RESEARCH HIGHLIGHT

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Special Topic: Marine Carbon Sequestration and Climate Change

A recent project shows that the microbial carbon pump is a primary mechanism driving ocean carbon uptake

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The microbial carbon pump (MCP) contributes to ocean carbon sequestration by converting reactive organic matter into recalcitrant dissolved organic carbon (RDOC) that can remain in seawater for thousands of years. The MCP is a potentially important ecosystem pathway operating in parallel with the well-known biological pump (BP), which turns atmospheric CO_2 into particulate organic matter that sinks to deep waters and the ocean bottom, where its carbon is sequestered. Since the MCP was proposed by Jiao *et al.* [1], it has become an important impetus for new research in the ocean carbon cycle (e.g. Legendre *et al.* [2]). A study of bacterial exometabolites recently showed that these dissolved molecules share many compositional and structural characteristics of recalcitrant DOC present in the deep ocean [3].

A project entitled 'Processes and mechanisms of carbon sequestration by the microbial carbon pump' was funded in 2013 by the Chinese Ministry of Science and Technology as part of the Key Global Change Research Program, which aimed to explore the detailed mechanisms and processes of the MCP. The project is led by Professor Nianzhi Jiao, who initially proposed the MCP idea. On 16 September 2017, a panel of international experts gathered in Qingdao, China, to evaluate the project and was impressed by several of its outcomes.

Among many important discoveries, this project substantiated the concepts of RDOCt (recalcitrant DOC in a specific environmental context) and RDOCc (recalcitrant DOC due to the extremely low concentration of its molecules), which unified the 'dilution hypothesis' and 'recalcitrance hypothesis' of RDOC [4]. A new modeling study concluded that a small pool of diluted DOC likely survives global ocean overturning along with a larger pool of recalcitrant DOC [5]. The findings of this project also emphasized (i) the active pathway of the MCP [6], (ii) the passive pathway of the MCP [7], (iii) archaeal community-mediated pathways of the ocean carbon cycle [8] and (iv) the role of the MCP in paleo oceans [9]. Modeling of MCP vs BP indicated that the importance of the MCP relative to BP may increase under global-warming scenarios [10].

These findings have laid solid foundations for addressing fundamental questions regarding the MCP. Particularly, it is important and extremely valuable to quantify the RDOC pool in modern and ancient oceans in order to better understand the coupling between the ocean carbon cycle and global climate in the Earth's history. The breadth and depth of this project, which was executed over the past five years, have highlighted the importance as well as the complexity of microbial processes associated with the MCP. The outcomes have profound implications for the understanding of biologically driven ocean carbon uptake and storage and thus potential ocean feedbacks to climate change. Though the project will end soon, the MCP has become a central paradigm that is shaping a new direction in ocean carbon cycle research.

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