Periodicity of Benthic Photosynthesis in Lake Fryxell, Antarctica

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INTRODUCTION: Filamentous cyanobacteria, the earliest known oxygenic photosynthesising organisms, are the primary structuring agents in modern-day benthic microbial mats. Under conditions of low sedimentation rates and slow water flow, gliding and colliding of the filaments create peaked and ridged structures with regular centimetre-scale spacing (Figures 1 and 2).

Petroff et alii (2010) suggest that this spacing is set to minimise competition between individual structures. In support of this hypothesis they show that the spacing between structures corresponds to diffusive distances generated by a rhythmically fluctuating metabolism with a period of approximately 20 hours—the periodicity of photosynthesis.

Fossil stromatolites show similar structures and spacing, which supports the still-contentious view that they are evidence of early photosynthetic communities and provides constraints on the origin of phototrophic communities in the early evolution of life on earth.

CONCLUSION: We found that the O₂ concentration gradient and irradiance were significantly linearly correlated despite a diel irradiance change of only 3 µmol quanta m⁻² s⁻¹ (Figure 4). This result supports the model by Petroff et alii and confirms our own previous conclusions regarding the mats photosynthetic competence.

PROBLEM: Ridge-peak microbial mats of the type and spacing considered by Petroff et alii are common in ice-covered Antarctic lakes. Such lakes provide a useful test of the diffusive mechanism of pinnacle spacing, since the weak diel variability in irradiance reaching the mats could be hypothesised as insufficient to generate metabolic periodicities. Centimetre-scale structures cannot relate to diffusive distances if metabolic cycles do not generate a marked diel pattern in resource availability in the water between structures, and the universal applicability of the Petroff model would be undermined.

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REFERENCES:


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