CHIRAL LIFE DETECTION . H. J. Sun, Desert Research Institute, 755 E. Flamingo Road, Las Vegas, NV 89119. henry.sun@dri.edu

One of the outstanding questions in the search for life on Mars concerns the nature of the Viking labeled release experiment (LR). The result of the early *in situ* experiment was consistent with the presence of heterotrophic metabolism on Mars. A mixture of sugars, lactic acid, and amino acids that were added to soil in an aqueous solution were rapidly oxidized to carbon dioxide (Levin and Straat 1976). The LR is controversial, however, because it could not rule out the possibility of an inorganic chemical reaction with soil oxidants. Recently, there has been some interest in the development of a chiral LR that could be implemented on Mars to resolve the debate. Instead of a racemic mixture, a chiral LR would use pure enantiomeric preparations. Biological activity is expected to be selective, destroying only one of the two enantiomers, whereas chemical reactions would destroy both.

I present the results of a comprehensive test of the chiral life detection concept using terrestrial microorganisms. Tested compounds include sugars, lactic acid, and amino acids. The results indicate that biological selectivity is not absolute. Lactic acid and amino acids can convert from one enantiomeric form to another by racemization. Many Earth microorganisms possess racemases that facilitate the conversion. As a result, they can metabolize the non-traditional enantiomer (L-lactate and D-amino acids) if given sufficient time to express the relevant racemases (Figure 1) (Moazeni, Zhang, and Sun 2010).

Sugars do not racemize. Also, they are brought into the cell by chirally sensitive transport proteins. As a result, microorganisms recognize or prefer the enantiomeric forms that occur naturally. Some sugars, such as glucose and xylose, occur naturally only in D-form. Soil microorganisms utilize these sugars only if they are provided in D-form (Figure 2) (Sun et al. 2009). Other sugars, such as fucose and arabinose occur primarily in L-form. Correspondingly, heterotrophic bacteria and fungi prefer these sugars in L-form.

The situation with sugars is complicated by cross reaction. Two different sugars can be structurally so similar that they could be transported and metabolized by the same enzymes. For example, bacteria that grow on D-arabinose also utilize L-fucose, and vice versa, without prior exposure.

This complexity and variability does not invalidate the concept of chiral LR. To the contrary, it adds strength. For example, if a planetary sample prefers one sugar in D-form and another sugar in L-form, it is difficult to argue that it could be due to anything other than life. Nor does the presence of amino acid racemases create a serious problem. It only means that it is important to collect the result early, before the racemase enzymes have a chance to be expressed.

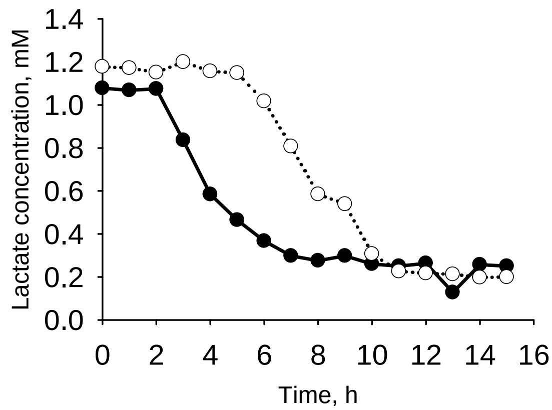

Figure 1. Consumption of D-lactate (closed symbol) and L-lactate (open symbol) added to a soil from the Atacama Desert.

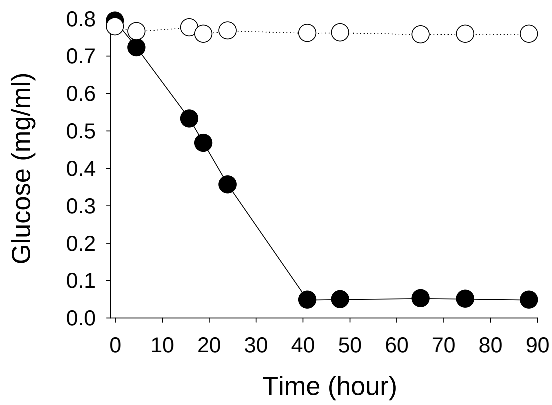

Figure 2. Consumption of D-glucose (filled symbol) and L-glucose (open symbol) added to a culture of *Penicilium expansum*.

Levin, G. V., and P. A. Straat. 1976. Viking labeled release biology experiment: Interim results. *Science* 194:1322-1329.

Moazeni, F., G. Zhang, and H. J. Sun. 2010. Imperfect asymmetry of life: Earth microbial communities prefer D-lactate but can use L-lactate also. *Astrobiology* 10:397-402.

Sun, H. J., V. Saccomanno, B. P. Hedlund, and C. P. McKay. 2009. Stereo-specific glucose consumption may be used to distinguish between chemical and biological reactivity on Mars: a preliminary test on Earth. *Astrobiology* 9:443-446.