Characterization of high molecular weight amino acid precursors formed in interstellar ice analog

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It is suggested that extraterrestrial organic compounds are important for chemical evolution toward the generation of the first life on the Earth. Bioorganic compounds such as amino acids were found in hydrolyzed extracts of meteorite [1]. The products before hydrolysis referred to as “amino acid precursors” were, however, little known. It has been sometimes claimed that a-amino acids found in meteorites were formed by the Strecker synthesis. If so, aminonitriles and amino acid amides are the precursors, but they have not identified as major precursors yet. Extraterrestrial amino acid precursors were probably synthesized in molecular cloud environments or small celestial bodies. We irradiated possible interstellar media, such as mixture of carbon monoxide, ammonia and water to simulate possible reactions among interstellar media in dense clouds. The irradiation products were analyzed by HPLC and mass spectrometry.

A gaseous mixture (CO and NH_3) was sealed in a Pyrex glass tube with liquid water. The gaseous mixture was irradiated with 2.5 MeV protons from a Tandem accelerator at Tokyo Institute of Technology. Total quantity of electricity was 2 mC. The name of the irradiation products is hereafter called CAW. CAW was fractionated by cation exchange HPLC into several fractions to discriminate the fractions with glycine amide or aminoacetonitrile (the Strecker-type precursors) and those without them. Each fraction was hydrolyzed with 6M HCl at 110 ˚C for 24h and was subjected to amino acid analysis. Molecular weights of CAW were estimated by ultrafiltration (molecular weight cut off: 3000), gel filtration (column: Shodex OHpak SB-802.5 HQ) and mass spectrometry by ESI-TOF-MS.

It was shown that glycine was rarely detected in the fractions with the Strecker-type simple amino acid precursors (aminoacetonitrile, glycine amide). It was suggested that the CAW (an interstellar organics analogue) contained complex amino acid precursors with molecular weights of some thousands. Compared with molecular weights standards (authentic proteins), molecular weights of CAW were estimated 6000 or more by gel filtration chromatography. Peaks of m/z = 1000 or over were detected by mass spectrometry. These results strongly suggested that complex amino acid precursors with large molecular weights could be directly generated from small molecules such as CO in interstellar environments. We are now trying to characterize amino acid precursors formed in interstellar ice analogue (frozen mixture of CH3OH, NH3 and H2O [2]) by heavy ions irradiation.

[1] K. A. Kvenvolden *et al.*, *Nature* 228, 923 (1970).

[2] K. Kobayashi *et al.*, *Electr. Commun.* Jpn. 91, 293 (2008).

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