Introduction

When Biospheres Collide

> Over the long term, the psychological and philosophical implications of the discovery could be profound … The discovery of even simple life would fuel speculation about the existence of other intelligent beings and challenge many assumptions that underpin human philosophy and religion.
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> *World Economic Forum, 2013*

> What has been will be again, what has been done will be done again; there is nothing new under the sun.
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> *Ecclesiastes 1:9*

In 2013 the Risk Response Network of the World Economic Forum declared the discovery of life beyond Earth one of five X factors – emerging concerns for planet Earth of possible future importance but with unknown consequences. Along with runaway climate change, significant human cognitive enhancement, rogue deployment of geoengineering in the Earth's atmosphere, and the costs of living longer, the authors of the report suggested these were serious issues grounded in scientific findings, but given less attention because they were overshadowed by more immediate concerns like armed conflict, failed states, and economic stability. Giving attention to X factors, they suggested, would lead to a more proactive approach if and when these events actually occurred, resulting in more "cognitive resilience" and perhaps preventing at least some undesirable social consequences. As indicated in the quotation that opens this introduction, such consequences could occur even if simple alien life were discovered.

Speaking on the same subject the following year in testimony on astrobiology before the US Congress, I ventured a bold statement that the authors of Ecclesiastes may have gotten it wrong, that in fact "perhaps there *is* something new under the Sun and the suns of other worlds." Sitting before the full Committee on Science, Space and Technology of the House of Representatives, with NASA's senior scientist for astrobiology and a prominent astronomer from MIT also at the dais, I suggested we need to pay more attention to the societal aspects of astrobiology, in particular what happens when the age-old search for life beyond Earth is successful.

Although there have been false claims of such a discovery in the past, the reaction to an *actual* discovery – now *that* would be something new under the Sun.

Both the concerns of the World Economic Forum and the very fact of the congressional hearings demonstrate that life beyond Earth has become not just a persistent theme but also an active policy issue, not only for funding reasons but also because of the dramatic impact such a discovery might have on society. Astrobiology today is a global and robust discipline that attracts researchers young and old across many fields of endeavor. The discovery of exoplanets by the thousands, of complex organic molecules in giant molecular clouds, of subsurface oceans on multiple Jovian and Saturnian moons, of plentiful water on ancient Mars, of extreme forms of life on Earth, and a variety of other observations, constitute only circumstantial evidence that life may exist. But these developments provide a new scientific basis and enthusiasm for a concept that has captured human imagination over the millennia. The focus of this book is neither the science of alien life nor its history, but the impact should such a discovery be made – cosmic encounters that will surely change our world and our worldviews. In short, this book begins where most other books about life on other worlds end.

In a significant way the idea of extraterrestrial life has already had its impact, for our culture and others have been "captured by aliens" in the felicitous phrase of *Washington Post* reporter Joel Achenbach. In his scintillating book by that title Achenbach examined how aliens have pervaded modern popular culture, from UFO enthusiasts and science fiction to the 39 members of the Heaven's Gate religious cult who in 1997 merrily committed suicide hoping they could then board an alien spaceship following in the wake of comet Hale–Bopp. Interest in aliens dates back much farther than that; as Michael Crowe, a premier historian of the extraterrestrial life debate, has put it, we have for centuries been invaded by aliens – in our imaginations. And as I have shown elsewhere, the scientific roots of the idea are found in the cosmologies of the ancient Greeks, the Copernican and Newtonian transformations of our worldview, the scientific advances of the past century, and a better understanding of our place in 13.8 billion years of cosmic evolution.

Here, however, I focus not on the mere possibility, but the actual discovery of extraterrestrial life. And if anything is clear, it is that the exact nature of the discovery scenario will significantly affect the impact – one of many reasons the word "discovery" appears in the title of this volume. The most startling scenario – celebrated in science fiction film and literature and the subject of sporadic effort in science itself – would be the discovery of extraterrestrial intelligence. The movie *E.T. the Extra-Terrestrial* has become a cultural icon immediately recognizable around the world as symbolizing contact with extraterrestrial intelligence, though not in a very scientific way. Mention E.T. and millions immediately envision a friendly, cuddly creature who enjoys "his" accidental visit to Earth but in the end

just wants to go home. UFO reports notwithstanding, such direct contact on Earth is unlikely. But it is not logically impossible, nor is there any guarantee of friendliness should it occur. Indeed, science fiction readers and moviegoers are also familiar with the *Alien* series, which depicts the other extreme in an entire spectrum of possibilities. Even these two extremes, and everything in between, do not cover the possibilities in a universe we are only beginning to understand. In my view direct encounters, either on Earth or in space, are unlikely to be our first experience with E.T.s, but they cannot be ruled out over the long or short term. They are represented in science fiction by movies ranging from *War of the Worlds* to *Close Encounters of the Third Kind*, and are immortalized in the five-year mission of the starship *Enterprise*: "to explore strange new worlds, to seek out new life and new civilizations, to boldly go where no man has gone before." Much more likely in the view of most scientists is Carl Sagan's *Contact* scenario, where initial contact is made via radio telescopes or detectors looking at some other part of the spectrum. But this is possibly a failure of imagination: we do not know how, when, or where it will happen.

Even more likely than the detection of extraterrestrial intelligence will be the indirect detection of more primitive life – the focus of most research in astrobiology today. This could come in the form of microbial life, discovered on Mars or in the oceans of Europa, Enceladus, Titan, or the several other ocean worlds now known to exist around Jupiter or Saturn. The term "habitable zone" has had to be radically redefined in the past few years. A subset of this scenario would be the discovery of fossilized life, a claim already controversially made in 1996 for the infamous Mars rock ALH84001. Yet another subset would be biosignatures in the atmospheres of exoplanets, a field that becomes ever more robust as spectroscopic techniques improve, more planets are discovered, and instruments such as the James Webb Space Telescope and the Transiting Exoplanet Survey Satellite (TESS) come online. The impact of such discoveries is likely to be quite different from the discovery of intelligence. But the reaction could be no less profound, as our worldviews change with the certain knowledge of alien life, and as the search for intelligent life is made more plausible and reenergized. The Europan scenario of life short of sentience is also celebrated in science fiction, ranging from Arthur C. Clarke's novels *2010: Odyssey Two* and *2061: Odyssey Three* to the intriguing film *Europa Report* about a manned mission to search for life. Hints of Europan sentience in *Europa Report*, and its explicit depiction in Kim Stanley Robinson's richly imagined *Galileo's Dream*, are evocative, if unlikely. But intelligence is not at all unlikely on some of the multitudes of worlds beyond our solar system, exoplanets now known to exist around virtually every star. And the impact of that discovery might be considerably greater than microbial life, even given the vast distances.

Our challenge in this book is how to gauge the potential impact of the discovery of extraterrestrial life beyond mere guesswork and facile generalizations. The first three chapters in this volume discuss three possible approaches to the problem, beginning with the reaction to historical episodes where we *thought* such life had been discovered. Such episodes are more common than one might think, and offer a variety of lessons based on real historical data. A second approach is to analyze the nature of scientific discovery itself, now known to be a much more complex process than commonly assumed, and thus an extended affair, a characteristic sure to affect societal impacts in all possible discovery scenarios. A third approach is analogy, frequently used and abused in discussions of alien life encounters without much sophistication. But analogy is a hot topic in cognitive science and philosophy of science, and after examining its validity as a mode of argument, I discuss what analogies might best be applied to our problem, and which to avoid. The promise and problems of analogy are a constant theme throughout this book.

Contemplating the impact of discovering life beyond Earth raises many critical issues. First, it forces us to think about some of our most basic human concepts in more general terms: life and intelligence, culture and civilization, technology and communication on Earth become only a subset of the possibilities in the astrobiological landscape. Chapter 4 analyzes these categories with an eye toward anthropocentric biases, since surely our assumptions about each of them will affect societal impact. The problem here is, how do we get out of our heads to think about the otherworldly? It is not easy, but it is also not entirely impossible. Second, our subject raises the question of whether human knowledge is universal, especially in the event that we discover intelligence. This is the subject of Chapter 5, where I examine how the natural and social sciences might help us determine impact, but also how an extraterrestrial life discovery might affect our knowledge in those disciplines. The questions here are foundational: Could there be a difference between human and nonhuman understanding? Are terrestrial science and mathematics universal? Are our best attempts at "human sciences" universal? The latest research in cognitive science and the philosophy of mind points to some surprising answers. Chapter 6 raises the central dilemma of this book: even applying our knowledge of history, discovery, and analogy, how can we possibly envision impact before it occurs? In other words, isn't this just an exercise in futility? Far from it, I argue. The World Economic Forum is only one among many institutions that constantly try to assess risks, even remote ones, that might affect the human future. And even if life is never found beyond Earth, raising questions we usually take for granted in their terrestrial dimensions makes the discussion worthwhile.

Chapters 7 through 9 of this volume provide the payoff: my best estimate of what the actual impacts will be, for different scenarios over both the short and long term. Any discovery of life beyond Earth, I argue, is sure to affect worldviews

ranging from the cosmological to the theological and cultural. In some cases even the *possibility* of life beyond Earth is already giving rise to new worldviews, including astrotheology, bearing on religious worldviews that affect a large percentage of the population. Furthermore, in dealing even with microbial life, and certainly with intelligent life, we will have to come to grips with issues of astroethics. What are our responsibilities to alien life forms, whether microbial or intelligent? What is it like to be an extraterrestrial, and how might extraterrestrials conceive of their responsibilities to us? Given answers to those questions, what does it mean to be human, and what does it mean to be alien? Scholars in the natural and social sciences, as well as the humanities, have begun to discuss these issues, most recently in an important volume of essays, *Encountering Life in the Universe: Ethical and Social Implications for Astrobiology*. How to prepare now, and what actions we might take when the discovery occurs, involves the formulation of what I call astropolicy, part of the embryonic field of astropolitics. This is the subject of Chapter 9, which ranges from protocols and policies for preparing for and managing the discovery of life beyond Earth, to "metalaw," formulating possible universal rules for interacting with intelligence in the universe.

In short, this book is one long argument, to use a Darwinian phrase: that given recent scientific findings, the discovery of life in some form beyond Earth is likely; that because it is a wild card X factor of global concern we need to study the possible impact of such a discovery; that the subject is amenable to study through history, discovery, analogy, and impact models; that we need to think out of the anthropocentric box in our ideas about what extraterrestrial life and its impact might be like; that our usual ideas of life and intelligence, culture and civilization might not be universal in a cosmic context; that our thinking will be transformed, quickly or rapidly depending on the discovery scenario, giving rise to issues in astroculture, astrotheology, astrophilosophy, and astroethics; and that we need to formulate policies to deal with such a discovery. Through all the arguments the reader will see two central concepts arise again and again. The first is the idea of transformation through changing worldviews, which frames my treatment of impact, especially in Chapters 6 and 7. The second is the idea of evolution, which I argue is likely to be universal in both its natural and social science aspects. "Taking Darwin seriously," as philosopher of science Michael Ruse puts it, provides a firm basis for discussing both the biological and cultural nature of life beyond Earth. Evolution's subsidiary ideas of chance and necessity, convergence and progress (or lack of it) frame the possibilities of what we may encounter, which are directly related to impact. Through it all I have also employed science fiction, which at its best represents an important body of thought related to impact. My readers should therefore not be surprised to hear about everything from psychohistory and postbiologicals to Overlords and other exotic aliens, not to mention cosmotheology.

Given how little we know about life beyond Earth, we should not shy away from the potentially negative side of these problems, what we might call "The Andromeda Strain Effect," after the Michael Crichton novel and movie where a microbial extraterrestrial organism wreaks havoc with humans on Earth as a result of back contamination. The *Andromeda Strain* scenario graphically evokes the negative possibilities when biospheres collide, and represents what could happen on other planets if the search for life contaminates the very object of our search. Ramped up to more complex life and intelligence, the Andromeda Strain Effect represents a suite of ethical and philosophical problems: If we decipher a signal from extraterrestrial intelligence, should we reply? Should we initiate messages to extraterrestrial intelligence? If so, who speaks for Earth? What are our moral responsibilities to other beings in the universe? These questions are not hypotheticals; they are real policy questions being asked in the wake of ongoing and proposed programs in the Search for Extraterrestrial Intelligence (SETI) and Messaging Extraterrestrial Intelligence (METI).

Our goals and methods may be seen as part of the broader problem of the impact of science on society. Scientists, historians, and policymakers, not to mention the US Congress, have come to realize the study of impacts is an important part of the scientific endeavor. Already in the 1990s the Human Genome Project set aside 3 percent of its $3 billion funding to study the Ethical, Legal and Social Implications of its work, a serious research program considered an integral part of the scientific project. In 2006 the National Science Foundation began funding the Center for Nanotechnology in Society, including environmental and health risks, as well as economic, technological, and policy impacts. During my days as NASA chief historian I initiated a series of studies on the societal impact of spaceflight, in accordance with the charter of the National Aeronautics and Space Act of 1958 to provide for long-range studies of the implications of NASA's work. And most recently programs are being initiated both in the United States and in Europe to study the problem of runaway artificial intelligence. Such programs and studies are key to the public understanding of science and its integration with the modern world, sorely needed these days more than ever. Surely the impact of the discovery of extraterrestrial life deserves no less attention. Both the World Economic Forum and congressional hearings on astrobiology have highlighted the question "What do we do?" in the event of discovery of life beyond Earth. This book begins to answer that question.

I have been privileged through much of my career to be embedded in the astrobiology community in a variety of forms, participating in astrobiology meetings around the world, attending NASA's small but pioneering "Cultural Aspects of SETI" workshops in the early 1990s, serving as historian of the NASA SETI and astrobiology programs, and undertaking numerous interviews with participants

in the field. In the wake of the announcement of possible nanofossils in the Mars rock in 1996, I participated in Vice President Gore's meeting to discuss the implications if it were true – and if it were not. Shortly after Carl Sagan's death I was deposed in the little-known case of *Francis Ford Coppola* v. *Carl Sagan*, having to do with property rights in his now classic book and movie *Contact*. Through all of this and more, the question of what would happen if we actually discovered life has been in the front of my mind. This volume, sprinkled with my personal recollection of these events, is the result of my deliberations on the subject over several decades.

I am acutely aware of the large number of scholars on whom this book depends, not only in the field of astrobiology but also in the many other fields I make use of. In order to think out of the box, one needs to know what is in the box, so in almost every chapter I have often had to describe at least briefly the major themes in subjects as diverse as philosophy of mind, philosophy of the social sciences, cognitive science, theology, and ethics in order to see how they could be applied in an astrobiological context. In the field of astrobiology I wish to thank NASA SETI pioneer John Billingham, who more than two decades ago drew me into the "Cultural Aspects of SETI" workshops, the results of which were later published as *Social Implications of the Detection of an Extraterrestrial Civilization*. A small but growing number of scholars have written on our subject, mostly in the form of articles cited in this volume. Many more have written on subjects indirectly related to the problem, and would no doubt be surprised to see their work used in this context.

I wish to acknowledge several authors who have published book-length works on this subject that have been essential to my work: Albert Harrison's *After Contact: The Human Response to Extraterrestrial Life*, Michael Michaud's *Contact with Alien Civilizations: Our Hopes and Fears about Encountering Extraterrestrials*, Milan Ćirković's *The Astrobiological Landscape: Philosophical Foundations of the Study of Cosmic Life*, and John Traphagan's *Extraterrestrial Intelligence and Human Imagination: SETI at the Intersection of Science, Religion, and Culture.* Similarly, a growing number of edited volumes now constitute a substantial literature on the subject addressed by dozens of authors: Doug Vakoch's four pioneering volumes (all listed in the Bibliography), Connie Bertka's *Exploring the Origin, Extent, and Future of Life: Philosophical, Ethical and Theological Perspectives*, Chris Impey's *Encountering Life in the Universe: Ethical Foundations and Social Implications of Astrobiology*, and David Dunér's *The History and Philosophy of Astrobiology: Perspectives on Extraterrestrial Life and the Human Mind*. Also relevant is Michael Ashkenazi's *What We Know about Extraterrestrial Intelligence: Foundations of Xenology*, published as this volume went to press. Given these volumes and more to come, it is not too much to suggest that a new field of astrobiology

and society is developing, part of the history, philosophy, and sociology of astrobiology captured in Dunér's title and systematically outlined in Dick (2012).

This volume was written during my time as the Baruch S. Blumberg NASA/Library of Congress Chair in Astrobiology, centered at the John W. Kluge Center of the Library of Congress in Washington, DC. The beautiful surroundings of the Thomas Jefferson Building have inspired many writers, myself included. The explicit purpose of the Chair is to look at the humanistic aspects of astrobiology. Barry Blumberg himself deserves my thanks for his support and memorable conversations in my office at NASA Headquarters before his untimely death. I would like to thank Jim Green, director of planetary science at NASA; Mary Voytek, senior scientist for astrobiology at NASA Headquarters; and Carl Pilcher and Edward Goolish, respectively director and acting director of the NASA Astrobiology Institute at the time of this research, for supporting such a forward-looking subject and for their encouragement during my tenure. At the Library of Congress I would also like to thank Kluge Center Director Carolyn T. Brown, as well as Jane McAuliffe, Dan Turello, Jason Steinhauer, Travis Hensley, JoAnne Kitching, Mary Lou Reker, Matthew Hinson, Austin Woodruff, and Nancy Lovas, for their support while I was in residence at the Kluge Center. In the Science Reference Section my thanks go to Margaret Clifton for unearthing many an obscure reference. During my time at the Library I had access not only to the tremendous resources of one of the best libraries in the world, but also to scholars in a variety of disciplines, including David Grinspoon, the inaugural Blumberg Chair who sat in the office next door and produced *Earth in Human Hands: Shaping Our Planet's Future*, a model of good writing on a subject very relevant to the present volume.

For reading chapters or sections, or for discussions relevant to their expertise I would like to thank Gregory Dick (geomicrobiology); Derek Malone-France (philosophy of knowledge); Kelly Smith (philosophy of knowledge and astroethics); Susan Schneider (philosophy of mind); Mark Lupisella (astroethics); Linda Billings (astroculture); Michael A. G. Michaud (SETI protocols and astropolicy); Margaret Race (planetary protection and astropolicy); Lori Marino (intelligence); Michael Meyer (Mars rock); John Rummel (planetary protection); John Traphagan (culture and civilization); Ted Peters (astrotheology); Michael Chorost (communications); and Anthony Dick, Adam Korbitz, Steve Doyle, and George Robinson (all on space law). For Figures 1.5 and 1.6 my thanks to Connie Moore at NASA Headquarters; for procuring Figure 7.5 my thanks to Alexander Geppert in Berlin (as well as for his concept of astroculture discussed in Chapter 7); and for Figure 1.1 thanks to Nasser Zakariya, whose book *A Final Story* has also influenced my thinking on the development of our current cosmic worldview. Finally, thanks go also to my editor at Cambridge University Press, Vince Higgs, for his encouragement and for accepting this, my seventh book for Cambridge University Press,

and to Esther Miguéliz Obanos, Samantha Town, and Ami Naramor for seeing it through production.

In addition to human and material resources in the Library itself, in September 2014 I convened scholars from many disciplines around the world to discuss the subject. Their discussion, published as *The Impact of Discovering Life beyond Earth,* has immeasurably enriched my view of the problem. They are acknowledged by the references to their work in each chapter. Readers of that volume will find some similarity in structure with this book, since both were being planned at the same time. This volume, however, is much more of a personal synthesis, and is only a beginning of the work that remains both before and after the discovery of life beyond Earth.