

**Dominance of MGII in surface ocean  
benefiting from the acquisition of  
proteorhodopsin during evolution**

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Marine Group II Euryarchaeota (MGII) are abundantly distributed in global surface oceans and commonly scarcely found in deep waters. The evolutionary implication of this phenomenon can be profound but has been poorly addressed. Most photic zone MGII have the proteorhodopsin gene indicative of a photoheterotrophic life style while all MGII from aphotic zone lack this gene and can be viewed as living a chemoheterotrophic life style. The combined analysis of previously published MGII MAGs with greater than 70% completeness and MGII MAGs newly recovered from Mariana Trench water column in our study indicated that MGIIB contain the highest proportion of proteorhodopsin genes and occupy the most diverse ecological niches, followed by MGIIA and MGIIC. However, the average genome size of MGIIC is the largest, followed by MGIIA and MGIIB. Analysis of high-quality MGII MAGs using Bayesian method revealed that chemoheterotrophic MGII dominated in older clusters while photoheterotrophic MGII dominated in younger clusters. Our study indicates that the acquisition of proteorhodopsin gene might have enabled MGII to reduce genome size and to be more competitive in surface ocean by harnessing light energy during their evolution.