人工濕地厭氧/缺氧土壤之嗜甲烷菌活性與族群結構之研究

Activity and composition of methanotrophs in the anaerobic/anoxic constructed wetland soils

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摘　要

人工濕地作為陸地、海洋及河口複雜生態系之交錯帶，多變的環境因子使濕地土壤中的微生物具高度生物多樣性、環境調節等功能，作為大型過濾系統，濕地中的植物和土壤儲存大量的碳，會產生溫室氣體—甲烷，以一百年週期，蓄熱潛力為二氧化碳之二十八倍，大量釋放會導致氣候的變化。近年來，越來越重視相關碳排及減排措施，聯合國氣候會議(COP)並將濕地產甲烷作為減排目標之一，勢在必行；另一方面，隨著人為活動的提高，在河口潮間帶有高濃度氮污染，使得濕地生態的氮循環被視為重要的角色。

厭氧/缺氧嗜甲烷菌是一群具有將甲烷氧化，且能將不同電子接受者(硝酸鹽、亞硝酸鹽、硫酸鹽、鐵/錳氧化物、腐植質等)進行還原並連結全球碳循環(C-cycle)及氮循環(N-cycle)的功能菌群，過去文獻量化了濕地甲烷的排放和族群分析，但對於濕地甲烷匯連結特定土壤微生物的證據，還尚不清楚。

本研究以次世代定序(Next Generation Sequencing, NGS)及定量即時聚合酶連鎖反應(Quantitative Polymerase Chain Reaction, qPCR)，將新海橋人工濕地土壤進行厭氧培養，在厭氧/缺氧濕地土壤找到潛力利用甲烷的厭氧嗜甲烷菌，並探討濕地厭氧土壤中微生物族群和各種可能厭氧甲烷氧化菌的作用及其相互關係，期望在工程上能建立有效管理人工濕地，達到減少溫室氣體排放及減少氮污染的生態系服務。

關鍵字：人工濕地，厭氧/缺氧嗜甲烷菌，次世代定序，微生物族群，生態系服務

Abstract

Constructed wetlands are the interlaced zone of complex land, ocean, and estuary ecosystems. The changeable environmental factors make the microorganisms in the wetland soil have functions such as high biodiversity and environmental regulation. In a large-scale filtration system, the plants and soil store a large amount of carbon, which will produce the greenhouse gas - methane. In a one-hundred-year cycle, the heat storage potential is 28 times

that of carbon dioxide, and a large amount of release will lead to climate change. In recent years, more and more attention has been paid to related carbon emissions and emission reduction measures. It is imperative for the United Nations Climate Conference (COP) to take wetland methane production as one of the emission reduction targets. The intertidal estuary is polluted with high concentrations of nitrogen, which makes the nitrogen cycle of wetland ecology regarded a critical role.

Anaerobic/Anoxic methanotrophs are a group of bacteria capable of oxidizing methane and reducing different electron acceptors (nitrate, nitrite, sulfate, iron/manganese oxides, humic substances, etc.) and connecting the global carbon cycle (C- cycle) and nitrogen cycle (N-cycle) functional flora, previous literature has quantified wetland methane emissions and population analysis. However, the evidence for wetland methane sinks linking specific soil microorganisms is still unclear.

In this study, using Next Generation Sequencing (NGS) and quantitative Polymerase Chain Reaction (qPCR), the soil of Xinhai Bridge constructed wetland was anaerobic/anoxic cultured to find methanotroph with the potential to utilize methane. It is expected to establish effective management of artificial wetlands in the project to achieve ecosystem services that reduce greenhouse gas emissions and nitrogen pollution.

Keywords: constructed wetlands，anaerobic/anoxic methanotrophs，next-generation sequencing，microbial populations，ecosystem services