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Effect of water temperature on a phycocyanin probe for monitoring cyanobacteria and its effectiveness on biomass estimation of three cyanobacteria morphotypes

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In a context of global warming and high anthropization of freshwater systems, cyanobacteria monitoring becomes a key priority. Thus, water companies have recently deployed large-scale submersible fluorescence sensors, capable of measuring diagnostic pigments and estimating cyanobacteria biomass in near-real time. However, these tools have several limitations, such as the detection limit of phycocyanin or the impact of temperature, one of the most important factors generating a bias on the measurement of phycocyanin probes. In an attempt to address these shortcomings, we compared the efficiency of a phycocyanin probe at different temperatures, first on three cyanobacteria cultures (*Microcystis*, *Dolichospermum* and *Synechocystis*) and secondly on a small eutrophic lake in continuous recording.

The *in vitro* results showed a high correlation between cyanobacterial biomasses, estimated by flow cytometry (*Microcystis* and *Synechocystis*) or by microscopic counting (*Dolichospermum*), and phycocyanin probe measurement, with R^2 higher than 0.96, even for biomasses lower than hundreds of $\text{mm}^3 \cdot \text{L}^{-1}$. A saturation effect was demonstrated only between 350 and 550 $\text{mm}^3 \cdot \text{L}^{-1}$ depending on the strains, corresponding to very high concentrations, far from the limit value for the use of water. However, laboratory tests on temperature highlighted the limitations of the sensor with a strong overestimation and underestimation at low ($< 15 \text{ }^\circ\text{C}$) and high ($> 25 \text{ }^\circ\text{C}$) temperatures, respectively. Given this discrepancy, a temperature correction factor was determined and applied over the three years of field data, which significantly improved the signal quality. The strong relationship found between the corrected signal and the cyanobacteria biovolume obtained by microscopic enumeration allowed us to validate this temperature correction factor, offering the possibility of using it for monitoring other lakes and to better understand the short-term dynamics of cyanobacteria.

Keywords: Cyanobacteria; Probe sensor monitoring; Phycocyanin; Temperature; Picocyanobacteria