Response of Algal Blooms to Endogenous Nutrient Accumulation in Primary Tributaries of the TGR Revealed by Sediment Cores

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Abstract

After the impoundment of the Three Gorges Dam, over 50% of its tributaries have experienced algal blooms, primarily dominated by *Dinoflagellates* and *Cyanobacteria*. Understanding the relationship between endogenous nutrient accumulation and algal blooms is crucial for maintaining reservoir water quality. This study focused on two primary tributaries within the same county with similar exogenous conditions—Pengxi River (affected by algal blooms) and Modao River (unaffected by algal blooms). In-depth studies of midstream sediment cores were conducted using $^{210}Pb/^{137}Ra$ dating methods. The findings revealed that post-impoundment, the sediment depth in Pengxi River was approximately 45cm with an average sedimentation rate of 2.3 cm/year, compared to 1.4 cm/year before the impoundment. In Modao River, the post-impoundment sediment depth was about 30cm with an average sedimentation rate of 1.5cm/year. Analysis of Pengxi River sediment cores showed post-impoundment average contents of organic matter (OM), total nitrogen (TN), and available nitrogen (AN) were 19.2g kg^{-1}, 0.9g kg^{-1}, and 0.09g kg^{-1}, respectively, compared to pre-impoundment values of 12.3g kg^{-1}, 0.53g kg^{-1}, and 0.06 g kg^{-1}. This represents overall increases of 56.1%, 69.8%, and 49.6% for TN, AN, and OM, respectively. In Modao River, post-impoundment average contents of OM, TN, and AN were 13.89g kg^{-1}, 0.88g kg^{-1}, and 0.062g kg^{-1}, respectively, compared to pre-impoundment values of 12.3g kg^{-1}, 0.75g kg^{-1}, and 0.055g kg^{-1}, representing overall increases of 12.9%, 17.3%, and 12.7% for TN, AN, and OM, respectively. High-throughput sequencing of 16S and 18S rRNA genes on the top 20cm of sediment cores (sampled every 5cm) indicated no significant differences in microbial community composition and diversity between the two rivers. Between 2010 and 2023, gene copy numbers of *Dinoflagellates* in Pengxi River increased by 3.8 times, while *Cyanobacteria* gene copy numbers only increased by 0.1 times. Conversely, between 2008 and 2023, gene copy numbers of both *Dinoflagellates* and *Cyanobacteria* in Modao River decreased by 0.5 times and 0.2 times, respectively. Correlation analysis indicated a significant positive correlation ($P < 0.05$) between *Dinoflagellate* gene copy numbers and organic matter content, and a positive correlation ($P < 0.1$) between *Cyanobacteria* gene copy numbers and both available nitrogen and organic matter. This study reveals that the primary cause of *Dinoflagellate* blooms is the differential organic matter deposition between the two rivers. It highlights organic matter content and accumulation rate as key indicators for predicting future *Dinoflagellate* bloom scales, providing scientific basis and management recommendations for river management and conservation.

Keywords

Three Gorges Reservoir, *Dinoflagellates*, *Cyanobacteria*, Organic Matter, Microorganisms