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PHOTOSYNTHETIC PERFORMANCE OF BENTHIC MICROBIAL MATS IN LAKE HOARE, ANTARCTICA

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We measured in situ photosynthesis of benthic microbial mats at various depths in Lake Hoare, a permanently ice-covered lake of the McMurdo Dry Valleys, Antarctica, using O_2 microelectrodes. We further investigated the vertical distribution and activity of pigments in the microbial mats using an imaging pulse-amplitude-modulated fluorometer. Microbial mats to at least 16.6 m water depth are net producers of O_2 during the summer period. O_2 production ranges from 100–500 µmol m^{-2} h^{-1}, at incident downwelling irradiances of photosynthetically active radiation (PAR) of 1.0 to 4.6 µmol quanta m^{-2} s^{-1}. Photosynthesis of mat-forming cyanobacteria and diatoms occurs at all lake depths, at or close to maximum efficiency. We measured absorption by the pigment arrays at a single water depth and, by assuming that absorption is water-depth invariant, we estimated an area-specific maximum community quantum yield of 0.073 mol C per mol photons. A community compensation irradiance of 0.1 µmol quanta m^{-2} s^{-1} was estimated, reflecting extreme shade acclimation. These results confirm estimates previously derived from laboratory gas-exchange measurements and imply that even minor changes in the intensity of the incident downwelling irradiance of PAR due to, for example, changes in the transparency of the ice cover or the optical properties of the water column can significantly alter rates of benthic carbon fixation. In situ measurements were confined to mats with flat surfaces. Laboratory measurements at the surface of mats with pinnacled surfaces revealed a complex small-scale chemical structure at the mat–water interface.