Optical signatures of the filamentous cyanobacterium Leptolyngbya boryana during mass viral lysis

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ABSTRACT: The inherent optical properties of absorption and scattering, the population density of virus-like particles, and the particle size distribution (PSD) for particles <0.7 μm of the filamentous cyanobacterium *Leptolyngbya boryana* were monitored for 72 h at 9-h intervals following infection with cyanophage LPP-1. Lorenz-Mie scattering theory and the anomalous diffraction approximation were used to derive the refractive index representative of the bulk of particles and to model the particulate backscattering coefficient [$b_{bp}(\lambda)$]. Upon lysis, particulate absorption [$a_p(\lambda)$] and scattering [$b_{bp}(\lambda)$] decreased, the number of free virus-like particles increased drastically, the PSD shifted to relative abundance of small particles, and average trichome length decreased sharply. The complex refractive index of the bulk of particles was comparable with literature values for cyanobacteria. Modeled $b_{bp}(\lambda)$ spectra were lowered upon lysis, while backscattering probability increased. The effect of underrepresentation of particles below the measurement limit of the particle sizer was studied; more small particles in the PSD resulted in higher, but still relatively low, backscattering probability. The consequences of the studied optical behavior on spectral reflectance was explored. Significant spectral changes at longer wavelengths were mostly masked by water absorption at nominal population densities. However, strongly reduced $a_p(\lambda)$ in the red pigment absorption bands resulted in a pronounced green peak in reflectance spectra, and it was concluded that reflectance band ratio algorithms targeted at the absorption of the pigments phycocyanin and chlorophyll *a* can be used to detect the mass mortality caused by viral infection. The integrated intensity of reflected light was too variable to serve as an optical indicator for lytic events.

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