



Tribute: a salute to Alexander Yurievich Borisov (1930–2019), an outstanding biophysicist

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On the 1st of June 2019, an outstanding Russian Biophysicist, Professor Alexander Yurievich (Yu) Borisov, passed away at the age of 89. He was born on June 29, 1930 in the city of Saratov. His father (Yuri Alexandrovich Borisov) was an Accountant, and his mother (Nadejda Loo-kinichna Borisova) was an English and German Teacher. His wife Olga Filippovna Borisova, who died in 2017, had been a Researcher at the Institute of Molecular Biology of the USSR Academy of Sciences under Lev A. Tumerman (1898–1986) and Mikhail Volkenstein. Olga was an expert on ‘The photophysics of nucleic acids, and the interaction of nucleic acids with dyes’ (see e.g., Borisova et al. 1974, where one of us, APR, was her coauthor). Alexander Yu. Borisov is survived by his two sons Andrey Alexandrovitch Borisov and Yuri Alexandrovitch Borisov and their families. See Fig. 1 for a portrait of Alexander Yurievich Borisov.

[As a side note on his personal life, Alexander Borisov fell ill during the World War II with tuberculosis. However, after recovering from this disease, he was actively involved in sports all his life, played volleyball, soccer, walked a lot, and rode a bicycle.]

Alexander Borisov entered the Physics Department of the Lomonosov Moscow State University and graduated from it in the early 1950s. He then worked for an institute that was classified for national security, where he measured distances by what was called “the phase method.” Three years later, he went to work at the Institute of Molecular Biology



Fig. 1 Alexander Yurievich Borisov, in early 1980s. *Source* Borisov’s family Archive

of the USSR Academy of Sciences. We note that there he was trained in the Laboratory of Lev Tumerman who had played a significant role in the development of Biophysics of Photosynthesis in Russia (Borisov 2005; Rich 1978). Here, Borisov worked as an Engineer and helped Tumerman build a ‘Phase Fluorometer.’ In the early 1960s, Borisov defended his Doctoral Thesis at the State Optical Institute in Leningrad. After that he moved to Moscow State University, to the Inter-Faculty Problem Laboratory, which later became the Andrey (A) Nikolayevich (N) Belozersky Research Institute of Physico-Chemical Biology. He remained at this institute for over 50 years. For many years, he served as the Head of the Department of Photosynthesis and Fluorescence Methods, which he had founded.

Note that Govindjee’s legal name since 2018 is ‘Govindjee Govindjee’, but he continues to publish under one name.

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Fig. 2 Alexander Yu. Borisov at A.N. Belozersky Research Institute of Physico-Chemical Biology, October 19, 2017. *Source* Borisov's Family Archives



Fig. 3 A photograph of the research group of A.Yu. Borisov in the early 1980s. *Clockwise* (starting on the left, from the person wearing glasses): Viktor Sidelnikov; Andrei Razjivin (one of the authors); Alexander Borisov; Elena Kotova (one of the authors); Sergey Kharchenko (with his right hand on the table); Zoya Fetisova; and Valentina Godik (bottom left). *Source* Archives of the Borisov's Family

Together with his younger colleagues, students, and postocs, he made pioneering discoveries on the transfer of singlet excitation energy in bacterial photosynthesis (see e.g., Borisov and Godik 1970, 1972; Godik and Borisov 1977; Razjivin et al. 1982; also see Borisov and Il'ina 1973 for Photosystem I of plants). For his experiments and ideas on membrane potential effects on luminescence in *Rhodospirillum rubrum*, see Borisov et al. (1980). We consider Borisov as one of the founders of the Russian school of *Excitation Energy Transfer in Photosynthesis*.

As a scientist of international recognition, Alexander Borisov and his coauthors were the first to demonstrate that excitation energy transfer from light-harvesting antenna to photosynthetic reaction centers, in photosynthetic bacteria, occurs within tens of picoseconds (see discussion in Borisov 2005; and in Mamedov et al. 2015). He was a good friend of many around the World, including James (Jim) Barber as well as Alison Telfer, both of UK. He kept contact with friends by e-mail for many years. In the recent past, he was excited about having estimated the time (~3000 years) that must have gone by in generating the present oxygen level in earth's atmosphere; this was published with Lars Olof Björn (see Borisov and Björn 2018, in celebration of Govindjee's 85th birthday).

Alison Telfer wrote to one of us (G): "Alex was always the one to come up with new ideas and intriguing suggestions and his enthusiasm will be greatly missed by us all." **Jim Barber** added: "You all have done a great job in honoring one of our top players in our field. Alex and I were good friends and I always found his science to be excellent, creative and solid in line with the best traditions in Soviet/Russian photo-physics."

Alexander Borisov continued to be engaged in science until the last years of his life. Figure 2 shows him giving essentially his last lecture in his life. His remarkable contribution to the field will remain in the history of Photosynthesis Research and in the memory of the scientists of the Photosynthesis community.

We salute this extraordinary and dedicated scientist—a friend, a mentor and one who did not hesitate to pursue ideas that were not accepted by others (see his "farewell" presentation by Govindjee et al. 2019, this issue; for an earlier brief obituary of Borisov, published in Russian, see the website of the Russian Photobiology Society: <http://www.photobiology.ru/ru/>).

We end this Tribute with a photograph of the members of the Department of Photosynthesis in early 1980s (Fig. 3).

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