游離氨基酸及其變動和海水特性之相關性

(Free amino acids and their variations with the seawater characteristics)

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一、中文摘要

游離氨基酸在提供海洋總有機碳、氮及海洋生態系碳、氮的循環上扮演重要角色。本研究在分析海水及沉積物的游離氨基酸及探討游離氨基酸的分佈與海水物化及生物特性的關聯性。游離氨基酸在水體裏分佈不均、通常在混合層分佈量較大，而在混合層下隨深度增加而減少。總溶解性游離氨基酸在夜間的分佈量比白天大。相關性分析的結果顯示，顆粒性與溶解性游離氨基酸的總量和海水銨鹽濃度是正相關。同時，顆粒性氨基酸和海水葉綠素 a 量也相關。顆粒性及溶解性游離氨基酸的組成大致相同，其中 glutamate alanine、serine、glycine 及 asparatate 為主要組成，佔總量約 60-68%，其餘氨基酸的含量很小。

關鍵詞: 游離氨基酸，海水物化及生物特性，分佈及組成

Abstract

Free amino acids contribute significant portions to total organic carbon and nitrogen in the sea; they are important in C and N cycles of a marine ecosystem. In this study, particulate and dissolved free amino acids in the seawater and bottom sediments of Kaopin canyon and its adjacent shelf areas were measured and related to physical-chemical and biotic characteristics of seawater. Both PFAA and DFAA were heterogeneously distributed in the water column, with higher concentrations in the mixing layer and decreased drastically in deeper water. Total DFAA in the water column were generally greater in the night than in the day. Total PFAA and DFAA were positively related to ammonium concentration in the seawater. Meanwhile, total PFAA was significantly related to chlorophyll-biomass. Compositions of particulate and dissolved free amino acids were generally identical, where glutamate, alanine, serine, glycine and asparatate were most abundant, accounting for 60-68% of the total free amino acids. Other amino acids occurred in smaller amounts.

二、緣由與目的

Free-form amino acids (FAA), both in particulate matter (PFAA) and in the seawater (DFAA), however, have not until recently received much attention. FAA are of ecological significance; they provide insightful and useful information in structure, biomass and physiological status of marine organisms (Siezen and Mague,1978; Williams and Poulet, 1986). PFAA have close relationship to phytoplankton nitrogen assimilation, i.e. formation of proteins, DNA, RNA, sustaining cellular growth and productivity (Lee and Cronin, 1984). Certain PFAA, e.g. glutamine and glutamate, can be used as a biomarker of nutritional status of algal cells (Flynn et al., 1994). PFAA also exist in bacteria, zooplankton fecal pellets and other biogenic particles. The dissolved form free amino acids (DFAA), in the seawater are mainly derived from grazing and excretion of zooplankton, icthoplankton and other marine animals (Williams and Poulet 1986). Bacteria contribute another significant portion of DFAA in the seawater via decomposition and remineralization of organic nitrogenous compounds, i.e. debris or detritus, in the water and on the sea floor (Lee and Cronin,1982). Additionally, DFAA function as nutrition for both autotrophs and heterotrophs (Mopper and Lindroth, 1982). Thus free amino acids are very important in nitrogen and carbon cycles in the sea. In this study, we measured both particulate and dissolved free amino acids in the seawater and bottom sediments of the Kaopin Canyon and its adjacent shelf to relate free amino acid distribution to biotic and abiotic characteristics of the seawater.

三、結果與討論

The mixing layer in the canyon lied in the uppermost 25 m only in June, but 100-150 m in December. Mixing layer on the shelf was 75 m deep. Average temperatures in the mixing layer were 28.3oC and 25.3oC in June and December, respectively. Below the mixing layer, water temperature dropped down to 10.7-15.3 oC at 300 m. Salinity of seawater fluctuated within a narrow range, i.e. 34.0-34.9 ‰ through the water column in June and December. Ammonium and nitrate concentrations of the seawater were generally <2.0 uM in the mixing layer of the June and December; however, it increased drastically below the mixing layer to a maximum value up to 24.0 uM. Phosphate concentration was in 1.5-10.6 uM and <1.0 uM in June and December, respectively, and also increased in the deeper water. Silicate concentration of the mixing layer was low, mostly <5.0 uM, but increased up to 40-60 uM below the mixing layer.

Chlorophyll fluorescence in the mixing layer of December was generally greater in the canyon than on the shelf, averaging 37.3 mg/m2 and 13.61 mg/m2, respectively. Meanwhile, picoplankton dominated total ch.a, followed by nanoplankton and netplankton.

Total PFAA in the mixing water ranged from 381.7 to 560.4 nmoles/m^2 in June, while it averaged 2.14 and 1.08 umol/m^2 in canyon and shelf stations, respectively in December. Meanwhile, day-night variation of PFAA distribution was not apparent during investigation. Maximal DFAA occurred at the bottom of mixing layer as well as in the thermocline (50-100 m) in June, reaching 1644-3148 nM. In December, total DFAA was also higher in the upper 25 m, however, it was greater in the canyon than on the shelf by 1.7 times in average. Meanwhile, total DFAA increased by 19 - 122 folds during the nighttime as compared to that in the daytime. During the early morning and early afternoon, DFAA concentration remained very low. Meanwhile, shelf DFAA tended to increase in deeper water during daytime and in the shallower water in the nighttime. Total free amino acids averaged 38-491 nmole/g in the canyon sediments (SFAA), and 0.17-0.38 nmole/g on the shelf sediments. As to the total free amino acids in the interstitial water of sediments (IFAA), it reached 29 - 60 uM, which was approximately tenfold higher than that in the surface water.

PFAA and DFAA compositions were generally identical in the mixing layer, being predominated by glutamate, serine, glycine, alanine and asparatate. These five amino acids accounted for 62 % and 68 % of the total PFAA and DFAA, respectively in December. However, DFAA had more glutamate, alanine and aspartate and PFAA glycine. Other amino acids occurred in smaller amounts, accounting for < 5% of the total free amino acids.

It appeared that neither PFAA nor DFAA had significant correlation with seawater temperature and salinity. However, a significant correlation existed between total PFAA and nitrate (negative), ammonium (positive) and silicate (positive) concentrations. With DFAA, concentration of ammonium, but not nitrate, nitrite, phosphate and silicate, was highly significant in correlation. It is deduced that the increase of ammonium concentration is related to zooplankton and other animal activities. Such heterotrophic activity largely influences the concentration of DFAA in the water column. Mopper and Lindroth (1982) found a "night-to-day " of DFAA in the upper water due to a net heterotrophic uptake rate.

Chlorophyll a had positive correlation with total PFAA, glutamine or glutamine /glutamate ratio in the canyon water. However, there was no significant correlation between chl.a and total DFAA. This suggested that a large part of PFAA was derived from phytoplankton biomass. Lee and Cronin (1984) found a greater PFAA concentration in more productive area. The glutamine/glutamate ratio can be a biomarker of algal nitrogen status

(Flynn,1988). The generally low ratio, i.e. 0.1-0.5, of these two amino acids in the study area probably reflected a N-limited phytoplankton growth.

DFAA was greater in the canyon water than in the shelf water, suggesting a relatively high input of nitrogenous compounds from runoff and abundant animals. The nocturnal increase in DFAA was very likely attributed to heterotrophic activity as reported by Mopper and Lindroth (1982). Our results also showed a maximal total DFAA in both surface and deep waters in the canyon during nighttime, implying that different heterotrophic communities probably inhabited in different water layers. Even though total DFAA concentration in the canyon failed to increase with increasing individuals of zooplankton and icthoplankton, probably due to rapid upward and downward movement of the planktonic animals in the water column.

四、參考文獻

Flynn, K.J. (1988) Some practical aspects of measurements of dissolved free amino acids in natural waters and within microalgae by the use of HPLC. Chem. Ecol. 3: 269-293.

Flynn, K.J., Jones, K.J., Raine, R., Richard, J. and K. Flynn (1994) Use of intracellular amino acid analysis as an indicator of the physiological status of natural dinoflagellate populations. Mar. Prog. Ser. 66: 197-203.

Lee, C. and C. Cronin (1982) Particulate amino acids in the sea: effects of primary productivity and biological decomposition. J. Mar. Res. 42: 1075-1097.

Siezen, R., J. and T.H. Mague (1978) Amino acids in suspended particulate matter from oceanic and coastal waters of the Pacific. Mar. Chem. 6: 215-231.

Williams, R. and S.A. Poulet (1986) Relationship between the zooplankton, phytoplankton, particulate matter and dissolved free amino acids in the Celtic Sea. Mar. Biol. 90: 279-284.