

专论与综述

稳定性同位素探测技术在微生物生态学研究中的应用

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摘要 稳定性同位素标记技术同分子生物学技术相结合而发展起来的稳定性同位素探测技术 (stable isotope probing, SIP), 在对各种环境中微生物群落组成进行遗传分类学鉴定的同时, 可确定其在环境过程中的功能, 提供复杂群落中微生物相互作用及其代谢功能的大量信息, 具有广阔的应用前景。其基本原理是: 将原位或微宇宙 (microcosm) 的环境样品暴露于稳定性同位素富集的基质中, 这些样品中存在的某些微生物能够以基质中的稳定性同位素为碳源或氮源进行物质代谢并满足其自身生长需要, 基质中的稳定性同位素被吸收同化进入微生物体内, 参与各类物质如核酸 (DNA和RNA) 及磷脂脂肪酸 (PLFA) 等的生物合成, 通过提取、分离、纯化、分析这些微生物体内稳定性同位素标记的生物标志物, 从而将微生物的组成与其功能联系起来。在介绍稳定性同位素培养基质的选择及标记方法、合适的生物标志物的选择及提取分离方法的基础上, 举例阐述了此项技术在甲基营养菌、有机污染物降解菌、根际微生物生态、互营微生物、宏基因组学等方面的应用。

关键词 [稳定性同位素探测技术](#); [微生物生态](#); [微生物功能](#); [应用](#)

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Stable isotope probing and its applications in microbial ecology

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Abstract Stable isotope probing (SIP), a combination of isotope labeling with molecular biological approach, is a technique that is used to identify microorganisms in environmental samples, and at the same time, to examine microbial functions during the biogeochemical processes operating in various environmental systems. The method has the potential for wide applications in the future, since it can provide abundant information about microbial interactions and metabolic functions in complex communities. The rationale of the SIP technique is as follows. Environmental samples in situ or in microcosm are exposed to substrates labeled with stable isotopes. Some microorganisms in these samples can metabolize the stable isotope-enriched substrates as their carbon or nitrogen resource for growth. The stable isotope assimilated by these microorganisms is then used to synthesize cellular components such as nucleic acids (DNA and RNA) and phospholipid fatty acids (PLFA). As a result, the microbial identity can be linked to their functions by extracting and analyzing these stable isotope-labeled biomarkers in the microbial communities. Here, with introduction to the range of stable isotope enriched substrates, the labeling techniques of such substrates to microorganisms, and the selection criteria of appropriate biomarkers and the methods for extracting and analyzing the biomarkers, we illustrate the applications of SIP in the functional analyses of methylotrophs, bacteria of organic pollutants degradation, rhizosphere-microorganism ecology, syntrophic microorganisms and metagenomics.

Key words [stable isotope probing](#) _ [microbial ecology](#) _ [microbial function](#) _ [application](#)

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