Experimental approach to the development of photosynthetic antenna systems

Mamoru Mimuro

Department of Technology and Ecology, Hall of Global Environmental Research, Kyoto University, Kyoto 606-8501, Japan.

Photosynthetic antenna systems are the specifically designed architecture for capturing light energy and transferring to photochemical reaction centers (RC). Compared with continuity of RC from photosynthetic bacteria to land plants, the antenna system shows discontinuity between photosynthetic bacteria and cyanobacteria (Fig. 1), that is, changes occurred with an appearance of an oxygen evolving system. It is necessary to search an origin and continuity of antenna components in oxygenic photosynthetic organisms to get general understanding of the antenna system. In cyanobacteria, the photosystem (PS) I consists of two major and distinct polypeptides (PsaA/B) and several minor polypeptides, and approximately 100 Chl *a* and 20 - carotene are confined. This architecture was succeeded from green sulfur bacteria and heliobacteria, even though in those bacteria, two identical polypeptides consist of the RC. We investigated several kinds of variations in PS I in cyanobacteria to get indication for the continuity of the antenna system.

Gloeobacter violaceus PCC 7421 has no thylakoid membranes in cytoplasm [1], and it is assigned to an early-divergent species by the 16S rRNA sequence analysis. In this PS I, Red Chl *a*, that is, Chl *a* whose energy level is lower than that of the primary electron donor in PS I (P700), was not found [2]. This shows a variation in the energy reservoir and energy flow in PS I. Regulation of PS I/PS II ratio in this bacterium seemed to be different from that in other cyanobacteria. It may be one of primitive properties of this species.

Acaryochloris marina is the only one cyanobacterium whose major pigment is Chl *d* [3]. Chl *d* is known to be antenna pigments [4] and primary electron donor of PS I [5]. Due to changes in a molecular structure of macrocycle of Chl *d*, the interaction between pigments and amino acid residues may be different from that in other cyanobacteria. This was reflected by variation in the amino acid sequence of PsaA/B. This shows a variation of pigment recognition.

Chl *b* is not an intrinsic component of cyanobacteria. We introduced the gene for Chl *b* biosynthesis (CAO) to *Synechocystis* sp. PCC 6803 [6] to monitor a transient state from cyanobacteria to a Chl *b*-containing species. We observed that Chl *b* was