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专论与综述

海水颗粒有机碳（POC）变化的生物地球化学机制

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摘要 海水中颗粒有机碳（POC）的生物地球化学行为是海洋碳循环研究的重要组成部分，近年来的研究取得了重大进展，主要阐述了海水POC生物地球化学研究的概况。海水POC在海洋中的分布受各种物理、化学、生物过程等多种因素的影响。不同海域、不同水层POC的含量与组成差异很大，在水平分布上，近岸高于远海，垂直分布上，表层高于中下层，含量通常为几十到几百个μg/L，主要由陆源碎屑、浮游植物、浮游动物及其新陈代谢产物和死亡残体组成，海水POC可来源于陆源、海源（海洋生物的生产）、海底沉积物的再悬浮以及溶解有机碳（DOC）的转化，其中海源是其主要贡献者。海水POC与生物过程的关系密切，海洋生物既是POC的组成部分也是POC的重要生产者，通过摄食-代谢过程产生碎屑POC，通过垂直洄游促进POC的向下沉降，通过细菌的降解将POC转化为其他形态。POC参与再循环与营养盐（特别是氮、磷、硅）之间有重要的协同作用，生命POC的新陈代谢造成了营养盐浓度的变化，反过来，营养盐浓度的变化又改变了生命POC的组成及数量；无生命的POC一方面在生物及化学作用下分解矿化释放出营养盐，及时补充了水体中氮、磷、硅等生源要素的含量，这在高生产力的珊瑚礁区尤为明显。另一方面，其又通过在沉积物中的矿化，产生吸附位点，吸附营养盐，影响着营养盐在沉积物与水体中的交换。

关键词 颗粒有机碳（POC）；生物地球化学行为；生物过程；营养盐

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Biogeochemical mechanism of particulate organic carbon (POC) variations in seawaters

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Abstract Marine biogeochemistry of particulate organic carbon (POC), as one of the most important branches in the global carbon cycle, is connected with biological bump process and ecoenvironmental variation in ocean. Marine POC study is a key link to demonstrate marine biogeochemical process. In this paper, Marine biogeochemical characteristics of POC in seawater is mainly reviewed.

The distribution of POC in seawater is affected by many factors， such as physical, chemical and biological processes. In general, the high concentrations of POC, ranged from tens to hundreds μg/L, appear in coastal water and surface water, and low in offshore water and bottom water. But in the regions of surface sediment strongly resuspension such as the East China Sea（ECS）, the POC vertical profiles show the contents of POC increase with the depth and have a high content in the bottom water. The POC is mainly derived from terrigenous material, biogenic matter and sediment resuspended. The source of POC could be deduced by estimating δ13C or C/N which should be combined to differentiate POC source. Of course, the information of POC source is also obtained from POC/PON (particulate organic nitrogen), the relationship between POC and Chl a or TSM (total suspended matter). It is estimated that the POC derived from the river input is about 0.43Gt/a and mainly derived from the detritus of grassland, cropland, forest and human discharged in the estuary. In oceans, the biogenic matter including living and nonliving PO

C is comprised of phytoplankton, zooplankton, detritus and fecal pellets, which play an importan t role in marine biological pump. Nonliving POC is very important in carbon cycling because it ma y be ingested by plankton and thus involved into food web and turns into living POC.
Marine organism is very important in POC transformation. Zooplankton and nekton, which can in gest in the surface waters at night and metabolize the fecal pellets below the mixed layer, are the i mportant producers of POC. In some sea areas such as the Arabian Sea, the flux of fecal pellets i s about 156mgm－2d－1 and account for 12% of the primary productivity. Zooplankton and ne kton can also actively increase the export of POC from the surface to the deep layer by vertical m igration which is very obvious in the open sea. Generally, the POC flux by the contribution of plan kton's vertical migration is from 4% to 34% in the total POC flux, in some sea areas it is up to 7 0%. Microbial communities are not only an important POC source but also a significant contribut or for the transformation of POC while oxygen penetration is generally limited to the upper of th e sediments. Bacteria can transform POC into dissolved organic carbon (DOC) and dissolved ino rganic carbon (DIC) by extracellular enzymatic hydrolysis, and the result is that POC could tak e part in carbon recycling process.
The POC in recycling has good relationships with nutrient, especially nitrogen, phosphorus and sili con because the phytoplanktons absorb the nutrient according to the constant Redfield ratio, But i f the nutrient ratio is out of Redfield ratio, one or several nutrients will confine phytoplankton repr oduction, growth and the primary productivity, and the composing and biomass of the living PO C also will change. Such as the Bohai Sea, the change of nutrient ratio has led to the replacemen t of diatoms by dinoflagellates, which is the main feature of phytoplankton community changes in r ecent years. On the other hand, the metabolism of living POC may affect nutrient contents by abs orbing and excreting, such as NH4-N, which is partly released by the excretion of living POC. Th ere is a positive correlation between nutrient and nonliving POC due to organic matter mineralizati on. In Jiulongjiang Estuary and Western Xiamen Harbour, the positive correlation between PO C with the dissolved inorganic nitrogen (DIN) and dissolved inorganic phosphorus (DIP) suggeste d that the DIN and DIP partly come from the decomposition of the POC. When environmental sit uation such as temperature, redox condition etc. is appropriate in coastal sediment, NH4-N is co ntrolled by POC decomposition.

Key words particulate organic carbon (POC)；biogeochemical mechanism；biologica l processes；nutrient

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