

Characterization of microbial community structure and function in *Synechocystis* sp. PCC 6803 photobioreactors

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Background

- Successful deployment of biotechnologies often requires a comprehensive understanding of the microorganisms present in the system and how they interact with one another and their environment¹
- Cyanobacteria commonly associate with diverse communities of heterotrophic bacteria² that can grow on soluble microbial products (SMP) produced by the cyanobacteria³
- Heterotrophic bacteria can colonize both small and large-scale PBR cultures



Hypothesis

Diverse consortia of heterotrophic bacteria grow in *Synechocystis* sp. PCC6803 PBRs using SMP as a source of carbon and electrons

Objectives

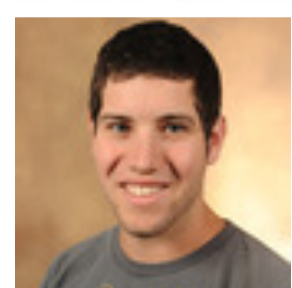
- Investigate the microbial communities in PBR cultures of the model cyanobacterium *Synechocystis* sp. PCC6803
- Develop strategies to manage heterotrophic communities in PBRs
- Determine how different heterotrophic bacteria affect the growth of *Synechocystis*
- Characterize the composition of SMP in PBRs
- Examine growth of heterotrophic bacteria on SMP

Methods

- PBR culturing
 - Flask to bench-scale PBRs
- Microbiology
 - Isolation/enrichment
 - Co-cultures
- Molecular biology
 - 16S rRNA gene sequencing³
- Analytical/Chemical techniques



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Acknowledgments

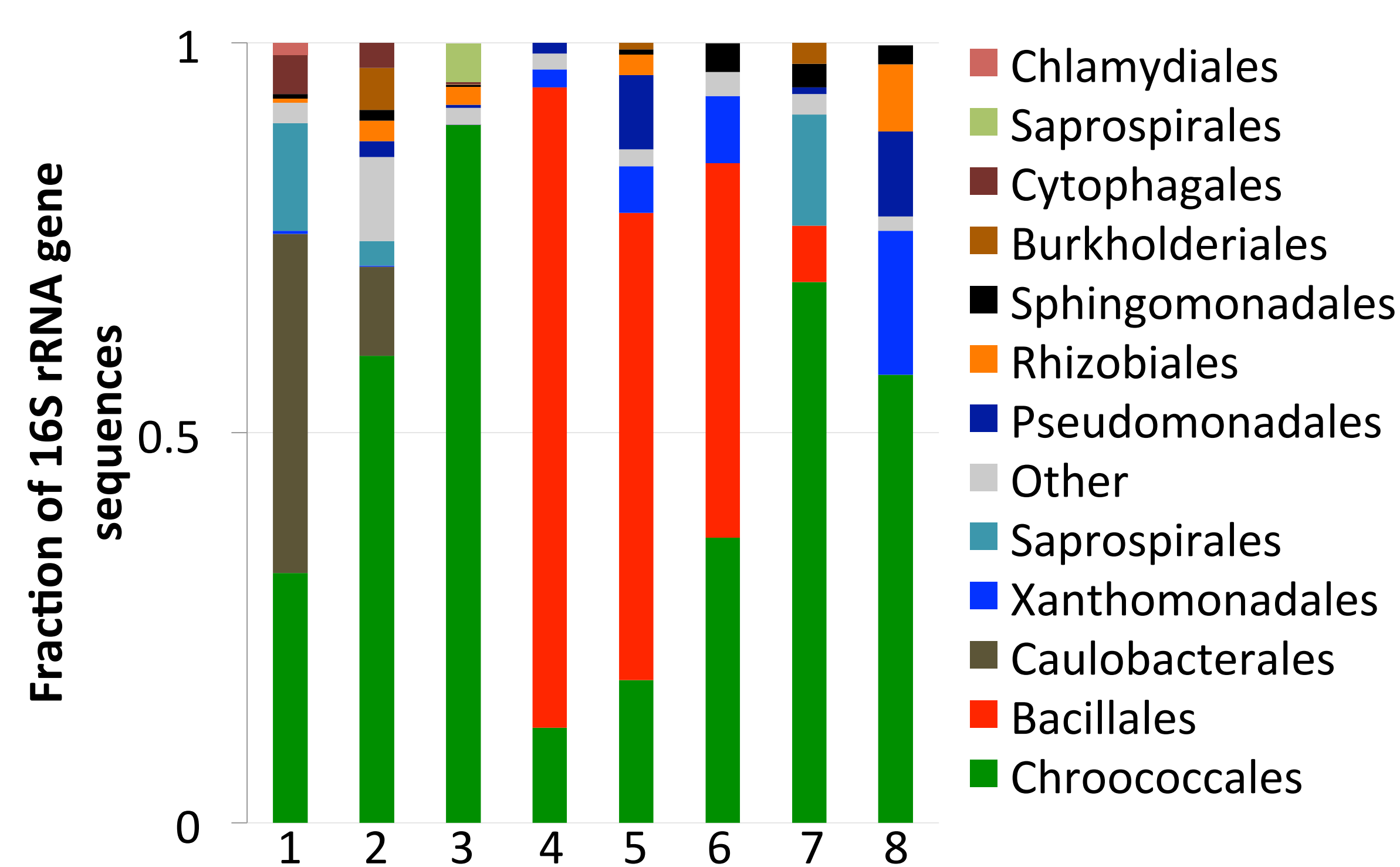
We would like to thank the laboratory of Dr. Willem Vermaas for maintaining mother cultures of *Synechocystis* PCC 6803. This work was performed with the support of awards from ARPA-E and DOE

References

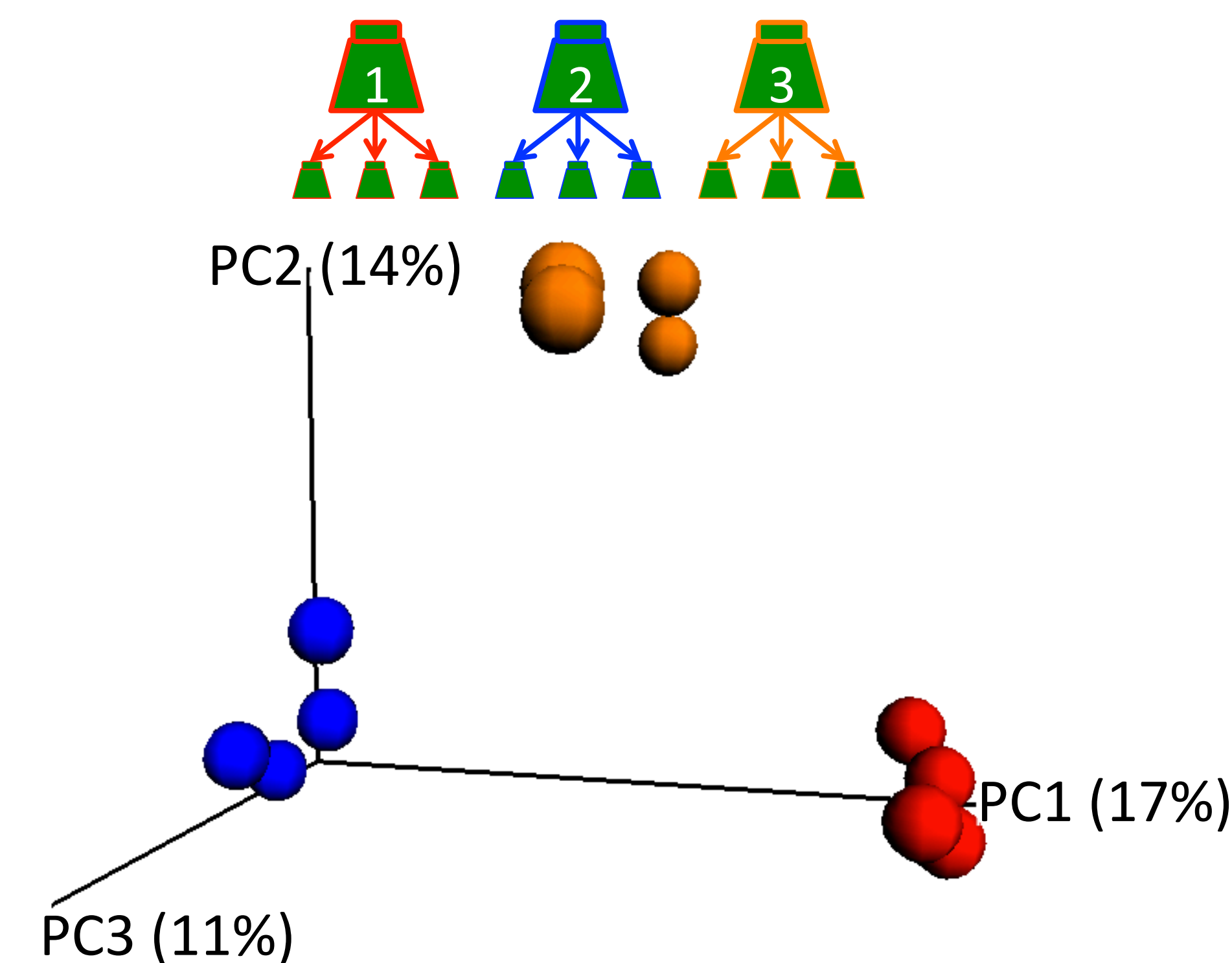
- 1) Rittmann, B. E.; et al. A vista for microbial ecology and environmental biotechnology. *Environ. Sci. Technol.* 2006, 40, 1096–1103.
- 2) Berg, K. A.; et al. High diversity of cultivable heterotrophic bacteria in association with cyanobacterial water blooms. *ISME J.* 2009, 3, 314–325.
- 3) Merkey, B. V.; Rittmann, B. E.; Chopp, D. L. Modeling how soluble microbial products (SMP) support heterotrophic bacteria in autotroph-based biofilms. *J. Theor. Biol.* 2009, 259, 670–683.
- 4) Caporaso, J. G.; et al. QIIME allows analysis of high-throughput community sequencing data. *Nat. Methods* 2010, 7, 335–336.

Results

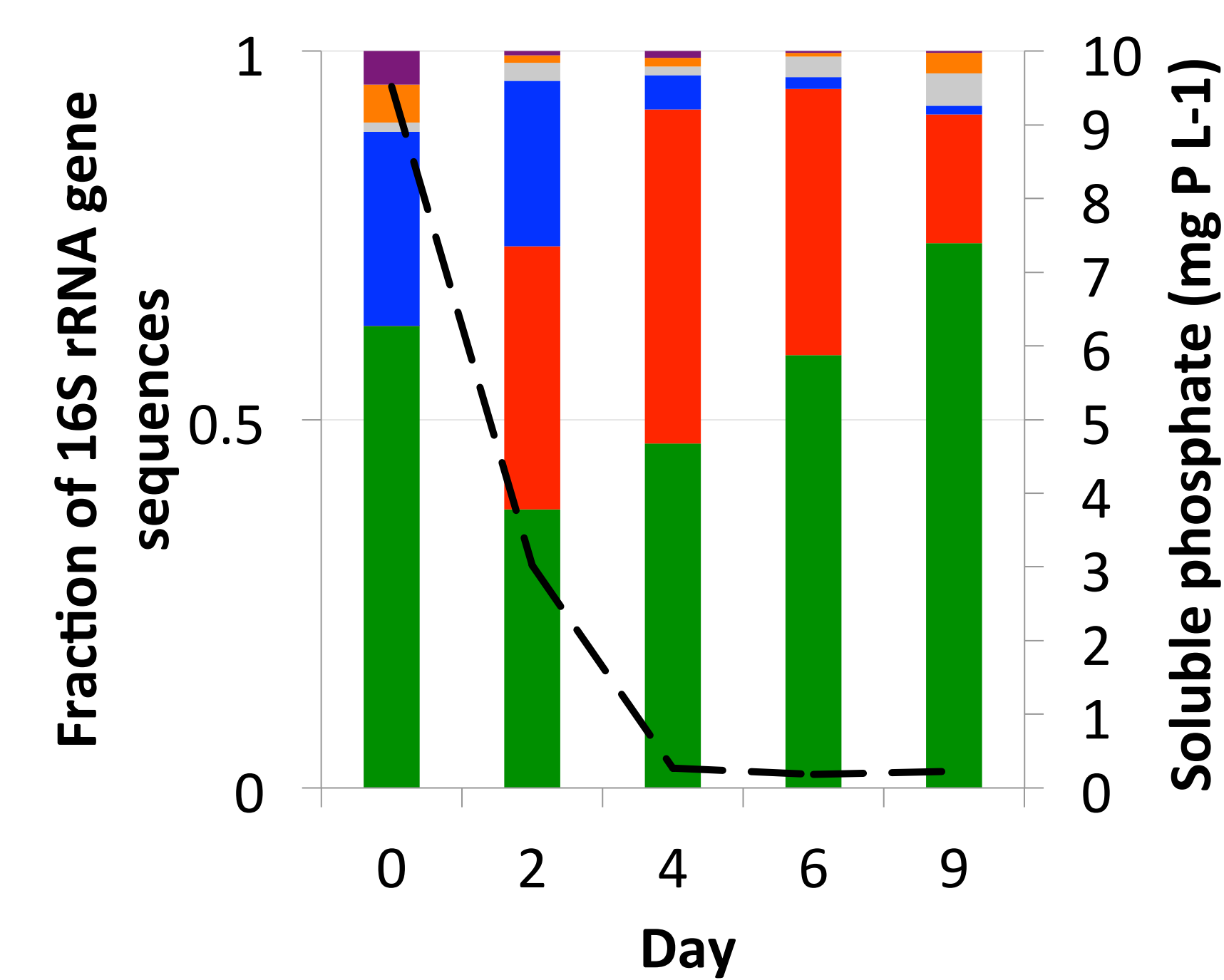
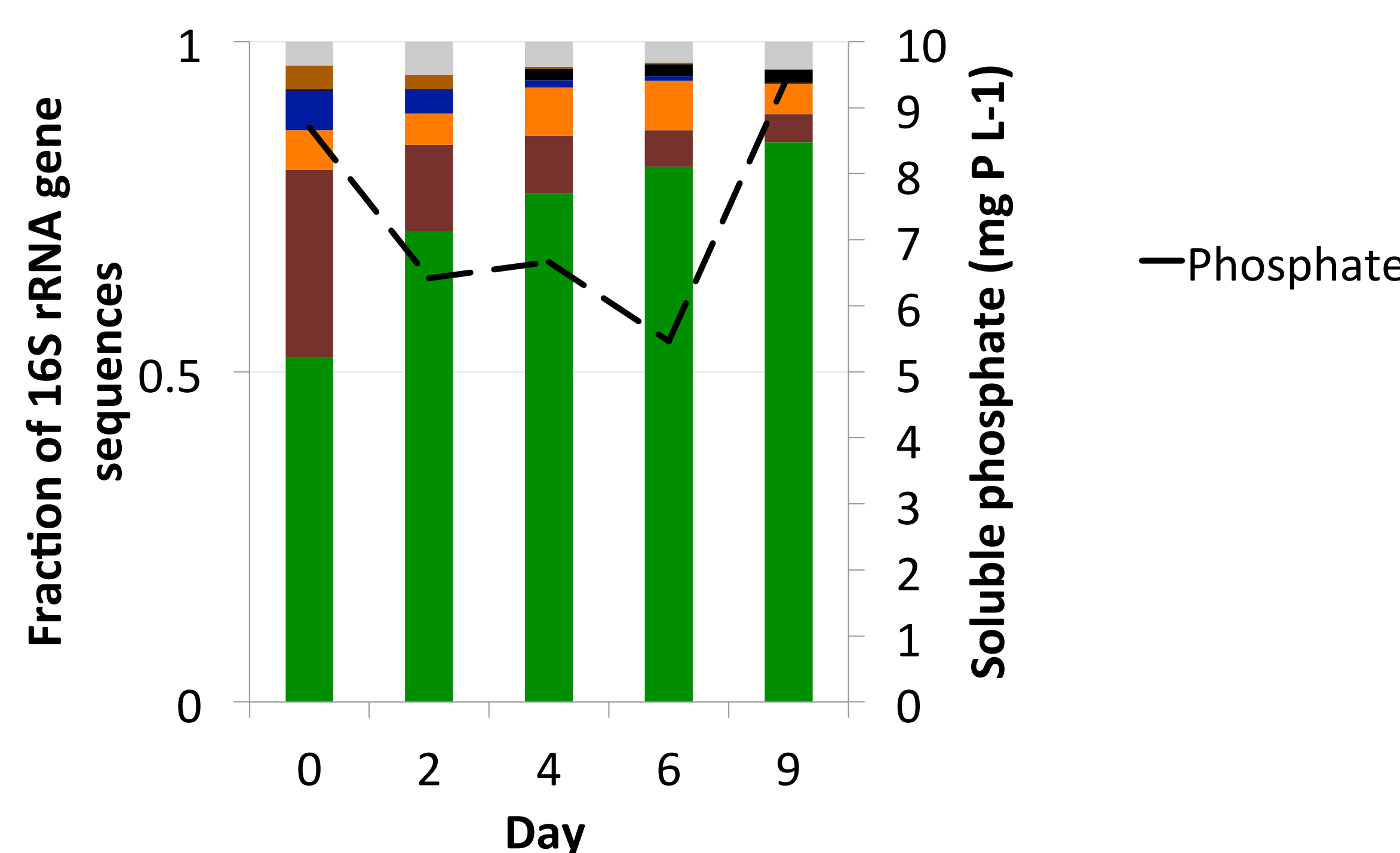
(1) Unique microbial communities in eight separate PBR experiments



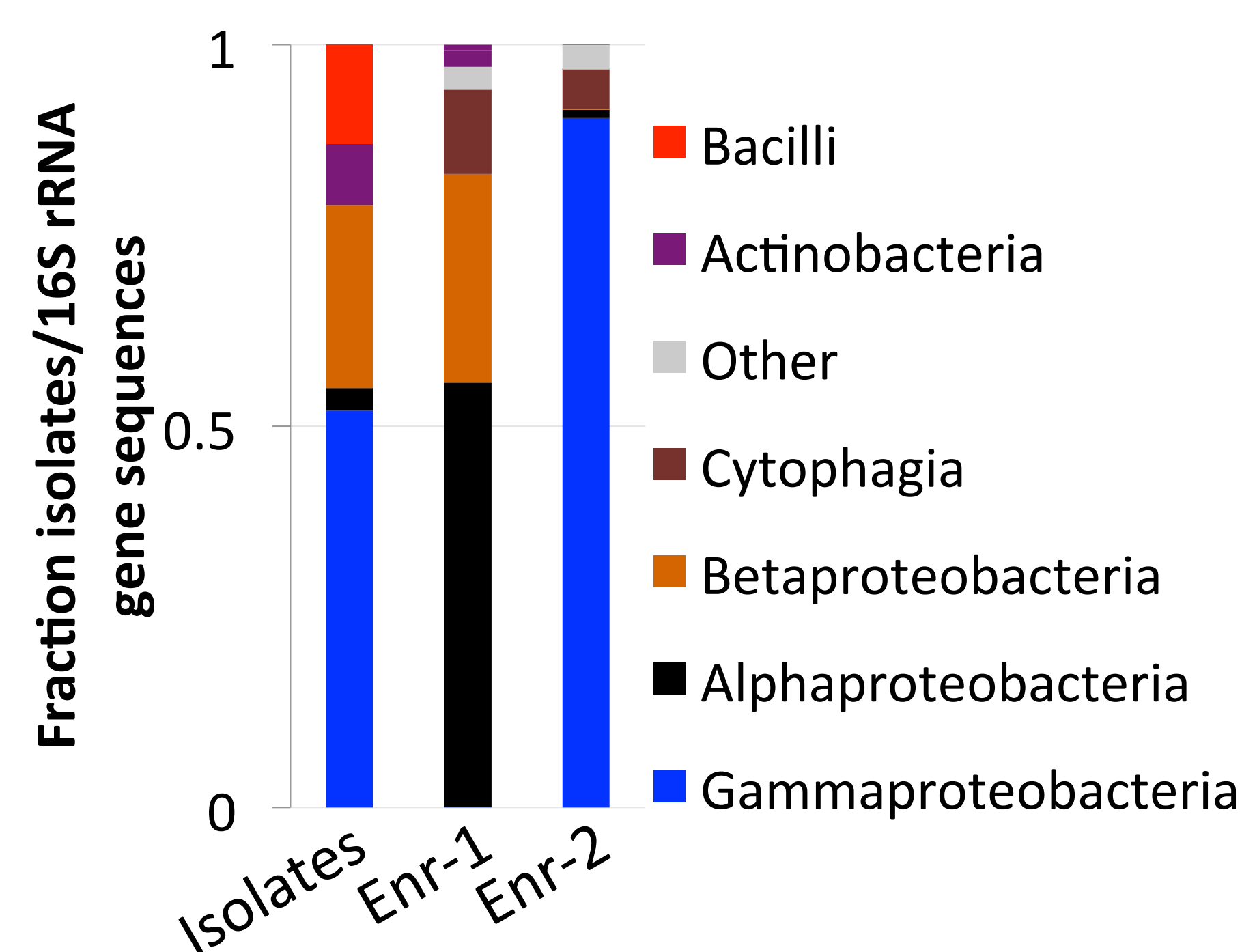
(2) Inocula strongly influence PBR microbial community structure



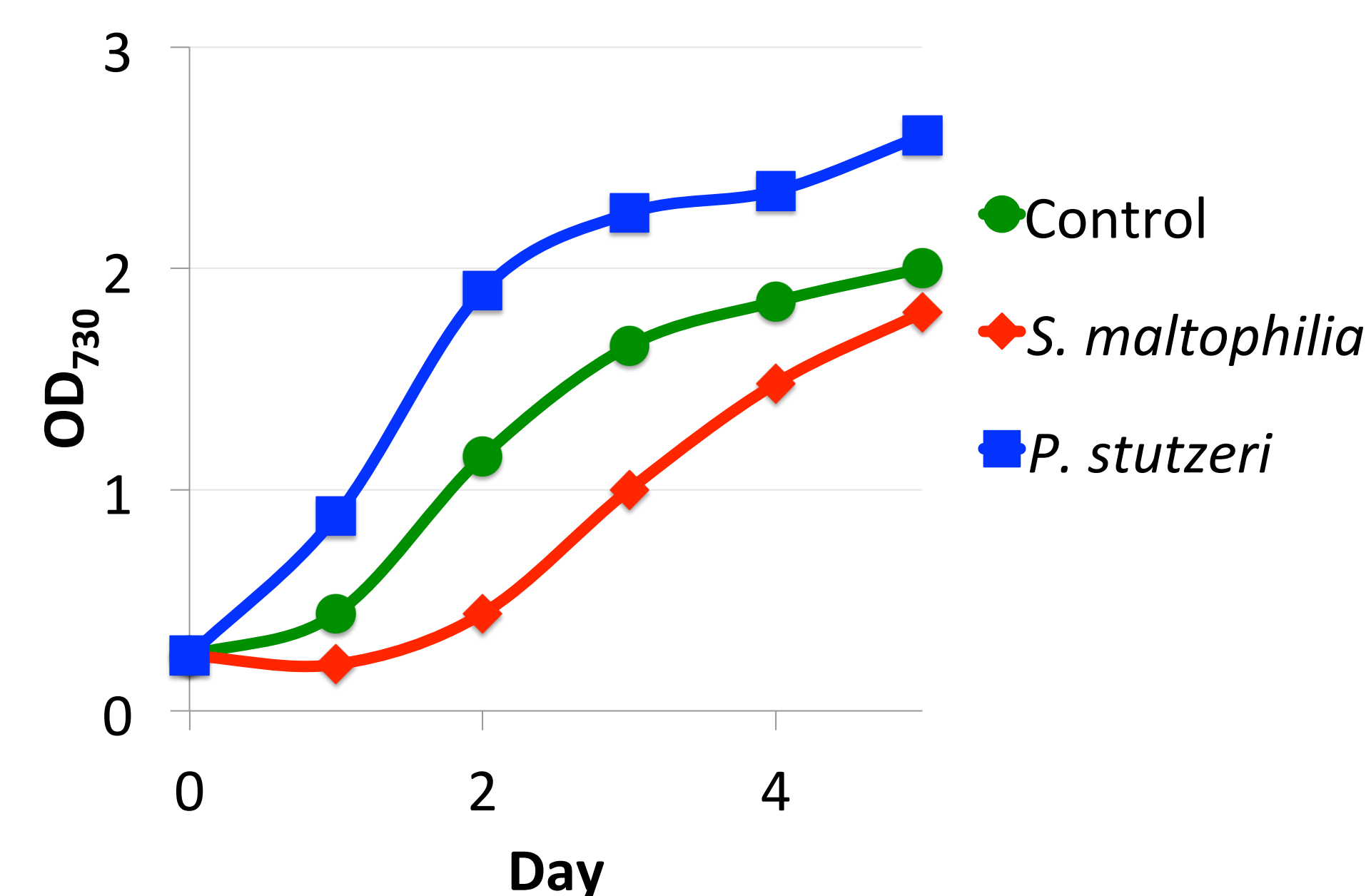
(3) More heterotrophic bacteria are present in PO₄³⁻ limited PBRs



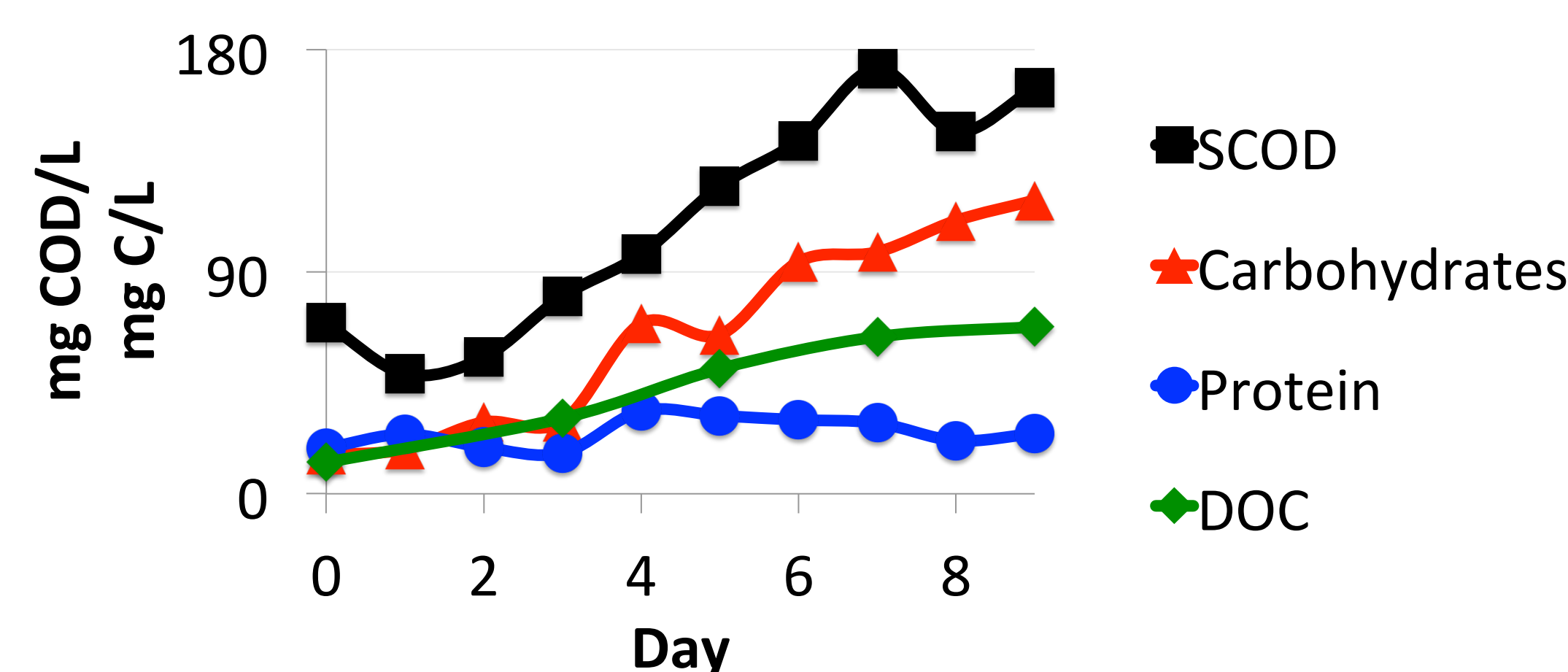
(4) Heterotrophic bacteria isolated and enriched from PBRs are phylogenetically diverse



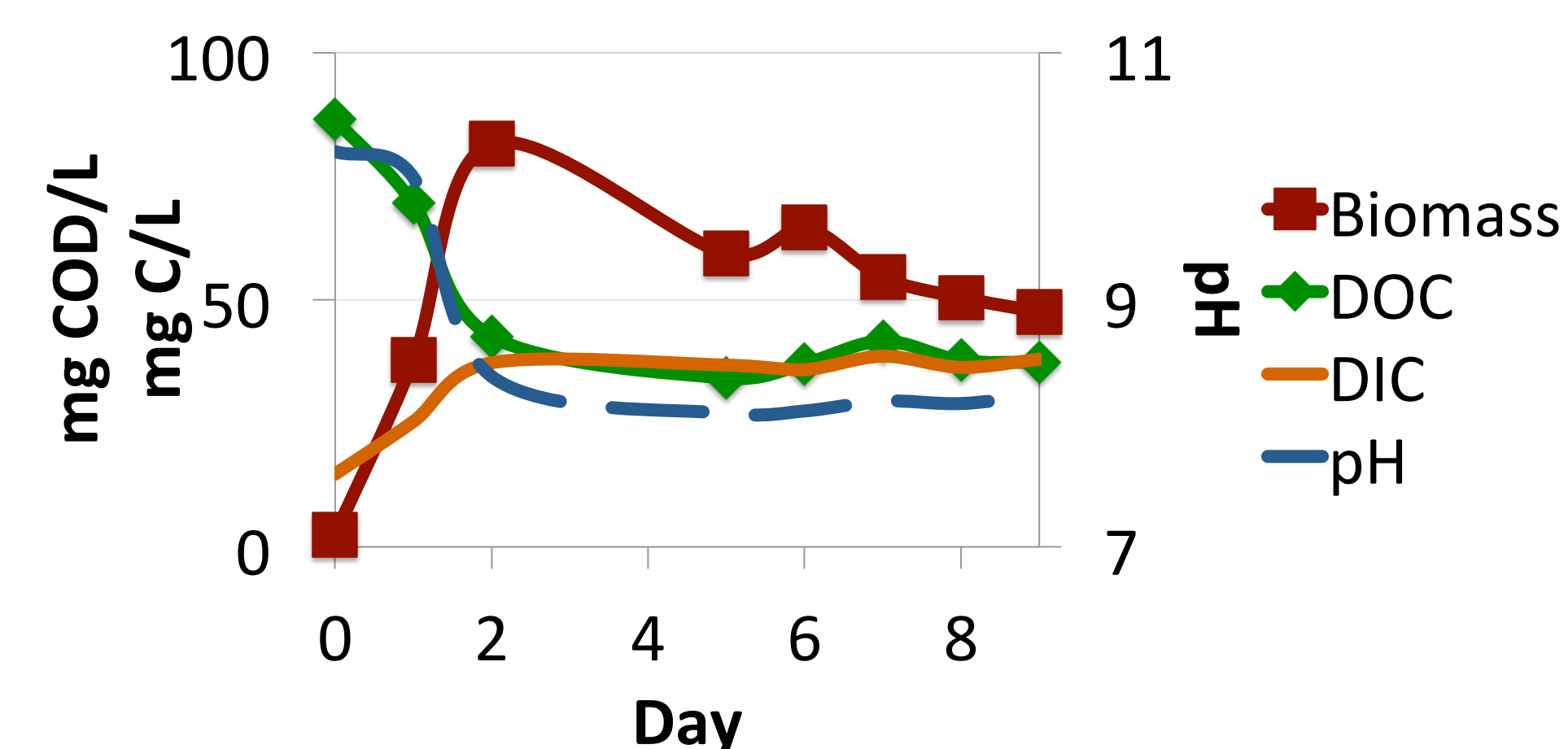
(5) Bacteria isolated from PBRs positively or negatively affect the growth of *Synechocystis*



(6) SMP in PBRs is composed mostly of carbohydrates



(7) Heterotrophic bacteria convert organic C in SMP to inorganic C



Summary and Conclusions

- The source of inoculum plays a major role in determining the structure of PBR microbial communities
- PO₄³⁻ limited PBRs have higher levels of heterotrophic bacteria
- Isolated/enriched heterotrophic bacteria were similar to those found in PBR cultures through 16S rRNA gene sequencing
- Heterotrophic bacteria can improve or inhibit the growth of *Synechocystis*
- SMP in PBRs is composed mostly of carbohydrates and protein
- Heterotrophic bacteria can grow on SMP produced by *Synechocystis*