The interaction of phytoplankton and bacteria in a high mountain lake: Importance of the spectral composition of solar radiation

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ABSTRACT: The role of spectral composition of solar radiation has seldom been considered as a critical factor controlling the algae-bacteria relationship. A coupled algae-bacteria relationship mediated by C released from algae was observed during a 2-yr period (1996-1997) in an oligotrophic high mountain lake, except at upper depths. The intensity of photosynthetically active radiation was negatively related to primary production, and the highest percentages of excretion of organic carbon (%EOC) from algae were found at upper depths of the water column. The effect of different spectral regions of solar radiation on the algae-bacteria relationship was assessed by in situ experiments, in which the exposure, tracer uptake by target organisms, and interactions among abiotic and biotic factors were simultaneous. Primary production was ultraviolet radiation (UVR) inhibited by 33-83% depending on depth and date, with ultraviolet-A radiation (UVA) exerting the main effect. EOC and %EOC yielded highest values under UVR exposure. Sunlight affected bacterial production (BP) only at upper depths. UVB inhibited BP by 39-82%, whereas UVA + photosynthetic active radiation (PAR) and PAR enhanced BP three- to fourfold. Full sunlight increased BP 2.5-fold in midsummer but inhibited it (37%) in the late open-water period. The percentage of photosynthetic exudates assimilated by bacteria, and photosynthetic carbon use efficiency by bacteria, showed a similar pattern to that of BP. The experimental results support our hypothesis that increased organic C release from UV-stressed algae stimulates bacterial growth if the bacteria are relatively well adapted to sunlight, determining a coupled algae-bacteria relationship. Thus, sunlight may play a key role as the underlying abiotic factor that regulates algae-bacteria interaction in shallow and clear-water ecosystems.