Astrobiology News for August 2013: Searching for Life in our Cosmic Backyard – a proposed mission to Europa

"All these worlds are yours except Europa. Attempt no landing there." This was the message to Earth from fictional astronaut Dave Bowman, now transformed, while the planet Jupiter was converted into a mini-sun… in the film based on *2010: Odyssey Two*, Arthur C. Clarke's 1982 sequel to his 1968 novel *2001: A Space Odyssey*. In the epilogue, we find out the reason for this warning: to enable the primitive life forms on one of Jupiter's moons – Europa – to evolve a civilization of their own.

Although Clarke's novels were science fiction, the possibility of life in subsurface oceans on Europa has been a topic of scientific discussion for a few decades. In contrast to the remote studies of exoplanets that are necessitated by the vast interstellar distances, it is possible to actually visit Europa in the foreseeable future. Just this month, an article appeared in the journal Astrobiology that discusses the scientific prospects of a future robotic mission whose goal is to explore Europa to investigate its habitability.[1] Some history of the debate regarding Europa's potential habitability may be of particular interest to my CLP audience.

Shortly before I began graduate school at the University of Arizona, the U of A's Steward Observatory became second home to the Vatican Observatory. It's an institution with a long history, whose current personnel include Jesuit Astronomers who perform research in many areas of astrophysics.[2] Getting to know this remarkable group of people while I lived in Tucson has had a lasting, and very positive, impact on my life. One of my good friends, Br. Guy Consolmagno, curates the Vatican meteorite collection at Castel Gondolfo and researches the origin and evolution of small bodies, such as moons, asteroids and comets, in our Solar System.

Years before I met him, when Guy Consolmagno was an undergraduate student at MIT, a homework problem and conversation with one of his professors led him to a Master's thesis on the icy moons of Jupiter (published in 1975). Years before the first close-up spacecraft data were in hand, he presented detailed computer models of Europa's interior that suggested Europa should have a liquid ocean under its surface. Thinking primarily of Carl Sagan and his well-known desire to find life everywhere in space, Guy ended his thesis by writing, "However, we stop short of postulating life forms in these mantles; we leave such to others more experienced than ourselves in such speculations." Ironically, this refusal to speculate was the first published suggestion of life in Europa!

Br. Guy recounts his theoretical work in this subject area, as well as subsequent observations and improved theoretical models, in the *Justice in the Oceans of Europa*

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[1] Pappalardo, R. T., et al. 2013, *Science Potential from a Europa Lander*, Astrobiology, Vol. 13, No. 8, 740-773

[2] See www.vaticanobservatory.org

chapter of his book, *Brother Astronomer: Adventures of a Vatican Scientist*.[3] *Justice in the Oceans of Europa* provides some excellent examples of how the interplay between observations, technology, models, and theories advances scientific understanding.[4]

Europa is considered to be one of the most important targets in planetary science because of its potential suitability for life.[5] Though slightly smaller than Earth's Moon, it is thought to share some similarities to Earth, such as an iron core, rocky mantle, and an ocean of salty water. Unlike Earth, the surface of Europa's ocean is frozen, although it is deep enough to cover Europa's surface! Europa's proximity to Jupiter results in tidal forces that raise and lower the sea beneath the ice. This constant motion is likely to cause the cracks in Europa's surface that have been seen by spacecraft fly-bys of this world. The tidal forces cause Europa to be warmer than it would otherwise be at its distance from the Sun, which could be critical to the survival of simple subsurface organisms that might exist within the ocean.

The proposed mission to Europa would address questions related to three important ingredients for life: a solvent capable of supporting complex biochemistry (for terrestrial life, this is water); a source of energy with which to create and maintain the complex molecules, structures, and pathways on which life depends; and the raw materials for biosynthesis (such as the elements C, H, N, O, P and S). The mission and instruments would be designed to gather critical information on the composition and chemistry of Europa's ocean, the thickness of its ice shell, dynamics of any ice and water layers, and to perform local experiments to study the formation and evolution of the surface.

What if we do find evidence of life on Europa? At an average distance of about a half-billion miles from the Sun, Europa is more than ten thousand times closer to the Earth than the nearest exoplanets. A second genesis of life within our Solar System, in our cosmic "backyard", so to speak, would at minimum indicate that the origin of life is not unique to the Earth, although the jury will likely still be out on how common more complex, sentient life is in the cosmos. In any event, the history of science teaches us to expect the unexpected. One sentence from the Pappalardo et al. article sums it up very nicely: "Finally, though hypothesis-driven science is well served by measurements that can help constrain Europa's habitability, the importance of discovery-driven science should not be overlooked in the astrobiological exploration of Europa."

Until next month,

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[3] Consolmagno, Brother Guy SJ. *Brother Astronomer: Adventures of a Vatican Scientist*. New York:McGraw-Hill, 2000.

[4] Br. Guy's story also explores how issues of ego and resentment started him on a personal journey that led to the Peace Corps, and eventually, into the Jesuit order.

[5] Space Studies Board 2011, Vision and Voyages for Planetary Science in the Decade 2013-2022, The National Academies Press, Washington, DC.

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