Different Nitrogen Forms and Denitrifying Bacteria Space Distribution Characteristics in Surface Sediments of Different Outfalls of Nanfei River

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In the process of the migration and transformation of nitrogen, sediments play an important role as the source and sink, and denitrification is an important way of sediment nitrogen removal. However, only convertible nitrogen, so-called effective nitrogen in sediments could participate in the nitrogen cycle with the action of microorganisms.

In order to investigate the potential risk of nitrogen release and the difficult degree of nitrogen removal in surface sediments of Nanfei River, a typical urban river in Chao Lake Basin, China, the surface sediment of four types of outfalls, including rainwater outfalls, rainwater and sewage outfalls, tributary outfalls and sewage plant outfalls, were sampled and researched. Through the chemical grade leaching, nitrogen is in turn classified into ion exchangeable form (IEF-N), weak acid extractable form (WAEF-N), strong alkali extractable form (SAEF-N), strong oxidant extractable form (SOEF-N), and residual nitrogen (RES-N). The first four are transferable form nitrogen (TF-N), while RES-N only marginally participates in the nitrogen cycle because it is not readily used by microorganisms. On the other hand, real-time fluorescent quantitative polymerase chain reaction (FQ-PCR) and terminal restriction fragment length polymorphism (T-RFLP) are used to analyze the quantity and spatial distribution characteristics of denitrifying bacteria. The relationship between denitrifying bacteria and different forms of nitrogen and other environmental factors are examined through the Monte Carlo Test and Redundancy Analysis.

The results show that the content of TF-N in surface sediments decreases in the following order: tributary outfalls > rainwater and sewage outfalls > sewage plant outfalls > rainwater outfalls, but the difference is not obvious between different types of outfalls, and IEF-N has the highest content of TF-N for all outfalls. There is a greater difference between the numbers of denitrifying bacteria in the surface sediments of different outfalls. Denitrifying bacteria strains with gene fragment length from 187.33 bp to 187.48 bp and from 188.32 bp to 188.46 bp are the most ubiquitous strains, and also the dominant species in the T-RFLP map. For different outfalls, there are no specific denitrifying bacteria strains. According to the Monte Carlo Test and Redundancy Analysis, TF-N has a major influence on the spatial distribution characteristics of denitrifying bacteria, and rainwater and sewage outfalls could provide much more carbon sources, nitrogen sources and energy sources for denitrification, while sewage plant outfalls provide the least of all.

In conclusion, the largest content of TF-N is in the surface sediments of tributary outfalls, which have the highest potential risk of nitrogen releases. In surface sediments of rainwater and sewage outfalls, denitrification is readily achieved, because surface sediments of rainwater and sewage outfalls have sufficient carbon sources, nitrogen sources and energy sources, whereas denitrification is limited in surface sediments of sewage plant outfalls and, therefore, should be diligently controlled and regulated.

REFERENCES