LETTER

Enantiomeric excesses in the Murchison meteorite and the origin of homochirality in terrestrial biology

Breslow and Cheng have recently proposed a scheme for how the enantiomeric excesses (ee) found for some non-protein amino acids in the Murchison carbonaceous chondrite might have been involved in the origin of biochemical homochirality on Earth (1). However, there is a central problem with their scenario: it would be difficult for any ee in non-protein amino acids such as isovaline to be efficiently delivered to the early Earth in significant amounts.

Meteorites such as Murchison represent only a tiny fraction of the material delivered annually to Earth from space (2). During the last heavy-bombard period ≈3.9 billion years ago, the estimated mass of total amino acids delivered to the Earth from carbonaceous chondrites was ≈10 kg/km^2 (based on ref. 2 and taking amino acids as 0.5% of the total organic carbon present in Murchison). If these amino acids fell in a body of water the size of Lake Mead (surface area, 640 km^2; volume, 35.2 km^3), their concentration would only be $\approx 2 \times 10^{-12}$g/L.

The largest mass input would have been from asteroids, comets and interplanetary dust particles (IDPs). The impact of asteroids and comets is a highly energetic event, as is demonstrated by the K/T boundary impact that killed off the dinosaurs. It is hard to imagine organic compounds surviving such a process. Although there is evidence that α-aminoisobutryic acid and isovaline are present in K/T boundary sediments, they may have been produced by gasification of carbon-rich material during impact rather than being delivered intact to the Earth by the bolide (3). For amino acids in IDPs, there is the problem that these grains are heated to high temperatures during atmospheric entry (some particles are totally melted). In studies designed to mimic atmospheric delivery of amino acids in Murchison-like IDPs, it was found that only glycine partially survived (4). Other amino acids were destroyed. Finally, an analysis of IDPs collected from Antarctic ice has so far found no evidence that amino acids such as isovaline are present in measurable amounts (5).

The meteorite enantiomeric excesses are interesting from a cosmochemical context, and the amplification studies of Breslow and Cheng (1) are elegant demonstrations of how enantiomeric excesses can be transferred to other molecules and amplified. However, it remains uncertain as to the relevance of these processes to the question of why life on Earth uses only L-amino acids and D-sugars in proteins and genetic molecules.

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