On the Rare Earth Hypothesis

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April 26, 2007

Abstract

Ward and Brownlee's *Rare Earth Hypothesis* might not be true, as far as the uncommonness of complex life in the universe is concerned, because life – contrary to the authors' assumption – is a *physical* phenomenon rather than a chemical one.

Peter D. Ward and Donald Brownlee wrote an intriguing book, published in 2000, whose title is "Rare Earth" and subtitle "Why Complex Life Is Uncommon in the Universe". In what follows I suggest that while they are convincing in the title, they have most likely failed in the subtitle.

The Rare Earth Hypothesis states that microbial life is common in the universe but advanced forms, from simple multicellular organisms to large animals, are uncommon and may even not exist outside Earth.

Throughout the book the authors elaborate on the several factors that make Earth unique as a habitat for the evolution of advanced life forms. Earth has the right mass, sits at the right distance from its star, which in turn has also the right mass. Earth follows a stable orbit, has a large Moon that stabilizes its rotation axis tilt, which has the right value for avoiding severe seasons. More, Earth has a giant neighbor – Jupiter – that prevents impacts from comets and asteroids, and it has plate tectonics that ultimately provides a global thermostat mechanism by means of recycling greenhouse gas, especially carbon dioxide. Earth has a magnetic field of the right magnitude so as to shield the surface from energetic cosmic particles. Earth sits in the right galaxy, at the right location, in a galaxy that has the right heavy element abundances. Furthermore, a dozen or so *mass extinction events* had driven biological evolution towards the highly developed mammals present on Earth today.

The combination of such specific conditions has led in the course of time to the development of specific life forms, all DNA-based organisms. Life on Earth is intrinsically a rare chemical phenomenon. Here the authors are probably

right: Earth as a laboratory is rare, the possible chemistry is rare, the resulting life forms are rare.

There are two problems though in extrapolating the "rare" reasoning above to complex life in the whole universe. First of all, life is not a chemical phenomenon, rather, it is a *physical* phenomenon. A living organism is a system that by energetically interacting with its neighborhood has its entropy decreased. In other words, it maintains itself in a *state of order* compared to the *disordered* neighborhood (Monod 1971). Secondly, being a physical phenomenon, life may manifest itself in unconceivable different chemical and non chemical processes. They are in principle as innumerable as the different environments that exists in the universe, and may be even spread *"serene in the space between the worlds"* like the structured minds envisaged by science-fiction author Ken MacLeod (2000), or like Fred Hoyle's living interstellar cloud (Hoyle 1957).

Ward and Brownlee's book is in the order of the day for two seemingly different reasons: the Rare Earth hypothesis will soon be tested because the search of extrasolar planets is almost reaching the earth-like domain, with many planned space missions worldwide, and, their somber suggestion that *"the rise of an intelligent species on any planet might be a common source of mass extinction"* due to their profligate use of planetary resources. Present global warming warnings show that they might not have erred in the latter.

References

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