My happy years of collaboration with Fumio Arisaka

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Meeting Fumio was a wonderful awakening for me. He introduced me to the various biological processes that occur in the life cycle of bacterial viruses. In our discussions, I started to realize that the structural information we were discovering on plant and animal viruses might help in finding the basis of some of the biological properties of the bacteriophages that Fumio was studying. I had been working on determining the structure of small, RNA plant (Abad-Zapatero et al. 1980) and animal (Rossmann et al. 1985) viruses using X-ray crystallography. My motivation had been primarily the physical challenge of collecting X-ray diffraction data on something as big as a whole virus, and the mathematical challenge in solving the “phase problem” (i.e., structure) of something as complex as a virus. I was particularly intrigued by the anticipated high symmetry of viruses, which eventually did turn out to be the key to the phase problem.

My first memories of Fumio are from a Federation of American Societies for Experimental Biology (FASEB) meeting on virus assembly in Saxton River, Vermont, perhaps in about 1990. I remember Fumio explaining to me, while standing on the entrance steps to one of the buildings at the meeting site, the nature of the infinite concatenated dsDNA genome of phage T4. He discussed with me the way the T4 DNA was packaged into the head capsid until the capsid was full, and that somehow the head recognized when it was completely filled with DNA, initiating the cleavage and termination of the packaged genome. These discussions led to a very productive collaboration and eventually also a Human Frontier Science Program grant to Fumio, Vadim Mesyanzhinov

(University of Moscow), and me. This, in turn, led to a study of DNA packaging into T4 capsids with Venigalla Rao (Sun et al. 2008).

Fig. 1 Structure of the (gp27-gp5)₃ trimer (gp = gene product). The three monomers within the trimer are colored *red*, *blue* and *green*. Figure reproduced from Kanamaru et al. (2002) *Nature* 415:553–557

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Fig. 2 CryoEM reconstruction of the in-vitro assembled hubless bacteriophage T4 baseplate. Figure reproduced from Yap et al. (2014) *J Struct Biol* 187:95–102

As the years passed, Fumio convinced two of his Ph.D. students to join my lab as postdocs to learn some structural techniques. The first of these was Shuji Kanamaru, who had been working on the T4 phage lysozyme in Fumio's lab. With help from Petr Leiman, a postdoc in my lab and former student of Vadim Mesyanzhinov in Moscow, Shuji determined the structure of the T4 “cell puncturing device” (Kanamaru et al. 2002) (Fig. 1). The second of Fumio's students to arrive at Purdue was Moh Lan Yap, who had been studying the assembly of the T4 baseplate in his lab. At Purdue, she was able to determine the structure of the baseplate (Yap et al. 2016; Yap et al. 2014) (Fig. 2). Both of these postdocs had extraordinary achievements made possible by their creativity encouraged while in Fumio's lab.

Over the years, Fumio and I co-authored 13 publications covering the time span from 2002 to 2016. We visited each other's labs and became close friends. I will never forget when, on one of Fumio's visits to Lafayette, we celebrated his visit with a picnic on the patio of my house. It was a beautiful warm evening, and Fumio entertained everybody

by playing his flute. Perhaps this particular evening is symbolic for the depth of appreciation I gained over many years not only for Fumio the scientist, but also and especially for Fumio the person, notwithstanding the oceans that separated our homes.

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Compliance with ethical standards

Conflict of interest Michael G. Rossmann declares that he has no conflicts of interest.

Ethical approval This article does not contain any studies with human participants or animals performed by the author.

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