Biochemical analysis and structural predictions of photosynthetic apparatus components in *Acaryochloris marina* spectral types

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Photosynthetic organisms rely on pigment-protein complexes to capture sunlight and drive charge separation, with cyanobacteria exhibiting remarkable diversity in their photosystems and antenna assemblies. Among them, *Acaryochloris marina* represents a unique case, using chlorophyll (Chl) *d* in place of the more common Chl *a* (**Fig. 1A**), thereby shifting its absorption cross-section toward lower energies. The most studied strain, MBIC11017, has yielded structural insights into both photosystem I and II, yet little is known about how antenna complexes and photosystems vary across other *A. marina* strains. Recent work has revealed three distinct spectral strain types exhibiting short, intermediate, and long-wavelength spectral characteristics (**Fig. 1B**), yet the molecular basis underlying these differences remains unresolved. Here, we investigate the pigment-protein complexes of representative strains from all three spectral groups using spectroscopic, proteomic, and electron microscopic approaches. Our analyses identify the source of spectral shifting among different strain types and provide preliminary structural information on some components of the photosynthetic apparatus. These findings expand the molecular framework for understanding low-energy photosynthesis and illuminate the ecological and evolutionary strategies that may have enabled *A. marina* to diversify and thrive in varied light environments.

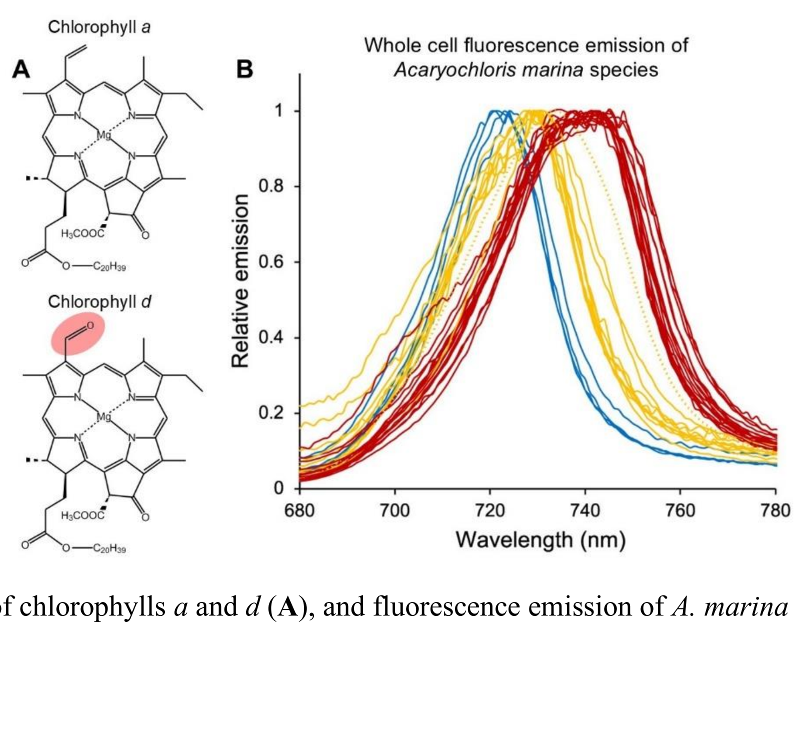

Fig. 1. Structures of chlorophylls *a* and *d* (**A**), and fluorescence emission of *A. marina* spectral types (**B**).