Red light irradiation effects on the microstructure of *Phormidium tenue* (*Pseudanabaena* sp.)

Kuniko Takemoto[1], Masashi Yoshimura[2], Hidetoshi Namba[3] and Hiroshi Kihara[2, 4]

1) Department of Physics, Kansai Medical University, 2-5-1, Shinmachi, Hirakata, Osaka, 573-1010, Japan

2) SR center, Ritsumeikan University, 1-1-1, Noji-Higashi, Kusatsu 525-8577, Japan

3) Department of Physical Science, Ritsumeikan University, 1-1-1, Noji-Higashi, Kusatsu, Shiga, 525-8577, Japan

4) Himeji-Hinomoto College, 890 Koro, Kodera-cho, Himeji 679-2151, Japan

Since 1969, a problem of musty odor in drinking water has occurred due to sudden propagation of certain plant plankton in Lake Biwa. *Phormidium tenue* (*Pseudanabaena* sp.) has been identified as a causative alga. From Nakamura's research, it is known that there are a green *P. tenue* (PTG) producing musty odor and a brown *P. tenue* (PTB) not producing musty odor [1]. However a morphology and pigmentation of cyanobacterium change depending on the environmental conditions. Therefore it is difficult to identify them by a light microscope (LM) and fluorescence microscope (FM). We have observed *P. tenue* with a soft X-ray microscope (XM) with much higher resolution than LM and examined a microstructural characteristic of *P. tenue* producing musty odor.

Growth of photoautotrophs cyanobacteria depend on the irradiation condition. Certain cyanobacteria can acclimate to the quantity and quality of light present in their environment. The following experiments were conducted in order to investigate the influence by an irradiation condition during cultivation. PTG isolated from Lake Biwa was cultivated stationary in CT medium under two irradiation conditions. The conditions are as follows: white light (2,000w) without filter, and with a red cellophane filter. The transmissivity of the red filter was about 13 %. A proliferative condition was confirmed by musty odor and/or color. Cell suspension without chemical fixation and staining was dropped onto a polyimide thin film (thickness < 300 nm) and air-dried. The cells were observed at soft XM beamline (BL-12) under atmospheric pressure. The X-ray images were taken with a wavelength of 2.0 nm (below the wavelength oxygen K-edge threshold, 2.28 nm). The XM observation was supported by the MEXT Project for Creation of Research Platforms and Sharing of Advanced Research Infrastructure [2].

Color of PTG cultivated without the filter (PTGN) and with filter (PTGR) suspensions were deep green and pale green respectively. The PTGN suspension showed pale green because the number of PTGN cells was smaller than that of PTGN ones. Characteristic orange-red fluorescence of phycocyanin under green light and musty odor generation were confirmed in both suspensions. Figures 1 show X-ray image of PTGN and PTGR. A filamentous cyanobacterium without a thick sheath is clearly observed in both. A granule which is a characteristic structure of PTG in XM observation is also clearly recognized in both. The large difference was not recognized in the granule size distribution between the two. However the difference was recognized in the cell size between the two. PTGN cells (Fig. 1 A) look thicker than PTGR cells (Fig. 1 B). The average cell widths of PTGN and PTGR were 1.69 μm and 1.35 μm, respectively. The growth rate, and cell size depended on the irradiation condition during cultivating. In contrast, the pigmentation, musty odor generation and granule size distribution didn't depend on it. Namely, the wavelengths of light and/or photon flux density were unable to control a metabolism although it were able to control a cell growth. An examination using LED lights is planned to elucidate the relationship between an ability to produce musty odorous substance and the wavelengths of light and/or photon flux density.

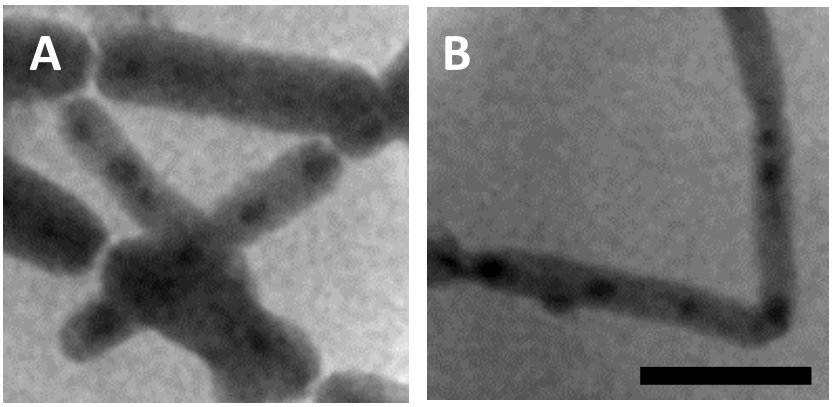

Figure 1 X-ray image of PTGN (A), and PTGR (B) [2]. Exposure times of A and B are 180 s and 240 s, respectively. Scale bar: 5 μm.

References

(1) Y. Niyama, *Japanese Journal of Limnology*, **2012**, *73*, 187-196 (in Japanese).
(2) Activity Report of Project for Creation of Research Platforms and Sharing of Advanced Research Infrastructure.