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Photosynthetic characteristics of marine aerobic anoxygenic phototrophic bacteria Roseobacter and Erythrobacter strains

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<INTRODUCTION> Aerobic Anoxygenic Phototrophic bacteria (AAnPB) containing the photosynthetic pigment bacteriochlorophyll (BChl) *a* can grow using both phototrophy and heterotrophy (Yurkov and Csotonyi 2009). Therefore, their metabolic performance is called photoheterotrophy. Recently, AAnPB and other photoheterotrophs including proteorhodopsin-containing bacteria and cyanobacterium *Prochlorococcus* have been classified into a new functional group in terms of energy acquisition (Beja and Suzuki 2008; Cottrell and Kirchman 2009).

From the ecological standpoint, Kolber et al. (2001) reported AAnPB comprised at least 11% of total bacterial abundance in the upper open ocean. Thereafter, it has become clear that AAnPB are widely distributed and their spatio-temporal changes are large in the upper oceans (e.g. Schwalbach and Fuhrman 2005; Lami et al. 2007). However, what controls their population dynamics is still an open question. One of the main reasons is that less is still known about the physiological characteristics of AAnPB. For example, the contribution of photosynthesis to their growth has seldom been quantified (Yurkov and Csotonyi 2003). Koblizek et al. (2003) determined the biochemical and physiological characteristics of several *Erythrobacter* strains in terms of 16S rRNA and *pufM* gene sequences, growth rates, in vivo absorption and fluorescence excitation spectra, and pigment composition. More recently, Koblizek et al. (2010) revealed the photosynthetic properties of AAnPB belonging to *Roseobacter* clade (strain COL2P). However, those parameters for the other AAnPB have not yet been reported. Moreover, the differences in photosynthetic characteristics between *Roseobacter* and *Erythrobacter* remain unclear.

<PURPOSE> The purpose of this study is to clarify similarity and dissimilarity in photosynthetic characteristics of the two AAnPB genera *Roseobacter* and *Erythrobacter* .

<MATERIALS AND METHODS> Here we isolated coastal marine AAnPB bacteria belonging to the genus *Roseobacter* (strain OBYS 0001) and characterized physiological and biochemical properties, especially in photosynthesis, and compared them to those of the *Erythrobacter* longus type strain (NBRC 14126). Both strains were cultured at 20 ^{o} C in ZoBell 2216E medium, the below 4 parameters were determined in each growth condition. 1. Growth rate by epifluorescence microscopy, 2. Photosynthetic activities by FIRe fluorometry, 3. Pigmentation by HPLC, 4. Absorption and fluorescence excitation properties by spectrophotometry and spectrofluorometry, respectively.

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<RESULTS AND DISCUSSION> Growth curves of the two strains represented similar patterns. Cellular bacteriochlorophyll *a* concentrations of the strains showed maxima in stationary growth conditions. In vivo fluorescence excitation/optical density spectra between 470 and 600 nm for OBYS 0001 represented higher values than NBRC 14126. Variable fluorescence measurements revealed that the functional absorption cross-section (sigma PSII) of photosystem II for OBYS 0001 was significantly higher than that for NBRC 14126 under green excitation. These results suggest that *Roseobacter* can capture green light more efficiently than *Erythrobacter* for photosynthesis. On the other hand, the photochemical quantum efficiencies (F_v/F_m) of photosystem II for OBYS 0001 were consistently lower than those for NBRC 14126. A relationship between the growth rate and F_v/F_m was significant for OBYS 0001, but that was not found for NBRC 14126. These results suggested that F_v/F_m for AAnPB could not be simply used for a proxy of growth rate, and the uncertainty was probably caused by their heterotrophy.

Keywords: aerobic anoxygenic phototrophic bacteria, *Roseobacter*, *Erythrobacter*, variable fluorescence, absorption spectrum, fluorescence excitation spectrum