Significance of Extraterrestrial Complex Organic Compounds in Origins of Life

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Earlier stage of chemical evolution process have been discussed basically in the context of the reactions of small molecules such as HCN and HCHO. Free amino acids, free nucleic acid bases, and free sugars should be formed at first in the conventional scenario.

Complex organic compounds have been discovered in extraterrestrial environments such as in comets, which suggested that they were possible sources of the terrestrial biosphere. It has been hypothesized that cometary and meteoritic organic compounds were first formed in interstellar dust particles (ISDs). Amino acid precursors have been reported to form in simulated ISD environments by proton or UV of simulated ISD ice mantles. Here we discuss nature of bioorganic compounds formed in simulated ISD environments.

Carbon monoxide, methanol, ammonia and water were among possible interstellar media. When a mixture of methanol (or carbon monoxide), ammonia and water was irradiated, amino acids were detected in each hydrolysate, even when the starting materials were frozen at low temperature. These results suggest that amino acid precursors can be formed in ISD environments quite effectively. The products themselves are proved to be quite complex organic compounds whose molecular weights were thousands.

Stability of amino acid precursors incorporated in the complex organics are much more stable than free amino acids against radiation or heat. According to these results, it is very likely that extraterrestrial complex organic compounds delivered to the Earth had important roles in generation of life on the Earth.

Finding of enantiomeric excess of amino acids in carboncesous chondrites suggests that the origin of biological chirality may have initiated in extraterrestrial environments. A possible scenario of the generation of enantiomeric excess of amino acids in spacefrom complex organics in extraterrestrial environments will be presented.

It is suggested that complex organic compounds abiotically formed in space had a quite important roles in chemical evolution toward the origin of life on the Earth. To test the hypothesis above, we need fossils of chemical evolution in space. It has been shown that Titan has complex organics (tholin) in its atmosphere. Analytical results of tholin by Huygens lander would give us many suggestion on the roles of complex organic compounds in chemical evolution.