HOW THE SEARCH FOR EARTH-LIKE PLANETS AROUND OTHER STARS CAN INFORM STUDIES OF THE ORIGIN OF LIFE

James F. Kasting

Department of Geosciences, Penn State University, University Park, PA 16802, USA

The mystery of how life originated is, to my way of thinking, simultaneously the most difficult and the most interesting question in all of science. One reason why it is difficult is because we do not know whether the origin of life occurred just once or whether it has occurred multiple times in various locations within the Solar System, our Milky Way Galaxy, or the Universe. Hence, we do not know whether it was an extremely unlikely event, a moderately probable event, or an event that occurs virtually every time the right conditions are presented. Of course, we also do not know exactly what those 'right conditions' might be.

The field of astrobiology addresses this problem by seeking to answer the question: Does life exist elsewhere than Earth? Most astrobiologists are focused on the search for life on other Solar System planets or moons, especially Mars, Europa, and, more recently, Enceladus. Finding life within the Solar System would be wonderful because one could bring it back to the laboratory here on Earth and study it in exquisite detail. Doing so, however, may or may not answer the question of whether life originated more than once, because life could have been transferred from one planet to another. If life was discovered on Mars, for example, and if it was based on DNA and shared our own genetic code, one would strongly suspect that it had a common origin with terrestrial life. We should also note that *not* finding life on other Solar System objects would not necessarily mean that the origin of life is unlikely; rather, it might simply imply that life requires a planet similar to Earth.

Here is where astronomy can play a role. Astronomers have now discovered several thousand extrasolar planets, a few of which are rocky and orbit with the liquid water habitable zone of their parent star. Most of these planets are quite distant from Earth and are not suitable candidates for follow-up observations. However, proposed future space telescopes, such as NASA's Terrestrial Planet Finder Missions and ESA's Darwin Mission, should be able to find Earth-sized planets around other stars and to study their atmospheres spectroscopically. With such a telescope, one could determine whether other habitable planets exist, as well as whether any of them are actually inhabited. This, in turn, should allow us to do statistics on the origin of life problem. If, for example, we discovered 20 Earth-like, water-bearing planets, none of which bore any traces of life, we would conclude that the origin of life was at least a modestly rare event. By contrast, if they all showed evidence of life, then the origin of life must be in some sense very easy. These proposed space telescopes are expensive, and none are currently under active development; however, we can expect that a large mission of this type will be launched within the next 20-30 years. Considering the slow pace at which major discoveries are announced in this field, this is something that we should all be anticipating.