



Honoring Bacon Ke at 100: a legend among the many luminaries and a highly collaborative scientist in photosynthesis research

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Abstract

Bacon Ke, who did pioneering research on the primary photochemistry of photosynthesis, was born in China on July 26, 1920, and currently, he is living in a senior home in San Francisco, California, and is a centenarian. To us, this is a very happy and unique occasion to honor him. After providing a brief account of his life, and a glimpse of his research in photosynthesis, we present here “messages” for Bacon Ke@ 100 from: Robert Alfano (USA), Charles Arntzen (USA), Sandor Demeter (Hungary), Richard A. Dilley (USA), John Golbeck (USA), Isamu Ikegami (Japan), Ting-Yun Kuang (China), Richard Malkin (USA), Hualing Mi (China), Teruo Ogawa (Japan), Yasusi Yamamoto (Japan), and Xin-Guang Zhu (China).

Keywords Photosystem I · Photosystem II · Charles F. Kettering laboratory · US–China scientific relation

Early life and an overview

Bacon Ke was born on July 26, 1920, in a very well-known family in Hankou, Hubei Province, China. His father Yang-huan (also known as Jingwen) Ge, who had come from Fengcheng, Jiangxi Province, was a lawyer and held important positions. Bacon Ke graduated, in 1943, from the Department of Chemistry of Tongji University in Shanghai, specializing in Physical Chemistry, and then, in 1945, from

the Department of Biology of Wuhan University; from there, he moved to the Western Sichuan province. In 1947, he came to the United States to continue his studies. He graduated from the University of Michigan and the Wayne State University, and then settled in USA for the rest of his life. He obtained his PhD in Chemistry, in 1959, working under the mentorship of Dan Trivich (1916–1983), a top chemist of his time. The title of his thesis was “Studies of the mechanism of bright plating in the acid copper bath”. However, earlier, he had worked with Trivich, and his research group, on the efficiencies of some solids as catalysts for “photosynthesis” of hydrogen peroxide—thus, he was into “artificial photosynthesis”—leading him to an interest in applying it to “natural photosynthesis”. In addition, Bacon’s interest in “instrumentation” dates to his work in making a device for preparing single crystal spheres (see “Box 12” and “Box 13” in Dan Trivich Papers, at Walter P. Reuther Library, Wayne State University; accession #: WSP000569). Soon thereafter, Bacon became a top research leader in physical chemistry and biophysics of photosynthesis at the world-famous Charles F. Kettering Research Laboratory (see Vernon 2003). Bacon’s standing in the field of photosynthesis is emphasized by his membership in a distinguished group of several important photosynthesis researchers at the Kettering Lab at that time, which included Charles J. Arntzen (then, a student; <https://sols.asu.edu/charles-arntzen>), and Richard Dilley (see their *Reminiscences*); Roderick Clayton (1922–2011; see Wraight 2014); Anthony San Pietro

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(1922–2008; see San Pietro 2008; https://www.findagrave.com/memorial/29962416/anthony-gordan-san_pietro); and, Leo P. Vernon (1925–2010; see Vernon 2003; <https://www.legacy.com/obituaries/saltlaktribune/obituary.aspx?n=leo-vernon&pid=143464844>).

We note that Bacon Ke's academic career, which spanned six decades, included research mostly at the Kettering Lab, but also at Standard Oil Co., and Amoco Chemical. He considers himself lucky since all the organizations he worked with gave him freedom to work on the important process of "Photosynthesis."

Figure 1 shows Bacon Ke, a great photographer himself, and a lover of nature, with one of us, Yun-Kang Shen (see Kuang et al. 2005).

To us, Bacon Ke has been an extremely thorough, open, caring, diligent and focused scientist; he indeed made many friends in the larger photosynthesis community in the World. He cared for the people and has been a major donor to the American Chemical Society. (See: <http://legacyplanning.acs.org/legacy-leader-stories/bacon-ke>). It is also known that he was often a tough, demanding mentor and sometimes this did not go well with some of the juniors; however, he meant well for them and supported them (see the *Reminiscence of*



Fig. 1 Left to right: Bacon Ke and Yun-Kang Shen in a garden near the memorial museum of PanTian Shou, in Hangzhou, 2006; photo by Teruo Ogawa

Sandor Demeter). Further, the Department of Chemistry at the Wayne State University, his Alma Mater, perpetuates his memory and scholarship through awards to their undergraduates, titled "*Dr. Bacon Ke annual scholarships*."

Research

Bacon Ke has had a high reputation in the international photosynthesis research community. His research has focused mainly on the primary electron acceptors of both Photosystem I and Photosystem II. This was possible because of his in-depth knowledge of physical chemistry and the precision instruments he had designed and assembled. As discussed below, together with Tetsuo Hiyama, and then with many others, including Vladimir Shuvalov, he discovered the Photosystem I electron receptor, labeled as P430, which had a distinct absorption spectrum.

Above all, Bacon has been a great instrumentalist: In the 1960s, at the Charles F. Kettering Foundation, in Yellow Springs, Ohio, he constructed, with the help of R.W. Treharne, and C. McKibben, a novel kinetic spectrophotometer to measure very small absorbance changes in various electron transfer intermediates in photosynthesizing samples exposed to high light (see, e.g., Ke et al. 1964). For complete information on the researchers at the Kettering Lab, see the overview by Leo Vernon (Vernon 2003); for a thorough and detailed review on the photochemistry of chlorophyll, see Vernon and Ke (1966). Soon thereafter, Bacon, with the help of R.H. Breeze and M. Green, ingeniously adapted a commercial Cary Spectrophotometer to measure circular dichroism in photosynthetic samples (Ke et al. 1968). His collaborative spirit led to the use of these new instruments to first study, with T.H. Chaney and Dan W. Reed, the interaction of cytochrome *c* with photosynthetic bacterial reaction centers (Ke et al. 1970). However, it was Tetsuo Hiyama's thorough and dedicated work, with Bacon Ke, which led to the most recognized and cited discovery of P430, an electron acceptor of Photosystem I, PSI (see Hiyama and Ke 1971a, b). At about the same time, Malkin and Bearden (1971) discovered bound chloroplast ferredoxin as an electron acceptor of PSI; soon thereafter, P430 was shown to originate from the iron-sulfur center FeS-A/FeS-B; this was possible because Bacon took the challenge and collaborated with Helmut Beinert (https://en.wikipedia.org/wiki/Helmut_Beinert); see Ke et al. (1973, 1974); here, his collaborators included R. E. Hansen as well as K. Sugahara. Just before this, and again in collaboration with Tetsuo Hiyama, the determination of the exact extinction coefficient of P700, the reaction center chlorophyll (Chl) of Photosystem I (PSI) was made (Hiyama and Ke 1972; also see Ke et al. 1977).

The discovery of P430 was possible because Bacon Ke had invited Tetsuo Hiyama to his laboratory in October

1969, who was then at the University of Pennsylvania in the laboratory of Britton Chance (1913–2010; see Elwell et al. 2011). At that time, Ogawa was working, at the Kettering Lab, in Leo Vernon's Lab, on the isolation of PS I complex from a cyanobacterium *Anabaena variabilis* (Ogawa and Vernon 1969; Ogawa et al. 1969) and he supplied the samples to Hiyama to be used for the kinetic analysis of P700, mentioned above. Figure 2 shows a picture of Tetsuo Hiyama with the families of Bacon Ke and Teruo Ogawa taken just before Ogawa was leaving the Kettering Research Laboratory.

In a collaborative research, with Sandor Demeter (see the section under *Reminiscences*), Bacon studied 'electron tunneling' in PS I (Ke et al. 1979). Later, Ke (2002) thoroughly reviewed the entire research area of "P430"—relating it to the research of many others.

The most important area of Bacon's research has been the primary photochemistry of the photosystems (I and II) of oxygenic photosynthesis. For PSI, see Shuvalov et al. (1979) and for PSII, see Klimov et al. (1980), where Bacon was helped by Ed Dolan and E.R. Shaw. See Allakhverdiev et al. (2014) for an article honoring Vladimir (Vlad) Shuvalov, and Allakhverdiev et al. (2018) for a Tribute to Vyacheslav (Slava) Klimov. These, along with other early measurements on primary photochemistry, including those by James Fenton on PSI (Fenton et al. 1979) and on PSII by Wasielewski et al. (1989) have been reviewed, and placed in perspective, by Mamedov et al. (2015).

Bacon's genius in instrumentation continued until he retired from the Kettering Lab in 1983—37 years ago! In his last instrument, he used an elasto-optic modulator, which provided the Lab a highly versatile spectrophotometer that was not only able to measure absorbance changes, but also

chlorophyll (Chl) *a* fluorescence yield (see Govindjee 1995, 2004), as well as circular and linear dichroism (Ke et al. 1985).

US–China scientific connection: involvement of Bacon Ke

In September 1974, a group of Chinese photosynthesis researchers, which included Yun-Kang Shen (one of the authors, who was the group leader), Yin-Fu Feng (from the Foreign Affairs Bureau of the Chinese Academy of Sciences, who was the Deputy group leader), and several others visited many institutions in USA including the University of Illinois at Urbana- Champaign (Govindjee's Lab) and the Kettering Research Laboratory. At the Kettering Lab, Bacon not only gave a wonderful talk in Chinese, even using interesting jargon, but also demonstrated his instruments. Figure 3 shows Bacon Ke showing his sophisticated instruments to the Chinese delegation visiting his Lab in 1974.

Bacon Ke has served as a perfect model for scientific exchanges between China and the United States.

After retirement

After his retirement from the Kettering Lab, Bacon lived in Japan for a few years. Bacon's wife Keiko was not only an outstanding artist herself, but she was a great piano player, and came from the family of one of the most famous artists of Japan: Koji Mayama. It was in Japan that Bacon wrote his famous Photosynthesis book in Chinese, at the invitation of the Chinese Academy of Science (Ke 1991; see the reminiscence

Fig. 2 From left to right: Tetsuo Hiyama, Ogawa's family (Chie, Kazuko, Teruo) and Ke's family (Keiko & Bacon), with their dog Chin. The photo was taken at Ke's home in March 1970. Source: Teruo Ogawa



Fig. 3 Bacon Ke (on the extreme left) showing his instruments, at the Charles F. Kettering Laboratory, to the visiting Chinese delegation in 1974. Back row: Yun-Kang Shen (first; extreme right); Jia-Mian Wei (not visible; second); and Yin-Fu Feng (third); first row: Ting-Yun Kuang (first), Long-Fei Yan (second), Qi-De Zhang (not visible; third); and Yue-Qun Zhou (fourth). Source: Yun-Kang Shen



of Xin-Guang Zhu). Bacon's legacy to the next generation includes, in addition, two important publications, one being an overall historical review by Huzisige and Ke (1993) and the other on "P430" (Ke 2002). However, an everlasting comprehensive account is '*Photosynthesis: Photobiochemistry and Photobiophysics*' (Ke 2001). It is just superb writing; it was the first single-authored book in the Series "*Advances in Photosynthesis and Respiration*." It is hard to believe that even today, many of us consult this book. The scope of the book is characterized by the time frame in which the light reactions and the subsequent electron transfers take place, from femtoseconds to several seconds! Further, a detailed account of photosynthesis research in China, upto 2004, is available in Kuang et al. (2005).

To provide an ambiance of Bacon Ke's life, related to China, we show here two photographs.

Figures 4 and 5 show Bacon, in 2 different groups, at the 1984 National Symposium on Photosynthesis" held in Yangzhou, Jiangsu Province, where he was a special guest.

Figure 6 shows Bacon with Chunhe Xu, another photosynthesis leader in China, an associate of several of us, and a former PhD student of one us (Govindjee) from the University of Illinois at Urbana-Champaign.

Messages for Bacon Ke@ 100

Robert Alfano (ralfano@ccny.cuny.edu)

Dr Bacon Ke has been among the luminaries in my early career who had helped me in my search to understand the underlying processes in photosynthesis and their nature. He stands among the ranks of luminaries, who I interacted with and learned from, which included Sir George Porter (Nobel laureate; time resolved flash photolysis); Martin Pope (a top expert on *excitons*); and Govindjee (an expert on primary events in photosynthesis, and a great teacher; see Fig. 5). I still vividly remember the classic chapter Bacon Ke wrote in a book I had edited in 1982 (*Biological Events Probed by Ultrafast Laser Spectroscopy*, Academic Press). Bacon was instrumental in my in-depth understanding of the early photochemical events in green plants through his classic research during 1972–1974, and then in 1980 with several others including Edward Dolan (see Fig. 4). It is indeed a pleasure to contribute to the celebration of 100 years of Bacon Ke's life.



Fig. 4 A group photograph of Bacon Ke, and his associate Ed Dolan, with members of the Photosynthesis Laboratory (Shanghai Institute of Plant Physiology, Chinese Academy of Sciences). *Front row* (from the left to the right): Shi-Gui Yu (first); Mei-Qi Wang (second); You-Ze Li (third); Hong-Zhang Yin (fourth); Bacon Ke (fifth); Ed Dolan (sixth); Yun-Kang Shen (seventh); Lu-Ping Qian (eighth); and Xiu-Fang Wang (ninth). *Second row* (from the left to the right): unidentified (first); Chunhe Xu (second); Chang-Xi Zhu (third); Yue-

Qin Qian (fourth); Gong-Muo Shen (fifth); Guo-Xiong Qiu (sixth); unidentified (seventh); and De-Yao Li (eighth). *Third row* (from the left to the right): Zhuo-Hui Huang (first); Jian-Ping Xiao (second); Jian-Ping Cai (third); Qun Zhou (third); Zi-Yun Du (fifth); Xiao-Yi Tang (sixth); Yu Feng (seventh); Shan-Yuan Yang (eighth); Xuan Liu (ninth); He-Ping Dai (tenth); Shi Tan (eleventh); Jia-Mian Wei (twelfth); Wen-Yi Shi (thirteenth); Yu-Qun Hong (fourteenth); and Bao-Jie Guo (fifteenth)



Fig. 5 A group photograph of the participants at the 1984 photosynthesis symposium, held at Yangzhou. Bacon Ke (in black shirt) is sitting in the first row (seventh from the left); others in the same row, from the left, are: Yun -Kang Shen (third); Ze-Sheng Lin (fourth);

Govindjee (fifth); Hong-Zhang Yin (sixth); Wah Soon (Fred) Chow (eighth); Yu-Zhu Gao (ninth); and Ting-Yun Kuang (tenth); cf. Kuang et al. (2005). Source: Yun-Kang Shen



Fig. 6 Left to right: Chunhe Xu and Bacon Ke, sitting and relaxing near the art gallery of Zhu Qizhan in Shanghai, 2006. Photo by Teruo Ogawa

Charles Joel Arntzen (Charles.Arntzen@asu.edu)

Bacon Ke was one of the ‘*Pillars of Photosynthesis*’ at the Charles F. Kettering Research Laboratory at the time I was doing part of my PhD thesis studies, as well as my postdoctoral work at that Institute (see Vernon 2003). I saw Bacon frequently because his laboratory was close to the electron microscopy facility where Hilton Mollenhauer was pioneering new approaches to the study of structural biology. Both of their laboratories were always quite dark because their research required it—Bacon for his sophisticated spectroscopy studies and Hilton for viewing of the dimly lit images in his microscopes. But the mood in both labs was anything but dark. Rather, there was an aura of excitement that might not be expected by an unfamiliar visitor. Both these scientists also shared a quiet, reserved persona which belied their deep curiosity and intelligence. I admired them and have great memories of these scientific pioneers that had a positive influence on my life.

Sandor Demeter (demeters44@freemail.hu)

In 1977, I received a 1-year fellowship from the United Nations Development Programme, UNDP, awarded by the Biological Research Center (BRC) of the Hungarian Academy of Sciences. I applied to work with Bacon Ke, who accepted me in his lab. I joined his Photosystem I (PSI) project and measured the light-induced oxidation of P700 and its dark reduction at 15 K at various negative redox

potentials. I also measured the kinetics of dark re-reduction of photo-oxidized P700 as a function of temperature between 5 and 294 K. Our data contributed to the later identification of the electron acceptors before the iron–sulfur complexes (Demeter and Ke 1977) and provided evidence for electron tunneling in PSI (Ke et al. 1979). Bacon Ke was a very quiet man with deep knowledge. He was working virtually all day in his office and only rarely talked to us, or faculty members of the Institute. Once a week or once in two weeks, he invited one of us to his office to talk about the experiments; then, he gave us clear instructions and advice. He himself and all of us in the lab worked until very late hours, sometimes till midnight. He demanded hard work and was strict about keeping order in the lab. At the same time, he was generous. When he learned about my very low amount of money given in my fellowship, he added a monthly sum half of the amount of what I was getting. After the end of my fellowship, he gave me a two-month extension. This was my first stay abroad (from Hungary, my home country); it was a great experience, which had a long-term impact on my scientific career, later in my own lab in the Biological Research Centre (BRC). I have very good memories from that time. Even today, as a retired scientist, I remember Bacon Ke with a grateful heart.

Richard A. Dilley (dilleyr@purdue.edu)

I worked with Bacon Ke at the Kettering Institute in the 1960s. He was a very friendly and helpful coworker. His lab was well equipped with real fancy gear for making important measurements on primary events in photosynthesis, and he helped me many times with my work on chloroplasts.

John Harvey Golbeck (jhg5@psu.edu)

I have but one memory of Bacon Ke. I had just left Anthony San Pietro’s laboratory with a Ph.D. and joined Bessel Kok’s laboratory as a fresh postdoctoral scientist when David Krogmann (1931–2016) called to ask if I would give a talk at the forthcoming 1978 Gordon Research Conference on Photosynthesis. The speakers in the Photosystem I session were Bacon Ke, Alan Bearden, Kenneth Sauer (if I remember correctly), and myself. I recall the organizational meeting prior to the session in which we decided among ourselves the order of speakers. When we had finalized the lineup, I think it was Bacon who remarked that in most other fields of science, there would have been a fight to be the first speaker, but we made our decision based on a logical unfolding of the work. That impressed me, as it spoke volumes about the people and culture in our small niche of the scientific world. However, Bacon had a much more lasting effect on my life, something he may not even be aware of. I remained at Martin Marietta Laboratories after Bessel Kok (1918–1979) had

died, working largely on corporate projects, but I was able to keep a small effort going in Photosystem I. In 1983, I submitted a proposal to the National Science Foundation (NSF) and although I had gotten very good reviews, the program director told me that he was unwilling to fund both Bacon Ke's renewal proposal as well as mine, given that both dealt with similar topics. I accepted my loss and started considering alternative areas of research when a few months later, the same program director called to tell me that my grant would be funded after all. It turns out that research priorities at the Charles F. Kettering Laboratory were changing, and at that point Bacon decided to retire. As he had not yet activated his grant, the decision was made to fund my proposal instead. When the Biosciences group at Martin Marietta was eliminated in early 1985, that grant became my bridge to obtaining a position in academia. In a very real sense, then, it could be said that I was able to keep Bacon's work on Photosystem I alive for an additional 35 years, up to the present day.

Isamu Ikegami (ii-ike@par.odn.ne.jp)

I was one of the last visiting investigators in Dr. Bacon Ke's Lab. My stay was only for one year, from October 1982 through November 1983, and I appreciated the care and concern received from him. We published two detailed papers on low temperature absorption, fluorescence and EPR spectroscopy of Photosystem I (see Ikegami and Ke 1984a, b). Further, my family and I enjoyed very much our stay in Yellow Springs (Ohio), which was a small friendly village in the big woods. I am delighted to have the opportunity to express my cordial thanks to Dr. Bacon Ke and, more importantly, celebrate his 100th birthday in 2020!

Ting-Yun Kuang (kuangty@ibcas.ac.cn)

Professor Bacon Ke has made a great contribution to photosynthesis research, especially in the primary reactions of photosynthesis. I appreciate his great support to all of us and congratulate him at his 100th birthday.

Richard Malkin (dickm@berkeley.edu)

When I first met Bacon, he was working at the Kettering Institute in Yellow Springs, Ohio; then, I was a student at the Antioch College, also in Yellow Springs. We realized this when we were at a meeting and we found out that we had this strong connection with each other. Bacon and I both worked on Photosystem I (PSI) and its primary electron acceptor. He used kinetic spectrophotometry, while Alan Bearden and I were using Electron Paramagnetic Resonance (EPR) methods, but both of our work contributed to the identification of an iron-sulfur protein as an early PS I electron acceptor (see, e.g., Ke 2001, 2005). But there was another side to Bacon.

He collected Chinese art works, and these were always on exhibit in his home. We were both opera fanatics and were fortunate to have the San Francisco opera so close by (when we both lived in California). And he loved good food and would often come into Berkeley from Walnut Creek for lunch at the famous *Chez Panisse* and I was pleased to join him. And, in this way, I think of Bacon as a wonderful friend and as a Renaissance man, ranging from science to the arts. I am happy to know he made it to 100.

Hualing Mi (mihl@cemps.ac.cn)

I met Prof. Bacon Ke on May 30, 2002, for the first time through Prof. Chunhe Xu, our research group leader (see Fig. 6). We talked a lot about research and our impressions of Japan. I found that Bacon Ke had made key discoveries in photosynthesis research. I told him that his book on "Photosynthesis", in Chinese, is one of the best textbooks on photosynthesis research. He was very happy to know that his book was popular among the many working on photosynthesis in China. I met him for the second time in October of 2006, when he visited Shanghai again. At that time, one of the authors, Prof. Teruo Ogawa (from Japan) was working with me as a visiting professor in the Photosynthesis Research Group, at the Institute of Plant Physiology and Ecology, Chinese Academy of Sciences. We had in-depth discussions, with Bacon Ke, not only on the intricate aspects of photosynthesis, but also on experiences living in Japan. I was deeply impressed by his profound knowledge not only in the *Sciences*, but also in the *Arts* and *Philosophy*. What touched me most was his approachability to the younger generation (see Fig. 7).

Teruo Ogawa (ogawater@xd6.so-net.me.jp)

After I finished my Ph.D. under Prof. Kazuo Shibata (at the Tokyo Institute of Technology, Japan; 1917–1983) on the separation of pigment proteins of two photosystems by SDS-PAGE (Ogawa 2003), I was invited by Dr. Leo Preston Vernon (1925–2010) (see Vernon 2003), as a postdoctoral fellow to work at the Charles Franklin Kettering Research Laboratory. I was there from January 1968 through March 1970 and worked mainly on the isolation of photosystem I complex from cyanobacteria. Tetsuo Hiyama arrived at the Kettering Research Laboratory in October 1969, to work with Bacon Ke, and we spent nearly 5 months in the same building. After the new year holidays in 1968, my wife, Kazuko, and I met Bacon Ke and his wife, Keiko-san (Keiko Mayama Ke (1919–2017)) for the first time. Bacon enjoyed arts, especially Chinese paintings, and classical music. They had two grand pianos in their home, and I remember that one of them was a Steinway piano. Kazuko was often invited to play piano with Keiko. Keiko's father Koji Mayama was

Fig. 7 A photograph of Bacon Ke at a restaurant in Shanghai, October 2006. Sitting (left to right): Yun-Kang Shen; Bacon Ke; Teruo Ogawa; Daquan Xu; standing (left to right): Jia-Mian Wei; Genyun Chen; Hualing Mi; and Chunhe Xu. Source: Hualing Mi's archives



a highly renowned Japanese artist (see Ko 2016), and we know that Keiko had gone to USA in 1952 on a Fulbright fellowship, but none of us know when and how her romance with Bacon had started. After retirement, Bacon and Keiko lived in Japan for a few years. Then, after they returned to San Francisco, Keiko often visited Japan. After I retired from Nagoya University in 2003, I worked with Hualing Mi (see *her reminiscence*) and met Bacon again when he was visiting Shanghai in October, 2006. Chunhe Xu (Fig. 6), a former PhD student of Govindjee, and a renowned photosynthesis expert in Shanghai, is also a connoisseur of Chinese paintings. During this visit of Bacon, Chunhe guided us through many museums and art galleries of Chinese arts including the art gallery of Zhu Qizhan, one of the great artist painters of China.

Yasusi Yamamoto (yasusiya@okayama-u.ac.jp)

I am extremely happy to know that Dr. Bacon Ke is 100 years old now. I was his postdoctoral associate for a year during 1979–1980. Before going to his Lab in Yellow Springs (Ohio), I had finished my Ph.D. under Prof. Mitsuo Nishimura (at Kyushu University, Japan). For research, I was interested in the biochemistry of Photosystem II, PSII (not PSI), as well as in membrane fluidity. My first surprise on joining Dr. Ke's lab was very nicely organized instruments in his lab, and it was indeed exciting to know that most of them were constructed and maintained by Bacon Ke himself; he was a very neat person, and I remember that everything

in his lab was nicely put in order by his own efforts. Dr. Ke was very kind to allow me to work on PSII, not PSI that he was working on—giving me the freedom to pursue my own research interest. Further, since my spoken English was not good, I communicated with him, using handwritten text, every Monday morning, and that too for one hour; this was really a good training for me. I learned a lot from him about science and life in the US. The research I did there was concerned with local fluidity around PSII, cationic regulation of electron transport of PSII, and membrane surface electric properties of PSII (see Yamamoto and Ke 1979, 1980a, b, 1981). I also cannot forget our friendship with the late Vyacheslav (Slava) Klimov (1945–2017; see Allakhverdiev et al. 2018) of the USSR (now Russia), who had come to the lab of Bacon Ke, during my stay there. The deep friendship between us lasted for a long time. After finishing my one-year postdoc at Yellow Springs, I moved to the Imperial College, UK, to join the laboratory of Professor James (Jim) Barber (1940–2020), unfortunately, deceased now (see: <https://www.imperial.ac.uk/news/194710/professor-james-barber-1940-2020/>).

Xin-Gung Zhu (zhuxg@sippe.ac.cn)

I remember Bacon Ke from his wonderful book on Photosynthesis in Chinese; it is a unique book as he had decorated it with delicate paintings at the end of each chapter. This book was the first introductory text on photosynthesis for me, when I started my research in 1996. I learned a lot from

this book. I deeply miss his presence and the wisdom he imparted.

We end this tribute by wishing Bacon Ke “Happy 100th Birthday” with the following message in Chinese.

Shòu bǐ nán shān, fú rú dōng hǎi

which means

**May you live as long as Southern Mountain and
your fortune be as boundless as the Eastern Sea!**

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Compliance with ethical standards

Conflict of interest The authors have no conflicts of interest to declare that are relevant to the content of this article.

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