INTRODUCTION

Special issue on Regulation of the Photosynthetic Systems in honor of Tingyun Kuang

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This special issue of Photosynthesis Research is dedicated to ‘Regulation of the Photosynthetic Systems,’ which was the topic of a conference held during August 16–20, 2014 at Guilin, China. This conference was held in honor of Professor Tingyun Kuang (Fig. 1) at the occasion of her 80th birthday, for her continuous contributions and enthusiasm to the photosynthesis research, and in particular for the leading roles she played in this research field in China.

Tingyun Kuang has been dedicated to photosynthesis research in the Institute of Botany, the Chinese Academy of Sciences (IBCAS) since 1962, where she became a group leader a few years later, and is still a professor there at present. She was born in Zizhong County, Sichuan Province of China in 1934, where she completed her elementary and middle school study. She graduated from Department of Soil Agricultural Chemistry, Peking Agricultural University (now China Agricultural University) in 1956, and obtained a Ph.D. degree in biology from the Moscow State University in 1962. She worked as a visiting scholar in Charles J. Arntzen’s Laboratory at Michigan State University from 1980 to 1981 on the isolation and

Fig. 1 Professor Tingyun Kuang

functional studies of light-harvesting pigment complexes. She was selected as an academican of the Chinese Academy of Sciences in 1995, and served as a member of the executive committee of the International Society of Photosynthesis Research during 1998–2004. She served a number of roles in national and international societies, including the president of the Botanical Society of China (1998–2002), honorary president of the Plant Physiology Society of China (2000–present), honorary president of the Botanical Society of China (2003–present), and academican of the International Academy of Sciences for Europe and Asia (2004–present). She also successfully organized the 15th International Congress on Photosynthesis in Beijing in 2010 with her colleagues.

Tingyun Kuang has focused her research on the structure and function of photosynthetic membrane protein

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complexes of various plants. Here major achievements can be summarized as follows.

1. *The role of manganese in photosynthetic function*

Professor Kuang started her photosynthetic career from the effects of manganese on the Hill reaction, and found that the activity of oxygen evolution is closely related to the concentration of manganese (Cui et al. 1964). She also investigated the effects of manganese on photophosphorylation and observed that manganese acts on the non-cyclic photophosphorylation rather than the cyclic photophosphorylation (Kuang et al. 1966).

2. *Structure and function of thylakoid membranes*

At the end of 1970s, Professor Kuang had an opportunity to visit the United States of America where she learnt the progress in photosynthesis research by visiting several famous photosynthesis laboratories. After returning back from USA, she decided to turn her research interests to the structure and function of photosynthetic membranes. She led her team to study the relationship between the structure and function of thylakoid membranes of plants and promoted the research in thylakoid membranes in China (Kuang et al. 1979; Lin et al. 1980; Li et al. 1986; Wang and Kuang 1988; Wang et al. 1989; Zuo et al. 1991, 1992; Chen et al. 1993, 1994; Shi et al. 1997; Tang et al. 1999; Xu et al. 2000a, b).

3. *Structure and function of the chlorophyll–protein complex of PSI*

In 1981, Professor Kuang proved for the first time that the 21 kDa chlorophyll–protein complex was the origin of the long-wavelength fluorescence emission band from PSI, while she was working in Charles J. Arntzen's Laboratory (Kuang et al. 1984). In 2006, she led her team to develop a novel method to isolate the large amount of PSI–LHCI complexes from spinach leaves with a relatively short time (Qin et al. 2006). Since a part of LHCII could be light-harvesting antennas for PSI, they tried to get PSI–LHCI–LHCII super-complex and studied its properties under high light conditions (Qin et al. 2011). Very recently, her team, in collaboration with Professor Jian-Ren Shen's team, successfully crystallized the PSI–LHCI complexes from *Pisum sativum* (pea) and solved its structure at a resolution of 2.8 Å (Qin et al. 2015). This study provided a firm structural basis for the understanding on the energy transfer and photoprotection mechanisms within the PSI–LHCI super-complex.

4. *The structure and function of chlorophyll–protein complex of PSII*

In 1984, Professor Kuang, collaborated with DJ Kyle, found the movement consequence of its phosphorylation, thereby revealed the lateral migration of light-harvesting chlorophyll protein complexes in the thylakoid membrane as a means for regulation of excitation energy distribution between the two photosystems (Kyle et al. 1984). She also proposed the possible kinetic model of charge separation in the PSII reaction center (Yu et al. 1992; Kuang et al. 1993), discovered the photodamage of His residues and pheophytin *a* in the PSII reaction center. She and her colleagues proposed a hypothesis for the physiological role of the second electron-transfer branch which is to protect the first branch against the excess excitation energy (Yu et al. 1994, 1995; Shan et al. 1999a, b; Wang et al. 1999). She also extended her research interests into the mechanism of water oxidation in PSII. In 1999, her team succeeded in predicting the binding mode of calcium in the water oxidation center (WOC) (Zhang et al. 2000). In the subsequent time, her research team reported spectral and functional studies on siphonaxanthin-type light-harvesting complex of photosystem II from *Bryopsis corticulan* (Chen et al. 2008; Wang et al. 2013). In 2004, her team collaborated with the research group led by Professor Wenrui Chang and reported the crystal structure of spinach light-harvesting complex (LHCII) at 2.72 Å (Liu et al. 2004).

5. *The structure and function of cytochrome *b₆f* complex*

In 2001, Professor Kuang and her colleagues discovered the presence of 9-*cis*-carotene (Car) in cytochrome *b₆f* complex from spinach (Yan et al. 2001). They further found the presence of α -carotene in the cytochrome *b₆f* complex from a green alga *Bryopsis corticulan* (Li et al. 2005). With this α -Car-containing cytochrome *b₆f* complex, they revealed the generation and mechanism of the high light-induced single oxygen and superoxide radical (Sang et al. 2010, 2011).

The functions of various photosynthetic systems have been studied extensively over several decades, and we have had a much deeper understanding on these functions at present. What appears to be less clear and equally important is the regulation mechanisms governing the functioning of various photosynthetic systems in vivo. It is for this reason that the international conference on “Regulation of Photosynthetic Functions” was organized, and this special issue is devoted. The special issue consists of 22 research papers and 4 review articles. The research papers cover a wide range of regulation and function of the photosynthetic systems from chloroplast gene expression, RNA editing and splicing, photoinhibition, photoprotection and repair of photosystem II, stability of apo-CP43, role of lipids in PSII

analyzed by site-directed mutagenesis of D1, to the function of lanthanum(III) and cerium(III) ions on water oxidation, the role of PsbQ in PSII assembly, absorption and transfer of light energy by fucoxanthin–chlorophyll-binding proteins, early chloroplast development, photosynthesis under elevated CO₂ conditions, metabolite signaling from mitochondrial alternative oxidase, binding and interaction of a large complex of NAD(P)H dehydrogenase with ferredoxin, and photochemical properties of rice leaves. The review articles include chlorophyll biosynthesis and assembly into the chlorophyll-binding proteins, protection of photosynthesis under abiotic stress conditions, proteomic analysis of *Synechocystis* sp. PCC 6803, and the photobiological hydrogen production and artificial photosynthesis for clean energy production. We believe that these contributions represent the state-of-the-art studies in this field, and will therefore greatly promote our understanding on the regulation of various photosynthetic systems.

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