To memory of Vladimir Leonidovich Zhuravlev – teacher, gifted scientist and mentor in Saint Petersburg University

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Vladimir Leonidovich Zhuravlev, physiology professor of Saint Petersburg University, was our mentor and friend. His untimely death on January 15, 2009 is for us a great lost. He was a talented person and scientist, whose discoveries in the field of the neuronal regulation of the heart, simple networks, and properties of neurons and cardiomyocytes have had an impact on physiology of invertebrates.

Vladimir Leonidovich Zhuravlev at work (December, 2003). The photograph was taken by M. Inyushin.

He was a remarkable person and gifted scientist with a solid reputation and positive human qualities; one of those individuals whom people truly respect.

Vladimir Leonidovich was born May 1, 1949 to a military family (his mother was a jeweler) in Kazakhstan in the former USSR. Later he moved to Leningrad, where was enrolled in school with the specific major of biology at Leningrad University. He graduated from the Biology Department, where then he worked until the last days of his life. He received a Ph.D. (1974) and subsequently D.Sc. (1999) degrees from the Department of Physiology and Ukhtomski Institute. Students and colleagues recognized him as a trusted expert in biology and its closely related disciplines. It was not possible to imagine the Department without him both scientifically and socially. It is perhaps appropriate to note that even during difficult times after the collapse of the USSR he would collaborate with other scientists in Asia, America and Europe. Furthermore, he managed to be a great experimenter, knowledgeable mentor, and approachable professor. It was common for students and colleagues to knock at any time on the door of his laboratory, office, and social room, all in one (see photo).

Prof. Zhuravlev was performing research using a simple model – Mollusca (Zhuravlev and Safonova 1974; Zhuravlev and Iniushin 1983; Zhuravlev et al. 1988; Safonova et al. 2009). There are a great number of similarities among vertebrates and Mollusca; e.g., the major brain functions and the myogenic origin of their heart's rhythm (Zhuravlev 1999) are similar. He addressed the brain's role in context with the heart function on his beloved giant African snails, *Achatina*. Earlier studies revealed that all myocardial cells in investigated species of Gastropods exhibit a slow diastolic depolarization. The isolated atrium, ventricle and even fragments of ventricle automatism in contractions, which is more consistent in the aortal part of the ventricle, and the atrium often possesses the inhibitory effects.

He was always up to date in the foremost achievements in physiology, and having extensive expertise, he developed a unique tool with the web access (Zhuravlev and Shabel'nikov 2005). The following is an excerpt from this source: "… indeed the experiments on frogs revealed the main features of nerves, cardiac and smooth muscles, as well as many other organs and tissues. Almost every researcher at some period of career has conducted first experiments on frogs, at least as a student. A most common task for junior students is the investigation of heart function. Although the procedures are described in myriad of manuals in many languages, the investigator cannot always take an advantage of the drawings in those manuals. Here we present several original figures and live movies, which will shed a light on the heart's structure and function in *Rana temporaria*". Vladimir Leonidovich was interested in the origin of heart rhythm and conductive system, and their comparisons in Molluscs and mammals. Since he was aware of importance of comparative studies, in 1996 he was invited for a collaborative project at Heidelberg University.

Vladimir Leonidovich was the representative of the old physiology school, but he always searched for new approaches. He knew sufficiently enough in order to build a sophisticated amplifier – the basic component of electrophysiology. The quality of the registration did not differ from professional equipment, but exceeded it by some parameters. He could challenge his time: in his laboratory simultaneous multichannel recordings from auricle, ventricle, and pair of excitatory and inhibitory neurons were accomplished; he had a number of inventions (Iniushin and Zhuravlev 1983; Murav'ev et al. 1983): e.g. the unique suction electrode for the ablation of heartbeat (Fig. 3A, B; Kodirov, 2011). The high K^+ solution was supplemented with dye in order to avoid bubbles and to facilitate a visual observation and ablation. Furthermore, since the heart of a snail is small, the mechanical disturbance and K^+ solution flowing out from the electrode can damage the myocardium.

The discovery of inhibitory neurons of heart in *Helix* (Zhuravlev and Safonova 1984) and *Achatina* is one of his significant achievements and he remained devoted to such a simple object (Shabel'nikov et al. 2006). Using the whole-mount preparation (that preserves connections between organs and neurons), new cardioregulatory inputs originating from giant multimodal neurons were discovered (Zhuravlev et al. 1993). The recent work from Prof. Zhuravlev's laboratory described three-dimensional electrical activity around the body of snails derived by neuronal firings (Shabel'nikov et al. 2006).

He was and will remain for us a scientific role model because of his dedication to science and honesty. Each of us has had our own pathways and motivation to enter the path of sciences. There is, however, the momentum during this journey, which unifies us – we all are students of Vladimir Leonidovich. He perhaps believed that the knowledge will gain a true value only when it is transmitted to others. He generously shared with us his time, widest erudition and talent. He introduced to us a taste of fascination for physiology, armed us with the adequate knowledge, skills and methods. It is pleasant to think about a simple, but at the same time very important direction for beginning scientists: "start to protocol before initiating the experiment" – recall Bychkov (Universidad Central del Caribe), Diakov (University of Erlangen) and Kodirov; this note was mounted right in front of the experimental setup.

Having said this much we are confident – he created a real school of his own and was not aware of this fact during his life. Despite the differences in our current interests, we are his next to kin in regard to scientific approaches and persuasions that he taught us. At least the knowledge in the field of electrophysiology that he shared with us enables us to conduct research with a great enthusiasm. During his relatively short lifetime, he shared his

fascination about the dynamic of the heart rate and different patterns of spikes in neurons with students. He trained many scientists, who continue research both in our country and abroad. They are investigating the synaptic plasticity and memory processes (short- and long-term) at neuronal (S. Kodirov), molecular and system levels (O. Senkov, University of Heidelberg), the functional structure of the cerebral cortex (V. Tsytsarev, Washington University in St. Louis) and the role of dopamine in the brain (M. Inyushin, Universidad Central del Caribe). Other directions concern the ion channels, including the epithelial Na^+ channels (ENaC) that participate in maintenance of the water-salt balance in kidneys (A. Diakov; A. Staruschenko, Medical College of Wisconsin), the Ca^{2+} channels and intracellular processes (V. Bugaj, University of Texas) and K^+ channels in cardiovascular system (R. Bychkov; S. Kodirov). One of his youngest students is investigating the diverse cells and their functions in the heart of Mollusca (S. Shabelnikov, Russian Academy of Sciences).

Vladimir Leonidovich was a good hearted, open-minded and unbiased-by-stereotypes person, and each of us lost not only a teacher but also a friend. With great appreciation, we will always recall the time, which we luckily shared with such a remarkable person and scientist. We – his students – will continue his initiations and trial. We will preserve his memory in our hearts with great care.

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