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Assessment of the cell biovolume of phytoplankton widespread in coastal and inland water bodies

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ABSTRACT

The biovolume of phytoplankton must be assessed accurately in order to identify the ecological status of water bodies in line with the WFD requirements. Hence, the current study has been carried out to verify and improve the precision of as well as to facilitate and accelerate estimations of phytoplankton biovolume by reviewing and rearranging the basic geometrical shapes of these organisms applied in such evaluations. The latest standards comprise 17 geometric shapes and equations suitable for estimations of cell/filament/colony biovolume and additionally include taxa-specific 'geometric correction factors' to fit real shapes and 'hidden dimension factors' to achieve data on hardly measureable dimensions. This paper also discusses possible obstacles to making correct biovolume assessments, especially when analyzing taxa of special concern, e.g. *Ceratium hirundinella*, *C. furcoides* or *Pediastrum duplex* and *Pseudopediastrum boryanum*. Our comparison of two approaches, the previous and the new one, revealed that they yield statistically significantly different biovolume results of these species. Some recommendations how to deal with the new and old methods of biovolume estimations and how to reduce the possibility of errors with overestimation and underestimation were also given. The more recent method can be said to give more precise estimates of phytoplankton biovolume. Besides, it facilitates more rapid phytoplankton analyses in most cases, which is very useful when assessing the ecological status of lakes during routine monitoring programs.

1. Introduction

The Water Framework Directive (WFD) lists phytoplankton among biological quality elements (BQEs) needed in ecological status assessment of water bodies e.g. lakes and coastal waters (EC, 2000), suggested that the composition, abundance and biomass of phytoplankton should be evaluated. Thus, an adequate biomass estimation has become a crucial step in attaining an accurate assessment of the ecological status of water bodies. Although some European assessment systems state that chlorophyll *a* is 'a valid and accepted surrogate of biomass', other countries prefer to analyze total biomass measured directly from cell biovolume (Phillips et al., 2014). For example, the phytoplankton-based method applied in Poland combines total biomass, cyanobacteria biomass and chlorophyll *a* content into a multi-metric Phytoplankton Metric for Polish Lakes (PMPL) (Napiórkowska-Krzebietke et al., 2012; Regulation of the Minister, 2014). Moreover, it is currently essential to establish appropriate threshold values for distinguishing between a high/good, good/moderate, moderate/poor and a poor/bad ecological status. While there are such class boundary values available for freshwater phytoplankton, including its total biomass, cyanobacteria biomass and, additionally, the intensity of potentially harmful cyanobacterial blooms (Phillips et al., 2014; Napiórkowska-Krzebietke, 2015). Biomass thresholds have not been determined thus far for coastal waters. A solution has been proposed by the HELCOM Phytoplankton Expert Group (PEG) (Olenina et al., 2006), which suggests a classification based on size-class parameters.

Several publications dealing with the procedures of biovolume estimation have appeared worldwide. Some recommend certain solution for obtaining the most fitting geometric figures and the most effective formulas for calculating biovolume (Hillebrand et al., 1999; Sun and Liu, 2003; CEN, 2006; Olenina et al., 2006; Brierley et al., 2007; Konoplya and Soares, 2011; Vadrucci et al., 2013). In Poland, guidelines for freshwater phytoplankton biomass

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