LETTER

Reply to Bada: The relevance of meteoritic alpha-methyl amino acids to prebiotic homochirality

In his letter Bada (1) is complimentary with respect to the work we actually performed and reported in a recent issue of PNAS (2). However, he is skeptical about the relevance of the alpha-methyl amino acids found by others in the Murchison meteorite, species with a few percent of an excess of the L enantiomers. He states that the amount delivered would not be "sufficient," although he does not produce or justify any estimate of how much would be enough to produce water solutions in which life could start. He does offer an estimate of what concentration one would have if such a meteorite fell into a lake the size of Lake Mead, but that is much less probable than that the meteorite would land on earth, as did the Murchison and Murray meteorites in recent times.

Some people worry that organic compounds could not survive frictional heating by the atmosphere in a fallen meteorite, but the evidence that they indeed survive is clear with chondritic (rocklike) meteorites such as the Murchison, and it is hardly surprising given that the meteorite started with a temperature of 10 K in space. I have been told that chondritic meteorites that have landed recently on earth have interior temperatures well below zero. Attempts to duplicate these situations in the laboratory should take account of the temperatures involved.

Apparently, Bada does not now dispute the findings by other experts of alpha-methyl amino acids with L enantioexcesses in the Murchison meteorite, a key part of our scenario. Thus, it is difficult to see what his objection is, except that he believes not enough of such material was available in a site where life could start.

In many lectures I have given before experts, including an invited lecture in Mexico this year at the International Conference on the Origin of Life, and lectures to astronomers, I have received general agreement that our version of how homochirality could have started was the most reasonable version people had heard. Of course, agreement is not the same as evidence. However, I find nothing in Bada's letter to change my belief that we have the most reasonable scenario so far to answer what has been a baffling question for many years.

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1. Bada J (2009) Enantiomeric excesses in the Murchison meteorite and the origin of homochirality in terrestrial biology. *Proc Natl Acad Sci USA*, 10.1073/pnas.0906490106.
2. Breslow R, Cheng Z-L (2009) On the origin of terrestrial homochirality for nucleosides and amino acids. *Proc Natl Acad Sci USA* 106: 9144–9146.

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