in high-altitude aviation and the safety of the deep-sea diving.

Orbeli's View on the Dialogue Between Science and Culture

The general cultural significance of science as a means of communication, recognition, and mutual understanding between peoples was obvious to all classical scientists. This is evidenced by the international character of the scientific schools of the nineteenth and twentieth centuries. This trend is present in the physiology schools of Carl Ludwig and I.P. Pavlov. There are no better means of mutual understanding, said the famous physicist of the twentieth century and Noble Prize laureate W.K. Heisenberg, than personal familiarity with the people of various nations (lecture "Science as a Mean of the Mutual Understanding Between Nations," 1956).¹

While exhibiting mutual interests, preeminent scientists and cultural figureheads were looking for ways to cooperate, stressing the unifying common factors. According to Orbeli, these unifying factors are imagination, beauty, freedom and flight of thought, and the art of communication. Science and art have one interest in common: the working of the human brain, human soul, and all higher manifestations of the human spirit. A theater director and a scientific mentor are interested in preparing the next theatrical or scientific generation. They have similar goals: to prepare an executor of a theater director's or of a scientific mentor's will or to prepare a creative individual.

The crowning achievement of science is the understanding of a creative process. However, this cannot be achieved by science alone since the most variable forms of creativity could be found in art. Bringing the scientists and artists together is necessary to the various forms of the creative process. It is not a coincidence then that a discussion on the creative process that was started by Orbeli with the theater community (MKhAT² and Malyi³) on July 12, 1945, lasted until 1949 (Orbeli, 1968a). Unfortunately, this productive dialogue between the scientists in the theater community was interrupted because of the "Pavlovian" session. Orbeli stated that for lifelike acting it is necessary to use the congenital abilities correctly. These abilities should be brought out and liberated from the inhibiting, binding, and slowing influences associated with the current cultural customs, from the formal interactions of life. Therefore a human being possesses unlimited capabilities: a fully manifested ability to reconstruct the coordination of movements and to reconstruct the forms of behavior. Orbeli called this adaptation of adaptability. He supported scientific research aimed to strengthen the links between art and science, and cooperation between the scientists and artists. In July 1947, under the chairmanship of Orbeli, there was a discussion following the report of the voice training

¹In the winter of 1955–1956 he gave the Gifford Lectures "On Physics and Philosophy" at the University of St. Andrews.

²Moskovskii Khudozhestvennyi Akademicheskii Teatr(MKhAT — Moscow Art Academic Theater was founded in 1898. The famous plays of A.P. Chechov — *The Seagull*, *Uncle Vanya* and *The Three Sisters* — were first staged in this theater by its leader K.S. Stanislavsky.

³Malyi Theater, the oldest theater of Russia, was created at the Moscow University in 1756.

methodologist K.B. Zlobin “Psychophysiology as a Scientific Basis of the Unified Voice Training School.” This occurred at the I.P. Pavlov Institute of Physiology of the Academy of Sciences of the USSR. In the introduction written by Orbeli to Zlobin’s monograph *Physiology of Singing in the Prophylaxis of the Voice Diseases in Singers* (1958), he mentioned the importance of the point that singing is not a function of the voice apparatus alone but a complex integrated function of the whole body. Nine years later, in 1956, there was a discussion of the manuscript of P.V. Simonov, the future member of the Academy of Sciences, *K.C. Stanislavsky’s Method and the Physiology of Emotions*. This was organized at the I.M. Sechenov Institute of Evolutionary Physiology of the Academy of Sciences of the USSR recently founded by Orbeli. The analysis of the Stanislavsky Method was conducted based on the achievements of neurophysiology. Simonov noted with gratitude that the work on the final version of the monograph “was quite helped by the comments of the member of the Academy L.A. Orbeli who reviewed the manuscript in the spring of 1956.” Simonov considered Orbeli his first reader and critic of the book (Simonov, 1981). It seems that the study of children’s drawings is an area far removed from Physiology. However, Orbeli was the only physiologist of that time who concluded the necessity of studying this activity in children as an indicator of the importance of functional development of higher levels of the brain in the child.

Under the leadership of Orbeli a study was conducted dedicated to the research of the physiological basis of children’s graphic artistic activity. In Z.V. Denisova’s monograph *The Physiologic Interpretation of Children’s Drawings* (1974), it was established that at the early stages of ontogenesis of a child there appear new and progressively more complex ways of reacting to the influence of the environment, such as the ability to perform such functions as drawing or playing musical instruments.



Figure 2. Orbeli in uniform as the director of the Military Academy.

The stenograms of Orbeli's speeches to the theater community have been published posthumously in the fifth volume of his *Selected Works* (1968b) and in a special edition of the *Vestnik Archivov Armenii* (1982, No. 1).

L.A. Orbeli in the Military Medical Academy (MMA) (1899–1950)

Orbeli entered the MMA as a 17-year-old young man. It is here that he became “privat-docent” (1911), lecturer (1913), professor (1925), and director of the academy (1943–1950); it is here that he delivered his last public speech “On the Interrelationship of the Evolutionary Physiology and Medicine” (1956). It is to his alma mater that Orbeli owes his scientific upbringing, the meeting with his first mentors and his friends. He was lucky to be a student and successor of Pavlov at the Department of Physiology (1925–1950).

There was a reorganization aimed at turning the direction of activity of the MMA from scientific to military, putting education and science at a disadvantage. Orbeli consistently spoke out in defense of the academy as the main scientific-medical center preparing physicians by fundamental medical-biological education. It was Orbeli's opinion that the departments of the academy have to participate in scientific work aimed at strengthening the defensibility of the country, and improvement of lifestyle and labor in the army. Along with these efforts, he said, it is necessary to maintain the status of the academy as a center of scientific research and as a breeding ground for the scientific forces of the whole country. Thanks to Orbeli, the militarization of the academy occurred without, what he called “de-intelligenciation.”

Having participated in the launch of one of the first stratostats in the USSR in the beginning of the 1930s, Orbeli actively participated in the systematic research in areas of aviation physiology, physiology of diving, and construction of the first powerful baro-laboratory in the USSR at the MMA.

Being a director of the academy, Orbeli created the Moscow branch of the academy including the Scientific Research Testing Sanitary Institute and the Institute of Aviation Medicine during the years of the Great Patriotic War (WWII). Under Orbeli's supervision, the problems of high altitude and high velocity flights, problems of hypoxia, protection of the pilots against the effects of high g-forces, and problems of catapulting were addressed.

In the late 1940s, following Orbeli's orders, a special group based at the Department of Physiology was organized. The aim of the group was to conduct experimental research to study the influence of the ionizing radiation on the human body and on animals. Orbeli was well informed about the military codes of conduct; he considered these to be very important documents since they reflect the military experiences of many years and the wisdom of extraordinary military leaders. These codes demand polite and respectful attitudes between the military personnel of the same rank and with the subordinates. He did not like when the military codes of conduct were broken. His influence on the MMA was enormous. Here, he created a scientific community of a rarely encountered intellectual, moral, and humanitarian intensity.

Orbeli as Head of the Division of Biologic Sciences of the Academy of Science of the USSR (1939–1948)

The Division of Biologic Sciences of the Academy of Science of the USSR was founded in February of 1939 (prior to that, biologic sciences were represented in the Division of Physics and Mathematics). Orbeli was unanimously elected as its head. From the very beginning, he concentrated his attention on the development of prospective directions in biology, biophysics, biochemistry, the evolutionary biology, and genetics. Being the Head of the Division for about ten years, from March 1939 until August 1948, he withstood the



Figure 3. Orbeli in the operating room.

attacks on genetics to the best of his abilities. Singularly, he came to the defense of N.I. Vavilov and the Institute of Genetics directed by him. It is not his fault that political terror predetermined the fate of the outstanding scientist and hindered the development of genetics in the USSR for many years. At the August session of the All-Union Academy of Agricultural Sciences (1948), Orbeli's performance as the Head of the Division who supported genetics and geneticists was condemned. As a result, he was relieved from his post.

The Scientist and the State

Physiology in the USSR experienced extremes in the relationship between science and the state — from complete support and generous financing of the research conducted by I.P. Pavlov to a ruthless suppression of the innovative schools and directions at the end of 1940s and the first half of 1950s. Orbeli was loyal to the state, adhering to the position of constructive cooperation. He believed that science was outside politics, that science and politics are two different areas of activity, and that politics should not intrude into science. The attitude of the state towards Orbeli was ambiguous and inconsistent. His first difficulty with the state occurred at the beginning of the 1920s because of the scientist's disagreement with the reforms in the area of higher education. He did not hide his negative attitude towards the endless "reforms" that were harming science and education. He declined to sign a collective letter of condemnation of the speech delivered by the Pope about the persecution of religion and the clergy in the USSR in the beginning of the 1930s. As a result that led to a political ostracism; he was not elected to the Central Committee of the Physiology Society. He was not allowed to participate in the 14th International Physiology Congress (Rome, 1932).

The state's attitude towards Orbeli changed after the successful 15th International Physiology Congress in the USSR (1935); upon I.P. Pavlov's insistence, Orbeli was the main organizer of the Congress. After Pavlov's death (1936) Orbeli was appointed director of the Physiology Institute of the Academy of Sciences of the USSR by the government. In addition to his scientific credentials, he had the reputation of an organizer of defense-related projects. Being director of the MMA and Head of the Military-Sanitary Committee during WWII, Orbeli provided the connection between the Academy of Sciences of the USSR and the Ministry of Defense. His activity was highly regarded — he was given the rank of Lt. Col. of the Medical Corps (1944) and Hero of Socialist Labor (1945).

The first postwar 7th Soviet Union Congress of Physiologists, Biochemists, and Pharmacologists took place under his chairmanship in Moscow in August, 1947. A variety of scientific schools were represented. However, 1947 became the last “peaceful” year in the life of Soviet physiology. Three years after the war, as a result of political actions against science after the session of the All-Union Academy of Agricultural Sciences (1948) and a Joined Session of the Academy of Sciences of the USSR and the Academy of Medical Sciences of the USSR (1950), Orbeli was stripped of all of his high scientific and administrative posts. He remained in profound disfavor for six years. Due to the development of the class concept the deformation of the scientific community grew more pronounced and unleashed into an unstoppable struggle with cosmopolitanism. Soviet scientists were accused of servility towards the West. Particularly active in this process were the newspapers *Culture and Life* — the publication of the Propaganda Department of the Central Committee of the Union Communist Party (Bolsheviks)— and the *Medical Worker* — the publication of the Health Ministry of the USSR. Two years prior to the “Pavlovian” session, the articles printed in these newspapers conducted a purposeful and consistent campaign arguing that the only acceptable direction in physiology and in medicine is Pavlovian. Everything new was declared to be a deviation from the Pavlovian path, betrayal of Pavlov, and crossing over to the side of “reactionary bourgeois science.”

From June 28 to July 4, 1950, a Scientific Session took place in the House of Scientists, dedicated to the problem of the scientific inheritance of the member of the Academy I.P. Pavlov. The session was organized by the Academy of Sciences of the USSR and the Academy of the Medical Sciences of the USSR. These two academies acted as obedient executors of the will of the Central Committee of the Communist Party. Members of the academy I.S. Beritashvili⁴ and L.S. Stern⁵ (accused along with Orbeli) did not participate in the preparation of the session. Beritashvili was in the hospital with a spinal trauma; Stern was exiled to Karaganda as a “member of the Jewish Anti-Fascist Committee.” More than 400 scientists participated in the preparation of session. They represented the leading physiological institutes, laboratories, and departments. Eighty-three persons participated in the debates.

The opening remarks of the President of the Academy of Science of the USSR and a member of the Academy of Medical Sciences of the USSR S.I. Vavilov ascertained general points about the cutting-edge of Soviet science and the significance of Pavlov's teaching for Physiology and Medicine. In prophetic words Vavilov expressed his true opinion about the “Pavlovian session” two days before its opening on the last meeting of the organizing committee of the session on June 25, 1950: “From the very beginning we must think about the end” (Archive of RAN).

⁴I.S. Beritashvili (1885–1924) — physiologist, founder of Georgian school of Physiology.

⁵L.S. Stern (1878–1968) — physiologist, biochemist, first female member of the Academy of the USSR.

In the speech of the vice president of the Academy of Medical Sciences of the USSR I.P. Razenkov, specific persons and scientific institutes that did not promote the development of Pavlovian teachings were named. Before all others there were Beritashvili, Orbeli, P.K. Anokhin, A.D. Speranskii, and Stern; the main physiology institutes of the USSR: the Physiology Institute of the Academy of Sciences of the USSR, the Institute of the Evolutionary Physiology and Pathology of the Higher Nervous Function of the Academy of Medical Sciences of the USSR (both led by Orbeli), the Institute of General and Experimental Pathology (director A.D. Speranskii).

All of the “accused” were selected long before the session. They were given standard accusations: dissension manifested in the deviation from the Pavlovian path, founding of personal schools, servility towards the West, insufficient mastery of the dialectic materialism method, incorrect system of organization of science, which lead to a monopoly of renown scientists, especially Orbeli. Also, Orbeli was accused of the fact that his interests and methodology were influenced not by Pavlov but by European physiologists.

The main speeches delivered by K.M. Bykov, “The Development of the Ideas of I.P. Pavlov,” and A.G. Ivanov-Smolenskii, “The Ways of the Development of Pavlov’s Ideas in the Area of Pathophysiology of the Higher Nervous Functions,” and the necessity of complete restructuring of physiology and medicine on the basis on Pavlov’s teaching were discussed. Both speeches were based on contrasting Soviet science to foreign science and on the denunciation of whole scientific schools and movements. These included the “brain pathology” of Shmarian, the theory of psycho-nervous activity of Beritashvili, the “mistaken position” of Orbeli in the questions of psycho-physiology, physiology of the vegetative (autonomic) nervous system (Stenographic report, 1950).

The direct result of the so-called “Pavlovian” session was the fact that the leading physiologists of the country lost the ability to teach and to conduct research. Under the guise of reorganization, physiology centers were liquidated, in particular the unique Institutes of Evolutionary Physiology and Pathology of Higher Nervous Function of the Academy of Medical Sciences in Klotushi, which were founded with participation of Pavlov. The activities of the schools of Orbeli, Beritashvili, and Stern were paralyzed. A.G. Ginetsinski (student of Orbeli), P.K. Anokhin, and N.A. Rozhanski (students of Pavlov) left their laboratories, departments, and institutes. The Leningrad physiologists noted correctly that the “Pavlovian” session caused more harm to physiology than the siege of Leningrad. As a result of the “Pavlovian” session, many promising directions of physiology were halted and denounced as reactionary. These included general neurophysiology, research of the problems of neuroendocrine regulations, and research in neuromuscular physiology and endocrinology. The fate of other branches of physiology — cardiac physiology, physiology of the vegetative nervous system — was just as sad. It was prohibited to teach these areas of physiology in the institutions of higher education of the country.

The so-called Pavlovian Scientific committee created at the Presidium of the Academy of Sciences of the USSR conducted further destruction of scientific schools of physiology after the session. During the meetings lasting many days, there was a pointed mockery of scientists who became victims of the political action. Orbeli and Beritashvili were unified in their evaluation of the Scientific Committee activity as being most harmful to the Soviet physiology. The session of the two academies and its consequence in the form of a deviant Scientific Committee brought about colossal harm to science and to the moral health of the scientific community. Coercion and lies, hypocrisy, and demagoguery were main instruments of the “activity” of the committee. The committee conducted a purposeful policy of separation of Soviet physiology from world physiology; and of Soviet physiologists from the scientific community abroad.

During these difficult years, Orbeli received an unshakable moral support from the outstanding neurophysiologist, Nobel Prize laureate, and president of the London Royal Society Henry Dale. As a sign of protest against the denunciations of Orbeli's activity at the post of Secretary of the Division of Biological Sciences of the Academy of Sciences of the USSR, he resigned as an Honorary Member of the Academy of Sciences of the USSR. Dale called Orbeli "my old respectable friend, member of the Academy Orbeli" (Dale, 1948).

Orbeli was a scientist of world renown. After the 13th International Physiology Congress (Boston, USA, 1929) he was invited by several American Universities to read lectures about the research conducted by his school on the adaptational-trophic function of the sympathetic nervous system. His works were well known and highly regarded by British physiologists. The introduction of Orbeli to British physiologists occurred in 1910–1911 when he was working in Cambridge at Langley's laboratory. He was associated with then young scientists of the future renown: A. Adrian, J. Barkfort, K. Lucas, H. Dale, and others. His contact with British scientists continued in 1945 during the celebration of the 220th anniversary of the Academy of Sciences and later on the first postwar International Physiology Congress on Oxford (1947). Orbeli was the head of Russian Physiology delegation. With gratitude Orbeli recalled working in Langley's laboratory in 1910–1911 (Orbeli, 1968c). Orbeli penned an article dedicated to the memory of Langley — "In memoriam J.N. Langley" (Orbeli, 1968c). Part of Orbeli's memoirs about the time spent in Cambridge was published in a prestigious British journal. In the introduction to the publication the renowned British biophysicist Archibald Hill noted "familiarity of the physiologists of the world with Orbeli." In a letter to the member of the Academy E.M. Kreps (July 10, 1970), Hill wrote:

Dear Kreps, I read the translation of Orbeli's "Memoirs" about 1910–1911 on the meeting of Physiology Society in Cambridge today. The success was gigantic. I was surprised by applaus that followed my reading. My presentation was illustrated by 18 small drawings. The drawings livened up the presentation greatly. It was suggested to publish the memoirs without changes in the *Journal of Physiology*. (Kreps, 1972)

It was only at the 8th All-Union Congress of Physiologists (Kiev, May 1955) that the activity of the "Pavlovian" scientific committee was denounced, which began the rehabilitation of Orbeli, Beritashvili, Anokhin, and Rozhanski. It is evident from the facts that there were no objective reasons for the session of 1950. The events of the 1950s were a purely political action and, therefore, are against the scientific inheritance of Pavlov.

Conclusions

The life of Orbeli, an outstanding physiologist of the twentieth century, was filled with scientific, social, and cultural events of historical importance. His scientific interests embraced almost all areas of physiology — classical as well as contemporary. The development of the evolutionary physiology is the accomplishment of Orbeli and his school.

His ideas are still being developed with an unflagging interest by his students and followers at the I.M. Sechenov Institute of Evolutionary Physiology and Biochemistry in St. Petersburg and at the L.A. Orbeli Institute of Physiology in Yerevan. The years following his death testify to the viability and longevity of Orbeli's school having defined the

fundamental problems of physiology for many generations of scientists. In addition to a large scientific inheritance, Orbeli bequeathed future generations of scientists priceless spiritual and moral potential, affection and loyalty towards humanitarian traditions, and courage in defending the scientific truth. Until the very end of his life Leon Abgarovich maintained exactitude and uncompromising adherence to his principles in questions of science and morality. All of his life Orbeli followed a straight and well-meaning path, carrying the responsibility to people for his words and deeds. Orbeli passed away on December 9, 1958. He is buried at the Bogoslovski Cemetery in Leningrad (St. Petersburg).

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