

## *In Memoriam*

### **Milka Ćulić MD, PhD (1946-2020)**

Gordana Stojadinović

*Department of Neurophysiology, Institute for Biological Research “Siniša Stanković” – National Institute of the Republic of Serbia, University of Belgrade, Bulevar despota Stefana 142, 11060 Belgrade, Serbia*

E-mail: ggrbic@ibiss.bg.ac.rs

Milka Ćulić (née Stanojević) MD-PhD, Principal Research Fellow of the Institute for Biological Research “Siniša Stanković” – National Institute of the Republic of Serbia, University of Belgrade, passed away on October 1, 2020.



Dr. Milka Ćulić was born in Belgrade on August 19, 1946. She graduated in 1970 at the Medical Faculty of the University of Belgrade and started her academic career in 1972 as a research trainee at the Institute for Medical Research in Belgrade, Department of Neurophysiology, under the direction of Dr. Jovan Vučo. In the neurophysiology laboratory, Dr. Ćulić and colleagues, Dr. Jovan Vučo and Dr. Radmila Anastasijević, studied the characteristics of the spinal motor neurons of cats, especially the existence of different functional types of these cells and their role in the regulation of the corresponding spinal mechanisms [1]. She defended her MSc thesis, “Recurrent inhibition of the reflex activity of cat’s spinal motoneurons”, in 1975 at the Medical Faculty, University of Belgrade, after which, with the financial support of the Serbian Science Association and the Italian Government, she attended the *Instituti di Fisiologia Humana* in Pisa in Italy for further study and training (1977/78). In collaboration with Dr. Ottavio Pompeiano, Dr. Brunello Ghelarducci, Dr. Pierre Magherini and Dr. Richard Boyle, Dr. Ćulić studied the response of Purkinje cerebellar cells to changes in afferent signals originating from the neck and vestibular system in cats [2]. She defended her PhD dissertation, “Effect of excitability of vestibular

apparatus and receptors in muscles and joints of the neck on Purkinje neurons and nucleus fastigii of cat cerebellum” in 1979 at the Medical Faculty in Belgrade. The following year, she was promoted to Research Associate and continued publishing articles about Purkinje cells and fastigial nucleus responses to vestibular receptors stimulation. She worked as a Senior Research Associate at the Institute for Medical Research in Belgrade until 1989.

Dr. Ćulić continued her academic career at the Institute for Biological Research “Siniša Stanković”, now the National Institute of the Republic of Serbia. Here, in the Department of Neurobiology and Immunology, she and Dr. Jasna Šaponjić continued to equip the electrophysiological laboratory and initiated research into unit and group cerebellar neuron activity in an acute model of epilepsy on laboratory rats. She was also interested in analyzing Purkinje cell activity after locus coeruleus stimulation and cortical lesion ablation. Additionally, she investigated the effects of some neurotoxins and neuropeptides on cerebellar activity.

From 2001, with an expanded investigative team, Dr. Ćulić continued to study the activity of cerebellar and cerebral rat cortical neurons. Applying spectral analysis, she and her colleagues Dr. Ljiljana Martać and Dr. Gordana Stojadinović showed that an injured brain emits specific electrical activity with high presence of fast frequency oscillations. She also revealed that some plant extracts and their constituents could

provoke epileptic discharges in brain activity. In a model with aluminum intoxication, she showed that this widespread element could be important in understanding certain brain pathologies such as dementia and Alzheimer's disease.

Dr. Ćulić enjoyed working in a multidisciplinary team. She and her colleagues Dr. Aleksandar Kalauzi and Dr. Slađana Spasić demonstrated the nature and meaning of interspike background activity (RBA) recorded in the Purkinje cell layer of rat cerebellum. She also applied the exploitation of consecutive differences as a method of signal fractal analysis and employed a calculation of fractal dimension (FD) in the analysis of brain electrical activity [3,4,5]. Dr. Goran Keković and Dr. Ćulić introduced the use of wavelet analysis and various parameters, such as the Hurst exponent and spectral entropy, in the analysis of brain electrical activity [6-8].

With financial support of the Serbian Ministry of Science, Dr. Ćulić succeeded in equipping an electrophysiological laboratory with the setup for wireless recordings in awake small rodents and fine navigation through brain cortical layers. This equipment modernized and actualized electrophysiological research at the Institute. In this respect, she and her colleagues Dr. Jelena Podgorac and Dr. Srđan Kesic shed light on electrical brain activity during sleeping and awakening as well as the electrophysiological properties of cerebellar layers [9]. Dr. Ćulić was also interested in neuroethics and neuromodeling. In later years, she was involved in understanding cerebellar non-motor functions [10].

Dr. Ćulić was a leader of Project No. 1660, "Modulation of membrane excitability and rhythms of bioelectric neuronal activity in invertebrates and vertebrates. Analysis and Modeling" (2002-2005), financed by the Serbian Ministry of Science and Environmental Protection, and Project No. 143021, "Effects of traumatic, neurotoxic and neuroprotective factors on electrical activity of mammals brain. Analysis and modeling" (2006-2010), financed by the Serbian Ministry of Education, Science and Technological Development.

Dr. Ćulić was a Visiting Researcher at the CNR Laboratories in Milano, Trieste and Siena (Italy). She was awarded a twinning research grant at the University of Patras (Greece), financed by the European Science

Foundation (Strasbourg). She developed a collaboration with the physicist Dr. Włodzimierz Klonowski and neuromotor control expert Dr. Nikolai Gantchev. She was a member of the Physiologic Society of Serbia, the International Brain Research Organization and Women in Neuroscience.

Dr. Ćulić was a representative of the European Dana Alliance for Brain Initiatives (Coordinator for Serbia and Montenegro), with the role of emphasizing the importance of neuroscience in life and society.

She enjoyed literature and painting. I will remember her as a bright, open and enthusiastic person. Colleagues from the Institute will remember her as an associate who contributed remarkably to the development of electrophysiological research in Serbia.

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