To the 100-Anniversary of A. K. Voskresenskaya

Professor A. K. Voskresenskaya

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September 1, 2004, was the 100-anniversary of Professor Anna Kapitonovna Voskresenskaya, an outstanding scientist, the founder of study of neurophysiology of the insect motor behavior, a pupil and successor of L.A. Orbeli.

In 1958, I, at that time still a beginner in research, happened to meet Anna Kapitonovna, and subsequently I was fortunate to work under her supervision for almost 10 years. I remember very well our first meeting: a small woman with perspicacious eyes was speaking with enthusiasm about perspectives of development of the Laboratory that just was founded at that time at Institute of Evolutionary Physiology. Much was not clear yet—in fact, the Laboratory did not yet exist, but the most important was already determined: direction of investigations, the circle of problems to be studied. All was thought over, nurtured beforehand.

The preciseness in setting up the tasks to be solved, the feeling of perspective, the ability to concentrate efforts for solution of the cardinal problems without distraction and getting scattered to details—here are the features that distinguished Anna Kapitonovna throughout her entire scientific life.

Meanwhile her scientific life started early. As a third-year student of Leningrad University, Anna Kapitonovna began her experimental work under supervision of A.A. Ukhtomskii. These were the first steps of A.K. Voskresenskaya in physiology—the science, in which subsequently her talent of researcher was so brilliantly displayed.

On graduating from University, Anna Kapitonovna was admitted to postgraduateship of Institute of Plant Protection. On graduating from the postgraduateship, she was became a member of the stuff of this Institute. Already at this period the future scientific interest of A.K. Voskresenskaya was clearly outlined—study of neurophysiology of arthropoda. It is remarkable that her first works in this field were dealing with solution of problems of an applied character. For 8 years of her working at the Institute of Plant protection she was studying physiological mechanisms of action of poisons on insects, elucidated causes of resistance of insects to particular poisons, developed methods of use of insecticides for fight with pests of agriculture and forestry. These studies became the basis of the Candidate Dissertation that A.K. Voskresenskaya defended in 1937. And subsequently, when working on fundamental problems that presumably were far from practice, Anna Kapitonovna always was able to find possibilities of their practical application, the ways of outcome of fundamental investigations into practice.

In 1938, A.K. Voskresenskaya started working in Kolttushi, at I.P. Pavlov Biological Station that later was renamed into Institute of Evolutionary Physiology and Pathology of the Higher Nervous Activity. He, in the research team headed by
L.A. Orbeli, she joined the development of problems of evolutionary physiology.

The years of working at this Institute (1938–1950) have turned out to be extremely fruitful for Anna Kapitonovna. At this period, she obtained data that have become a part of the capital of evolutionary physiology. When studying functional peculiarities of the insect neuro-muscular apparatus in ontogenesis, Anna Kapitonovna managed to reveal similar regularity of establishment and development of functional properties of muscles of insects and vertebrates and to demonstrate parallelism in development of the muscle apparatus functions in various phylogenetic series.

Thus, she has established the presence of “fast” and “slow” muscles in the insect locomotor apparatus. Function of such muscles operating in the leg and wing apparatuses has been shown to be distinguished by several peculiarities. For instance, the stimulation frequency producing solid tetanus in wing muscles is higher than in leg muscles: summation of individual contraction into the solid tetanus in locust leg muscles starts at a frequency of 20/s, whereas wing muscles respond with individual contractions or a rather low toothed tetanus to a stimulation up to 50 stimuli/s and even higher.

For the subsequent years, at the Laboratory of Neurophysiology of Insects founded by Anna Kapitonovna, these data were developed further: it has been established that insect muscles, like vertebrate muscles, can also contain transitory fibers.

At the same period, Anna Kapitonovna demonstrated two functional types of influences of the nervous system on insect locomotor muscles—the triggering influence initiating muscle contraction and the regulating influence that does not produce contraction of muscles, but changes their functional properties. Works of this period were included into the Doctorate Dissertation defended by A.K. Voskresenskaya in 1956 and in her monograph “Functional Properties of the Insect Neuro-Muscular Device” published in 1959.

It is interesting that innervational relations in insect muscles have been subsequently established to be even more complex than in vertebrate muscles. Due to the polyneuronal and accordingly polyfunctional innervation (fast, slow and inhibitory = regulating), muscles of insects turned out to be able to realize very complex combinations of central commands. The motor integration at the periphery seems to provide “economy” of connections between central neurons, which is essential for the small animals, such as insects that have ganglia of small sizes. Besides, each of the existing functional types of axons is able, if necessary, to vary the impulsation rhythm, which increases even more the number of variants of muscle responses.

However, here came the 1950s—the complex time for the further development of works in the field of evolutionary physiology and, first of all, for investigations carried out in L.A. Orbeli’s teams. Anna Kapitonovna had to temporarily cease her study of the insect neuro-muscular apparatus—the investigations that she had started so successfully. But she kept working in Koltushi, although was studying now another problem—conditioned reflex reactions in behavior of honeybees. In these works partially performed in cooperation with other authors Anna Kapitonovna studied problems of structure of conditioned reflexes in insects (coinciding, delayed, natural, to a chain of indifferent stimuli, etc.), location of their closure, participation of various insect brain parts in conditioned reflex reactions.

Based on the performed experiments, Anna Kapitonovna has come to the conclusion that an essential role in realization of conditioned reflexes in honeybees is played by mushroom bodies of the supraesophageal ganglion. An important result of her investigation was establishment of similarity of the main regularities of formation of conditioned connections and various kinds of internal inhibition (extinguishing, delayed, differentiating, conditioned) in insects and in vertebrate animals. It has been shown that some types of conditioned reflexes (honeybees) can be elaborated extremely fast, which indicates a high level of development of the higher nervous system of these animals.

In 1956–1957, L.A. Orbeli got a possibility to develop again in the full scale problems of evolutionary physiology. He was also given a possibility to found a special institute—Institute of Evolutionary Physiology, later—Institute of Evolutionary Physiology and Biochemistry. It was not by chance that among the first whom Leon Abgarovich offered to head one of laboratories of the new Institute was A.K. Voskresenskaya. In 1958, she founded laboratory to study neuro-muscular function (in