Study on the Mechanism of Dinoflagellate Bloom and Water Browning in the Three Gorges Reservoir Area Based on Dinoflagellate Mobility

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Abstract

To investigate the effects of vertical migration on the dominance of dinoflagellate populations and water browning in the Pengxi River of the Three Gorges Reservoir Area, a comparative experiment was conducted using an in-situ culture device (Device 1) and a device with a 5 m depth barrier to block dinoflagellate vertical migration (Device 2). The effects of dinoflagellate vertical migration on algal bloom and water browning were analyzed. The results showed that: (1) Total Phosphorus (TP), Dissolved Total Phosphorus (DTP), Orthophosphate (PO_4^{3-}) and Ammonium (NH_4^+) in both Device 1 and Device 2 showed a gradual accumulation pattern in the lower layer. Compared with May 6, these parameters increased by 498%, 342.87%, 1955.14% and 247.81% on May 30, respectively. In contrast, Total Nitrogen (TN), Dissolved Total Nitrogen (DTN) and Nitrate (NO_3^-) showed a gradual consumption pattern in the upper layer, decreasing by 72.02%, 57.24% and 76.64%, respectively. This was mainly due to sufficient light in the upper layer for algae to absorb nitrogen, while hypoxia in the bottom layer led to anaerobic decomposition of settled organic matter, massive phosphorus release and accumulation of ammonium nitrogen. (2) In Device 1, the dinoflagellate density in the water column was significantly correlated with the vertical variations of DTN, DTP and PO_4^{3-}. Affected by the physical barrier, the dinoflagellate density in the lower layer of Device 2 decreased rapidly to an extremely low level, and the overall dinoflagellate density was significantly lower than that in Device 1. (3) In Device 2, the physical barrier reduced the dinoflagellate biomass in the lower layer, and cyanobacteria and green algae became the absolutely dominant group. The dinoflagellate biomass in the upper layer decreased with the reduction of DTN and NO_3^-, and the total dinoflagellate biomass on May 20 was 32% lower than that in Device 1. This was mainly because DTN, NO_3^- and other nutrients in the upper layer were continuously consumed, and the barrier in Device 2 restricted dinoflagellates from obtaining nutrients in the lower layer.In conclusion: compared with cyanobacteria and green algae, the vertical migration ability of dinoflagellates enables them to overcome the differences in water column density and access nutrients and organic matter in the lower layer, which is an important reason for them to become the dominant algae in algal blooms.

Keywords

Dinoflagellate Bloom, Vertical Migration, In-situ Culture, Three Gorges Reservoir Area