Vertical distribution of zooplankton in subalpine and alpine lakes: Ultraviolet radiation, fish predation, and the transparency-gradient hypothesis

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ABSTRACT: The transparency-gradient hypothesis argues that ultraviolet radiation (UV) is a primary determinant of the vertical distribution of zooplankton in transparent lakes with fewer fish, while fish predation is the primary driver in less transparent lakes where fish are more abundant. We measured vertical profiles of UV, photosynthetically active radiation (PAR, essentially visible light used as a proxy for fish predation), temperature, pH, conductivity, chlorophyll a (Chl a), and zooplankton in seven subalpine and alpine lakes and examined the distribution and abundance of the major zooplankton groups relative to environmental variables using a canonical correspondence analysis (CCA) and multiple regression. Pigment concentrations and UV tolerance of representative species were examined experimentally. The CCA revealed that conductivity, PAR, and UV were most related to zooplankton distribution and abundance. The cladoceran *Daphnia* was associated with high PAR, while cyclopoids and nauplii were associated with low PAR. In contrast, the vertical distribution of calanoids was positively related to UV, while *Holopedium* was negatively associated with UV. The regressions revealed that UV consistently explained more of the variance in zooplankton vertical distribution than did either PAR or chlorophyll. Calanoids had high concentrations of photoprotective compounds and a relatively high UV tolerance compared to *Daphnia*. The positive association of *Daphnia* with visible light (PAR) and the importance of UV in overall zooplankton vertical distribution support the transparency-gradient hypothesis, indicating that UV is more important than fish predation in controlling the vertical distribution of zooplankton in more transparent lakes.

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