

The Astrosociological Implications of Astrobiology¹

Jim Pass, Ph.D.

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Abstract

The recent scientific furor over astrobiology, while indeed justified, continues to assemble formalized associations and organizations to support it under the guise of the so-called “hard” sciences (e.g., biology and the related physical sciences). The so-called “soft” sciences – including sociology and the other social sciences, the behavioral sciences, and the humanities – remain largely separated from this dynamically forming new field. However, as argued in this paper, space exploration involving the search for extraterrestrial life should be viewed as consisting of two interrelated parts (i.e., two side of the same coin): astrobiology *and* astrosociology. Together, these two fields cover the complete set of topics related to extraterrestrial alien life as appropriate. Moreover, with a formalized system of collaboration, they would also focus on the implications of their research to human beings as well as their cultures and social structures. By placing the astrosociological implications of astrobiology at a high enough priority, scientists interested in the search for alien life augment their focus to include the social reality always associated with their work (yet previously overlooked and understated).

Introduction: Astrobiology and Astrosociology

Why should the scientific community provide astrosociology, a developing and by no means widely-accepted field, with a standing equal to astrobiology? As the founder of astrosociology, I possess obvious incentives to promote this new field. Nevertheless, the more significant answer relates to the very nature of the sciences themselves, which are roughly divided into the physical and social/behavioral categories. One curious fact remains amid this furor over the rapid development of astrobiology. The social and cultural implications associated with the study and discovery of extraterrestrial life affect the imaginations of laypeople and

scientists alike, as well as their actions and larger patterns of behavior at the micro, middle, and macro levels of social reality (from individual persons to the community and societal levels). Moreover, the significance of astrobiology as a growing *international* field must receive due recognition. When astrobiologists and other space scientists speak about non-human life in the universe, they inevitably begin to touch on concepts associated with sociology and the other social sciences (Pass 2005a). This fact unmistakably suggests an untapped relationship between the work of astrobiologists and the work of social scientists, with significant implications for societies around the world. Hence, while currently not formally accepted as a source for collaboration, the social sciences receive acknowledgement on an informal basis, perhaps making the divide between the two scientific camps seem less serious at first glance. Even so, the degree of separation between the physical and social sciences on a formal basis remains high enough to merit formal attention (Dudley-Rowley 2004; Harrison 1997). It is time to formalize the informal recognition of the significance of the social and cultural ramifications of space activities, including the search for extraterrestrial life.

The emerging field of astrosociology specifically focuses on the relationship between any aspect of space-related activities and societies. The very focus of the relatively new field of astrosociology strongly implies that astrobiology possesses astrosociological (that is, societal) implications! Our species thought about questions such as “who are we?”, “how did we come to be?”, “where do we fit in the big picture?”, and “are we alone?” from the time rational thought was possible and then humans gazed at the heavens. We explored the Earth to provide some answers to these questions, so we will very likely continue our exploration of space for the same rationale. As Carl Sagan (2000:13) has stated, “The nature of life on Earth and the search for life elsewhere are two sides of the same question – the search for who we are.” Expanding on this

notion, the comprehensive answers to such questions truly involve *all* of the sciences because we are a social species and not just a biological one. Knowledge for knowledge's sake may be important in its own right, but the application of knowledge for the benefit of society raises its value to a still higher echelon. (I use astrobiology as an obvious example of a field with strong ties to astrosociology, but the other space sciences possess similar ties as well. At the same time, the search for extraterrestrial life holds a special place in human cultures, both past and present).

Incredibly, then, astrobiology and all the space sciences have historically pursued their scientific objectives largely without the benefit of *significant* input from the social sciences, even in avenues of inquiry most suited to the social sciences rather than the physical sciences. This reality continues even as we approach the fiftieth anniversary of the space age. However, as we venture out beyond low Earth orbit, this approach that overwhelmingly relies on the physical sciences inevitably becomes less effective in its coverage of all the important scientific questions involved in the various areas of space travel, habitation, and exploration. Human groups will someday move into space in search of nonhuman life. While robots increasingly become more sophisticated and thus more capable, their ability to detect and properly analyze possible life on Mars or in other space environments cannot soon match the prowess of human beings. Like planetary geologists, astrobiologists look forward to working in extraterrestrial environments.

Definition of Astrobiology and Astrosociology, and Their Relationship

When discussing these two fields, it is of course important to define them. Of even greater importance, however, involves consideration of the relationship between the two, especially because this latter focus remains underemphasized. That is, the greater significance relates to the connection between the two fields specifically and that between the physical and

social sciences in general. Related to the former consideration is the necessity to encourage a much greater collaboration between the two fields of astrobiology and astrosociology.

Therefore, the issue of creating a permanent and formal association between the two, an important objective of astrosociology, represents an important overriding theme of this paper as well. Astrosociology can provide the framework for correcting this ongoing absence of formal communication by focusing on all issues that somehow involve the relationship between space and society, and this brings in astrobiology. The relationship between astrobiology and astrosociology is rooted in the relationship between the physical and social sciences, tied together by their mutual focus on outer space as both a physical and social environment. Both must contribute to our overall understanding of space exploration due to the simple reason that human behavior makes space exploration possible, and human behavior happens to be the focus of the social sciences.

Astrobiology Defined in a Social Context

In its *Roadmap*, NASA's Ames Research Center's *Astrobiology at NASA site* defines astrobiology as related below.

Astrobiology is the study of the origins, evolution, distribution, and future of life in the universe. It requires fundamental concepts of life and habitable environments that will help us to recognize biospheres that might be quite different from our own. Astrobiology embraces the search for potentially inhabited planets beyond our Solar System, the exploration of Mars and the outer planets, laboratory and field investigations of the origins and early evolution of life, and studies of the potential of life to adapt to future challenges, both on Earth and in space (NASA Ames Research Center 2003).

According to the NASA Institute of Astrosociology (2006), the types of questions listed below “exemplify the breadth and depth of astrobiology.”

- How do habitable worlds form and how do they evolve?
- How did living systems emerge?
- How can we recognize other biospheres?
- How have the Earth and its biosphere influenced each other over time?
- How do rapid changes in the environment affect emergent ecosystem properties and their evolution?
- What is the potential for biological evolution beyond the planet of origin?

Surely, the social and cultural implications of these questions, and the very pursuit of human beings to answer them, should be evident to everyone. Unfortunately, from astrobiologists and other physical scientists, this recognition currently fails to receive serious consideration on an extensive basis.

The introduction to the *Roadmap* goes on to call for interdisciplinary research. As is common within the physical sciences, however, this reference seems confined to the physical sciences. The social and behavioral sciences receive no overt acknowledgement:

Interdisciplinary research is needed that combines molecular biology, ecology, planetary science, astronomy, information science, space exploration technologies, and related disciplines. The broad interdisciplinary character of astrobiology compels us to strive for the most comprehensive and inclusive understanding of biological, planetary and cosmic phenomena (NASA Ames Research Center 2003).

The pursuit of astrobiology in the traditional manner represents an extremely positive endeavor and it should continue, though the thrust of the argument presented here focuses on the need to *add* additional scientists to study the relationship between the search for extraterrestrial life and its effects upon societies and other social structures. That is, it strongly calls for the inclusion of the social sciences through the recognition of astrosociology as an important complementary field. From the perspective of social scientists currently working on issues related to space and its implications for human societies, they need to recognize the fact that they do so in isolation within their disciplines and from one another. Astrosociology was developed, in part, to allow for these social scientists to come together as astrosociologists so they may collaborate under the

banner of a single field. Once this occurs to an appreciable extent, they can then approach the field of astrobiology with an organized, coherent voice requesting formal working arrangements that will benefit both fields.

Astrosociology Defined in a Physical Sciences Context

Astrosociology is defined as the study of *astrosocial phenomena* (i.e., the social and cultural patterns related to outer space) (Pass 2004a). This definition places no values on the level of space-related development within a particular society. Astrosocial phenomena existed in ancient societies, they exist in contemporary societies incapable of spaceflight, and of course within space capable societies. In other words, these particular forms of social phenomena simply relate to any human behavior that somehow relates to space. The preparations for sending a rocket into space qualify, but so do the activities of ancient astronomers at Stonehenge. An important implication of this, then, is that astrosociology possesses an historical perspective. The connection to astrobiology relates to the following type of question: how long have human beings gazed at the nighttime sky and wondered if they were alone? Indeed, ancient cultures have incorporated ideas related to their explanations of extraterrestrial life. Ancient murals and other writings hint at such beliefs. Additionally, ancient human societies have conducted astronomical research and even organized themselves around their findings.

The historical period that inspired the development of astrosociology is a much more recent one. Since the successful launch of Sputnik by the Soviet Union in 1957, humans from various societies around the world contributed directly and indirectly to the increasingly sophisticated achievements that characterize the space age. Despite the long list of accomplishments and their relationship to human societies, the development of a social science

field within sociology or the other social/behavioral sciences never developed. Individual social scientists of various disciplines have worked in the general area of astrosocial phenomena though they never developed a scientific field to do so in an organized way, an approach that would have allowed for collaboration among scientists. Discoveries from the space sciences abound, yet we fail to inquire about how they affect human societies. Astrosociology now exists to fill this void.

The Relationship between Astrobiology and Astrosociology

To be fair, the societal implications of astrobiology were never ignored totally. In the NASA publication entitled *Workshop on the Societal Implications of Astrobiology*, astrobiology is defined as:

...the study of the origin, distribution, and future of life in the universe. It applies multiple scientific disciplines and space technologies to address how life begins and develops, whether life exists elsewhere in the universe, and life's future on the home planet and beyond. It thus integrates the interests of people who search for evidence of life beyond the Earth, and people who seek to establish a permanent human presence in space (Harrison and Connell 1999:5).

It is clear that astrobiologists do, in fact, recognize the social implications of their scientific perspective. Indeed, social scientists were involved in the NASA study that produced the definition above. In this report, they clearly call for social scientists to join the astrobiological community. While I agree with this general notion, I believe it is best for social scientists to join them as astrosociologists specializing in astrobiology and SETI rather than as dislocated individuals. In this way, the focus on the social implications of astrobiology will become part of the astrosociological literature and easily accessible to social scientists, astrobiologists, and all other interested parties. At that time, the advocacy for interdisciplinary collaboration in this report represents more of a recommendation than an actual development. Much difficult work

awaits us in formalizing the interdisciplinary cooperation between the physical (“hard”) sciences and social (“soft”) sciences.

Initially, I regarded astrosociology as the *sociology of outer space*, and it still may be characterized as such within sociological circles to a great extent. In other words, for an extremely short time during its initial development, I viewed astrosociology as purely a subdiscipline of sociology. This status remains acceptable within the sociological community as long as sociologically-trained astrosociologists review all literature from astrosociology inclusive of all relevant fields on an ongoing basis. (This observation refers again to the value of a single field of astrosociology). Merit exists for the idea that sociologists should take a sociological perspective while anthropologists should take an anthropological perspective, and so on, within the field of astrosociology. Of course, this approach has its limits unless every scientist interested in astrosocial phenomena collaborates. All who focus on astrosocial phenomena are encouraged to identify themselves as astrosociologists regardless of their training or background. Those who choose to study astrosocial phenomena on an exclusive basis *should* identify themselves as astrosociologists. An astrosociologist is simply a scientist who studies astrosocial phenomena, inclusive of their innumerable implications and consequences for societies in all historical epochs.

It cannot be overemphasized that, in the present context, the most important element of the astrosociological approach relates to the collaboration among astrosociologists within the social/behavioral sciences with one another as well as their collaboration with space scientists and engineers interested in the social implications of space exploration (including astrobiology). While astrosociology was originally established to fill a void created by the historical absence of a sociological focus on space as a subfield, it became clear almost immediately that a

multidisciplinary field was required. Whenever humans organize themselves to accomplish something, including space exploration, then the connection of the physical sciences to society and culture should be obvious. In reality, however, it is not obvious. Astrosociology seeks to bridge this historical isolation in a formal and purposeful way so that physical and social scientists, and all members of a particular society, benefit in ways not currently possible. Astrosociology encourages interdisciplinary/multidisciplinary collaboration among all scientists principally and this produces a more balanced understanding than is impossible with an approach reliant exclusively on the physical sciences (Pass 2005b).

Astrosociological Implications of Astrobiology

The astrosociological implications of astrobiology involve the effects of astrobiological research on societies and their cultures, including the investigation of terrestrial analogs and the search for alien life, as well as the indirect work done to support such activity, and any more tangential efforts that support astrobiology. These implications refer to the following types of substantive areas (this is an incomplete, though representative, list):

- the cultural justifications for the search for extraterrestrial life from scientists, public, and others;
- counteracting social forces opposed to astrobiological research;
- the social organization required to conduct the search for extraterrestrial life;
- social-structural forms of astrobiological research organizations and how they conduct their research, including how they work with other types of physical scientists (i.e., organizational analysis);
- interactions between the research findings, including among various societies;
- how resources are allocated and spent, and who is involved in such decisions;
- the social/cultural ramifications of relevant astrobiological discoveries that fall short of discovering extraterrestrial life; and:
- impact of an outcome: (1) the detection of a message from an extraterrestrial intelligence, (2) discovery of a low form of alien life, *or* (3) the perceived failure of the search (we give up and turn our of attention elsewhere).

To reiterate, any social or cultural patterns that somehow relate to extraterrestrial life directly *or* indirectly possess astrosociological implications. The astrosociological implications of astrobiology exist simply because the search for alien life occurs within a stable and enduring social environment. Everything humans do involving space science and exploration occurs within the context of a social system and therefore possesses social and cultural implications for the rest of that society.

In turn, human actions result in reactions from the other elements of society. In sociology, such ideas are part of the *functional perspective* which states that all parts of society are interconnected and contribute to an existing equilibrium. When one of these parts is affected by social forces resulting in changes, this new reality has effects on the other parts of that society. Social change is viewed as an evolutionary process. Of course, the discovery of extraterrestrial life would involve revolutionary social change (a prediction from the *conflict perspective* that views the various types of conflict in society as causes for change).

The overriding assumptions here relate to the ideas that (1) all astrosocial phenomena possess social implications for their societies and (2) astrobiological forms possess special implications due to the very nature of their field. Astrobiologists seek answers to fundamental questions about life in the universe. Until recently, their ability to seriously address such questions was frustratingly out of reach. Astrobiology developed into a serious field in large measure due to the advancement of science and technology that finally allowed for its credible development and support by scientists and non-scientists alike. Not too long ago, people of all backgrounds were scoffing at the possibility of alien life, calling it the “search for little green men” (Harrison 2005). Today, a lot of these same individuals no longer see the absurdity they once did in the search and understanding of extraterrestrial life. Let us look at this in more detail.

In the early 1960s, the idea to search for alien life in the Milky Way galaxy seemed like a fool's errand to many within the scientific community, not to mention the majority of the public. Today, a great number of scientists from various fields, and a growing number of individuals from various other walks of life, believe that the existence of extraterrestrial life seems more likely than not. By 1996, nearly 72% of the public believed that alien life in some form exists in the universe (according to a Gallup Poll from that year).² The development of astrobiology as a legitimate new field attests to a core support of scientists who joined with others to forge a general change in attitude. Recently, the level of indirect evidence consistent with the possibility of extraterrestrial life has accumulated to strongly reinforce this evolving line of reasoning and acceptance. The more we study the problem of detecting extraterrestrial life, including analogs here on Earth, the more we find clues that support the strong possibility of the existence of such life rather than those that tend to refute it.

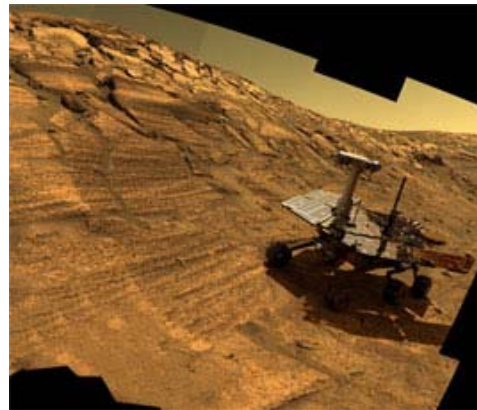
Social/Cultural Connections to Astrobiological Findings

The work and passionate explanations of astrobiologists (and space scientists generally) establish strong connections to other elements of society (i.e., individuals, social groups including organizations, institutions, larger society, and a society's culture). Again, the work of astrobiologists especially speaks to the age-old question: are we alone in the universe? The possibility of alien life represents an idea that most human beings seem willing to accept in contemporary societies yet was unthinkable before Nicolaus Copernicus' heliocentric planetary theory became widely known during the mid-sixteenth century and started humanity on the road to a new mindset. It may be stated as a question as well: Is it truly possible that human beings comprise the only intelligent species among all the planets orbiting around the billions of stars

within the billions of galaxies in the universe? We live on a seemingly ordinary planet at the outskirts of a typical spiral galaxy in an average part of the cosmos. It seems common today to think that we just cannot be alone. Nevertheless, in the beginning when SETI researchers set out on their basic undertaking to detect an alien signal, their optimism of success was much higher than the average citizen in the United States. Recently, tangible discoveries have changed things on more of a revolutionary basis. Our hopes are now supplemented with scientific discoveries made possible by technology.

Recent findings by astrobiologists provide support to the logical increase in the expectation among most human beings that life in the universe is abundant rather than rare, or most especially, confined only to the Earth. Microbial ET life almost seems inevitable. The possibility of extraterrestrial, *non-human*, intelligent beings seems more likely today than even ten years ago due to several astounding developments as related below.

- The important findings of the Mars Rovers *Spirit* and *Opportunity*, and supportive orbiting spacecraft, point to past and present water on the planet and consequently the possibility of past and/or present life. The rovers represent far-flung elements of material culture, tangible proof of humanity's desire to explore relatively unknown frontiers for knowledge and benefit (photo right from NASA).³



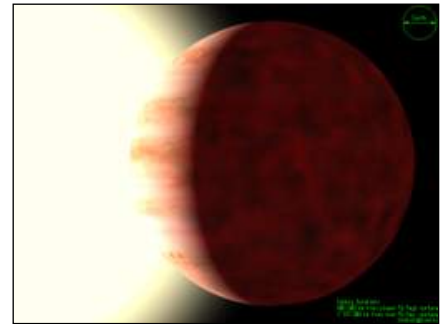
- Terrestrial *extremophiles* or organisms adapted to live in extreme conditions demonstrate that life is far more tenacious than previously believed. (They include life not dependent on the Sun's energy, discovered deep on the ocean floor, as shown right, in caves, and other extreme terrestrial biosphere niches).⁴



- Meteorite ALH 84001, found in the Allan Hills region of Antarctica in 1984, may contain Mars fossils as reported by a NASA team. Whether the claim is true or not, the very possibility provided an additional stirring of the imagination as it relates to alien life. Moreover, like the other findings, it contributed to the cultural imperative to explore Mars and seek life elsewhere in the solar system⁵ (see McKay et al. for a full discussion of this potential discovery).



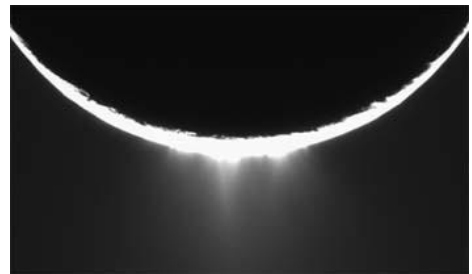
- The discovery of more than 150 extrasolar planets so far starting with *51 Peg b* in 1995 that is only about 40 light years away (shown right as an artist's depiction).⁶ Even the discovery of huge gas giants proves our solar system is not unique in the cosmos. The detection of an Earth-like planet represents the current challenge. It would greatly increase the perceived likelihood of finding extraterrestrial life.



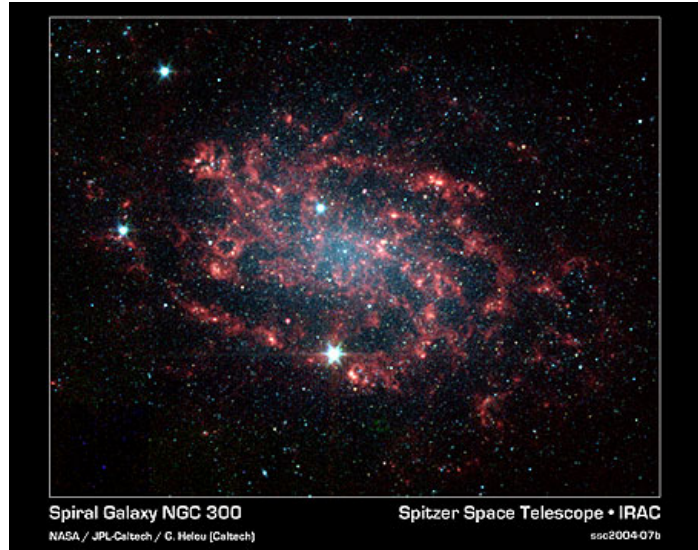
- An “Earth-sized” planet only 5.5 times more massive than Earth, dubbed OGLE-2005-BLG-390Lb, was announced on January 25, 2006. It was discovered using the method of gravitational microlensing. It orbits a red dwarf star approximately 28,000 light years away at 2.5 astronomical units. While probably too cold to support life at more than 360 degrees below Fahrenheit, it provides hope for life elsewhere. It proves smaller planets *do* exist beyond our solar system.⁷



- The Cassini spacecraft captured pictures of jets, possibly water geysers, coming from the southern pole of Saturn's moon Enceladus in February, March, and July 2005. The third flyby, only about 170 km above the south pole, actually passed through the ejected gas. This tiny moon joins Europa, Callisto, Ganymede, and Mars as possible current locations for water, and thus for possible extraterrestrial life as well.⁸



- Astronomers have discovered various organic molecules and compounds, including gaseous precursors to DNA and proteins, in copious quantities in space (examples include organics within comets and asteroids, around young stars, and within cosmic nebulae). The example right from the Spitzer Space Telescope reveals the organic compounds in red. This abundance these of organic substances infers that life itself may well be abundant throughout the universe.⁹



Such discoveries possess scientific significance in their own right, of course. However, the effects that such discoveries have on the public are typically overlooked, including influences on non-space scientists. Hence, astrosociological implications add a missing dimension. Greater awareness among non-astrobiologists potentially provides added support for astrobiology and SETI in the form of encouragement to continue as well as voluntary assistance and monetary donations from public and private circles. This will prove invaluable as NASA begins to decrease funds allocated to its science programs generally and astrobiology specifically (by 50 percent for 2006?) to pay for the President Bush's *Vision for U.S. Space Exploration*. It seems logical to predict that an increasing number of "ordinary" people will feel an increasing level of excitement as the types of indirect evidence discussed above accumulates. In what specific ways does this trend affect the cultures of societies and their socially organized efforts to respond to it? This area of research requires scientific investigation.

In no small manner, the growing supportive evidence for the possibility of alien life in our galaxy creates a growing need to answer questions about where we fit in the cosmic scheme of things. Time and time again, humans theorized that the Earth and humankind were at the

center of the organization of the universe only to be proven wrong on a consistent basis. Ideas in our culture today that relate to the possibility of extraterrestrial life contribute to the recently established movement toward favoring the possibility of alien life in contrast to the historically longstanding belief that our human species exists alone at the center of our vast universe. Religious values that once supported the idea that humankind represents the only form of intelligent life in the cosmos were forced to adapt to changing scientific findings and change their longstanding cultural ideas. Some religious groups had an easier time with this process of adaptation than others (Pass 2005a). Historically, religious groups had to cope with new verified realities that pushed humanity further from its original place of central importance.

Expanding Astrobiology

In general, despite its recognition of possible contributions outside of its field, the current focus of astrobiology remains largely preoccupied with biology, planetary geology, and the other physical sciences. In my opinion, expansion of this focus to include social and cultural considerations represents the next step. Formal collaboration with astrosociologists would ensure an enduring relationship and a constant focus on the social implications of astrobiological research. It would benefit astrobiologists by providing an expanded perspective, of course. That is, the inclusion of astrosociological issues would demonstrate a connection between astrobiological research findings and their relationship with society. This type of collaboration would provide (1) all scientists with an understanding of astrobiological issues in a broader context and (2) all citizens with a greater sense of the importance of how the possibility of extraterrestrial life relates to terrestrial life.

While this proposal does not involve changing the central focus of astrobiology itself, it *does* involve as a minimum, the expansion of its ties to the social sciences in the form of formal collaboration with the developing field of astrosociology. In the future, I can envision astrosociologists specializing in astrobiological issues, spending their entire careers on the significant implications of astrobiological research on society (and vice versa). Arguably, the social implications of astrobiology and SETI are much more important than the astrobiological findings themselves.

The Astrobiological and Astrosociological Implications of SETI

Although it developed as purely an independent field, SETI became incorporated into the growing field of astrobiology. In many important ways, this development resulted in a greater scientific standing for SETI. As discussed earlier, the general idea of “trying to communicate with little green men” served as a longtime problem for SETI (Harrison 2005). In fact, astrosociology and SETI share an interesting common problem: both have faced the criticism of being linked to UFOs, alien abductions, crop circles, astrology, and other topics related to the so-called “pseudosciences” (Pass 2004c). For the most part, SETI has removed the shackles applied to it by critics alleging its connection to non-scientific topics. Astrosociology, in contrast, finds itself at a very early point in its development and therefore more susceptible to such criticisms. It is certainly conceivable that a subdiscipline similar to astrosociology never formed previously due to perceived connections to unscientific subject areas (Pass 2004c). Collaboration depends on perceptions that both fields are legitimate, so astrosociology must overcome inaccurate perceptions regarding its true focus although this misconception among some is not serious enough to forestall formal collaborative efforts.

The astrosociological implications of SETI involve issues related both to human societies and extraterrestrial societies. Without the discovery of extraterrestrial message, even scientists can only speculate about (1) how the discovery of such life would affect humans and their societies and (2) what the discovery would yield in terms of the possibilities associated with studying the extraterrestrial civilization in contact with us. Nevertheless, these circumstances lead many individuals and social groups to follow the path of exploration. This process better prepares us as a species to cope with the likelihood of discovering life when it actually occurs. An astrosociological approach can make social problems associated with detection easier to identify and resolve.

As related by Steven Dick below, the more we apply sociology along with the other social sciences and humanities to astrobiological theory and research, the more comprehensive our knowledge becomes for both astrosociologists *and* astrobiologists.

The goals of involving social scientists and scholars in the humanities in astrobiology include increasing understanding, developing information useful for policy and moving towards “consilience” or the unification of knowledge (Harrison and Connell 1999:27).

Each of these three benefits is significant. First, astrobiologists do their work in the context of society and thus the implications of their work involve understanding astrobiological issues in a social/cultural context, both with applications to human societies and potentially even to extraterrestrial societies. The very exercise of investigating the Milky Way Galaxy for non-human life pays dividends in many forms, including gaining a better understanding of ourselves in the process. Second, space policy of any type must take into account social and cultural considerations before well-informed decisions can be made. Policy decisions in other areas require it, so space policy must take a similar approach and take advantage of astrosociological research. Third, the unification of knowledge always represents a grand goal of science. Any

field, including astrobiology, possesses less explanatory power and less relevance in isolation. The addition of astrosociological knowledge results in a new and powerful perspective currently unknown. Each of these three areas further points to the increasingly important relationship between astrobiology and the developing field of astrosociology.

The social and cultural implications of space phenomena *do* reflect preexisting concerns (though the study of them remains largely untapped). In fact, in 1961, at the first SETI meeting in Green Bank, West Virginia, radio astronomer Frank Drake first proposed his analytical tool for estimating the number of communicative civilizations in our galaxy. The Drake equation, as it is now known, is usually expressed in the following manner (SETI Institute 2005):

$$N = R_* \cdot f_p \cdot n_e \cdot f_l \cdot f_i \cdot f_c \cdot L,$$

where N = the number of civilizations in the Milky Way Galaxy whose electromagnetic emissions are detectable; R_* = the rate of formation of stars suitable for the development of intelligent life; f_p = the fraction of those stars with planetary systems; n_e = the number of planets, per solar system, with an environment suitable for life; f_l = the fraction of suitable planets on which life actually appears; f_i = the fraction of life bearing planets on which intelligent life emerges; f_c = the fraction of civilizations that develop a technology that releases detectable signs of their existence into space; and L = the length of time such civilizations release detectable signals into space.

Most of the variables in the equation obviously relate to space phenomena, yet the final two also relate to a different set of astrosocial phenomena related to non-human, currently hypothetical, civilizations (i.e., those associated to humans pondering the galaxy's possibilities as they relate to extraterrestrial life). These two variables place a great deal of unpredictability in the solution of the dependent variable, N . They point out that extraterrestrial societies must

develop and progress for an appreciable time in order to make radio astronomy and other technologies possible. How common is this? Currently, we can only guess. The last variable, L , is probably the most controversial estimate though the successful survival of the human species past the Cold War perhaps provides scientists with greater optimism. What do our estimates of these values tell us about ourselves (including how much we dislike the idea of being alone in the universe)? What do they tell us about how we will react to the detection of extraterrestrial life should it occur? We do not want to be all alone in the universe, but, on the other hand, can we handle definite proof of intelligent extraterrestrial beings? Perhaps at least some of those who offer low values are trying to protect the status quo of a solitary human intelligence.

The contributions of social scientists and scholars in the humanities represent a vital source of missing data. The example of the Drake equation serves to illustrate the point that the silence of these scientists and scholars virtually guarantees a greater level of uncertainty about their most logical values. The last two variables directly relate to extraterrestrial societies and require input from the very scientists who specialize in societies to participate. The Drake equation should have made it clear long ago that the social sciences and humanities were essential. Why have the space scientists refused to invite formal participation from the social scientists? Conversely, why have the scientists within social science disciplines failed to demand their inclusion? While a few social scientists and scholars from the humanities participated all along, the formal development of a new social science-based field never occurred until now; and hence a coordinated, large scale form of collaboration was never likely. The need for formal collaboration between astrobiology and astrosociology exists now more than ever before.

The Social, Cultural, and Ethical Implications of Detection

The potential of the social sciences to contribute appreciably to our overall understanding of astrobiological issues cannot be judged as a truly new approach as exemplified by social scientists' ongoing, though uncommon, participation. The need for their *formal* collaboration with the physical sciences cannot be emphasized too strongly or too often due to the significant knowledge that can be added to the astrobiological field. The confirmed detection of ET life by astrobiologists involves complex and varied issues that require a high level of investigation. That is, such a confirmation, especially regarding intelligent life, would transform human societies in countless and unexpected ways (see, for example, Vakoch and Lee 2000; Tough 1998; Harrison 1997).

There are important questions about the days, weeks and months after detection, then the intervening years as we get used to the idea that we are not alone, and then the long term consequences, which will mirror in their significance the discoveries of Galileo, Newton and Darwin. These questions embrace most fields of human endeavor. They are of obvious import for science. However, the point of this meeting is to examine the broader societal issues, and so focus on human behavior. Key areas are anthropology, sociology, and individual, group and social psychology. Reactions will vary according to the social attributes of individuals, and the social, economic and political contexts within which the discovery has occurred. Other important questions are the history of analogous events in our past; political, institutional, international, governmental and legal affairs; the effects on different organized and diffuse religions; the media; and education. There are broad cultural and ethical issues [as well] (Harrison and Connell 1999:47).

Unfortunately, insights such as those above continue to exist on the extreme outer periphery of acceptance within the physical sciences. The successful meeting of the goals of SETI, and more generally of astrobiology, clearly requires the support of social scientists. If SETI researchers and astrobiologists truly expect to discover extraterrestrial life, they should strive to prepare themselves for this eventual outcome. From the other side of the divide, astrosociologists must organize themselves *now* and formally collaborate with space scientists. Otherwise, they will be

brought in after the fact in the midst of the confusion caused by news of the discovery of extraterrestrial life, especially intelligent life. Under such circumstances, social scientists are much more likely to participate in an unorganized fashion yielding less helpful results. An unprepared society may well prove more likely to make unethical decisions regarding their citizen's various reactions.

According to Douglas Vakoch of the SETI Institute, we should conduct research prior to detection in order to anticipate the various reactions from various cultures and subcultures around the world so that we can develop relevant and effective policies when detection occurs:

There are many cultural and individual differences in expectations about life in the universe and how different expectations are likely to prompt different responses to the discovery of extraterrestrial life. Therefore we should conduct empirical studies relating cultural and individual differences to beliefs in extraterrestrial life and how the discovery of such life could influence humanity (Harrison and Connell 1999:29).

Because various societies possess dissimilar cultures and social structures beyond very general universals, dissimilar reactions to proof of an extraterrestrial civilization will inevitably occur. The major institutions of these different societies (e.g., politics, economy, religion, family, criminal justice system, education) would logically need to adapt differently. Even subcultures within various segments of the same society would vary. The greater we can understand all of these differences among all of our social systems, and differences within each of them, the better we can hope to deal with the news that we are positively no longer alone in the universe.

Although the citizens of human societies are continually exposed to new discoveries associated with the seemingly greater likelihood of extraterrestrial intelligence, the actual detection of an extraterrestrial signal would reflect a much different set of reactions. We cannot assume that humankind ever experienced this type of shift in its sense of social reality, and so, we cannot expect to know how social groups and individuals will react to it. As such, the need

for the involvement of astrosociologists in preparing for, and reacting to, a confirmed indication of extraterrestrial intelligent life seems obvious and therefore represents a high priority.

Social/Cultural Considerations Related to Sending Interstellar Messages

The social sciences can prove themselves valuable in devising added ways to construct interstellar messages. In order to communicate successfully with an alien species, it becomes necessary to understand their culture and social organization. While possessing such knowledge is obviously impossible, we can make educated guesses about alien civilizations. The best way to do this with any modicum of success relates to the idea that we must first understand human cultures and extrapolate from there. Astrobiologists currently focus on the potential biological characteristics of extraterrestrial beings, but they do not specialize in the potential characteristics of their social systems. The collaboration between astrobiology and astrosociology would result in a complementary approach and, in so doing, a comprehensive perspective.

Shifting to the area of message construction, mathematical formats may prove to be universal forms of communication as many SETI scientists argue. However, it seems best to formulate and send messages based on several different root concepts, including those from the social sciences, humanities, and the arts. While mathematics seem the more obvious approach, the assumptions made for messages based on social and cultural concepts may prove a bit more difficult. Nevertheless, determination of universal social and cultural concepts can prove as an extremely useful exercise in trying to understand alien civilizations and ourselves as well. We should not focus solely on principles related to mathematics or the concepts of the physical sciences lest we miss the chance to develop a successful instance of shared meaning.

The theme of CONTACT 2006, *The Music of the Spheres*, relates strongly to the implications of sending messages to potential extraterrestrial civilizations. Music represents a form of communication created within social groups by individuals for the enjoyment of themselves and others in various segments of a particular society and worldwide. We find certain patterns of sounds enjoyable, even mathematical, so we must consider the possibility that sending messages based on musical notation may indeed tie into a universal body of knowledge on a cosmic scale. For that matter, we must also look for musical coding within any messages we may detect. Musical notes are universal, based on a shared physics throughout the cosmos, so we can assume that certain commonalities may exist.

Exercises involving construction of interstellar messages possess important lessons for humanity. They can assist us in determining our levels of ethnocentrism and thereby allow us to overcome them. Even if intelligent extraterrestrial life is never detected, we can learn more about ourselves and our differences with other human cultures. On the other hand, such exercises will prepare humanity for interacting with another intelligent species, if that is indeed possible. Through understanding our own cultural idiosyncrasies and deficiencies, we may be better prepared to communicate with aliens without projecting arrogance, hostility, or other potentially negative traits. We should keep in mind that we can better anticipate future possibilities by examining past cultural ideas and actual events (Vakoch 2000). This will assist us to advance as a species and our societies will advance as well.

We must view *both* the construction and pursuit of detection of interstellar messages as exercises contributory to our own development as both a species and a collection of social beings capable of bettering ourselves along with the societies in which we live. Astrosociologists can help us to identify the lessons we learn along the way and incorporate them into our own

development as an intelligent terrestrial species. This element of our pursuit of verifying extraterrestrial life is vitally important to *us* and therefore deserves attention in its own right.

Conclusions: Collaboration and Increased Understanding

This essay has touched on important issues related to astrosociology's development and its relationship to astrobiology, a relationship also extremely relevant to the other space sciences in many ways. This essay was written primarily to promote new ways of thinking about the connections between the two fields of astrobiology and astrosociology, and thereby about the reasons for establishing formal collaboration between the two. The astrosociological implications of astrobiology abound yet, historically, they attract very little formal interest from the professional organizations within the space sciences and, sadly, from the main professional organizations representing the social sciences. Among the important objectives at this early stage in the development of astrosociology are changes consistent with fostering formal collaboration with the fields of astrobiology and SETI.

Therefore, astrobiologists and other scientists in the physical sciences comprise the intended audience of this paper. Social scientists comprise a vital secondary audience, especially for those already focusing on astrosocial phenomena as individuals or small groups. Enough scientists exist from various backgrounds to organize themselves as astrosociologists and to begin development of a coherent body of knowledge and literature worthy of an important new emerging field. Such an organizing effort creates something tangible for those interested in astrosocial phenomena with which to identify and join. Astrosociology must develop simultaneously by better organizing itself and by seeking collaborative relationships with astrobiologists along with other space scientists and engineers.

We must open ourselves up to more inclusive possibilities for the future. Rather than utilizing space exploration to stir the imaginations of only potential space scientists and engineers among our youth, we should also do so to motivate all potential scientists. As an additional step, we must utilize space exploration to encourage potential *astrosociologists* to follow a different, though related, path. In order to ensure the greatest, most comprehensive understanding of humanity's destiny in space, we must encourage students in the physical sciences and engineering disciplines, who serve as the usual targets, *but also* those in the social and behavioral sciences, and the humanities to become involved in the study of astrosocial phenomena. This implies that government agencies and private organizations should bring the inspirational effects produced by outer space into social science classrooms. It will prove in our best interests to make funding available for astrosociological programs as well as for astrobiological ones.

Those in the “soft” sciences will become increasingly important in the future. Many social scientists refer to their particular disciplines as comprising the “harder sciences” due to the difficulty of studying a subject matter that is both complex and ever changing making “laws of behavior” more elusive than the laws of nature. While many may see this shifting characteristic of social forces and behavioral laws as a weakness, it should be viewed as simply a greater difficulty facing social and behavioral scientists and nothing more. For astrosociologists, social reality is a fact that lends itself to scientific scrutiny, and hence social forces and social conditions may be identified, examined, and result in a greater understanding of the human condition. More precisely, astrosocial phenomena exist and must receive the attention of astrosociologists lest we venture into the cosmos (literally and figuratively in the current state of astrobiological research) blindly.

Does it make sense to ignore, or worse, to discourage potential astrosociologists? Given the foregoing arguments in this essay, the answer seems quite obvious. Too often, the social sciences receive disparaging evaluations from public and physical science circles. On the contrary, astrosociology as one particular field must not be devalued just as human societies begin to increase their efforts to explore our solar system and other parts of outer space. Astrobiologists have much to gain by embracing astrosociology due to the fact that the social and cultural implications of their work impact greatly on their societies and their societies influence them as well. To ensure its proper development, astrosociology, in part, seeks to (1) end this unreasonable treatment and (2) increase the recognition, and the utilization, of social science research for the benefit of anyone interested in any of the aspects of space travel and exploration.

The work of astrobiologists increasingly makes the possibility of extraterrestrial life seem more and more likely. Astrosociologists, in the process, increasingly recognize the implications of this trend for all elements of human organization and the possibilities in the future. Social scientists have shown that ideas can have powerful effects on social and cultural patterns. We must recognize how accumulated knowledge regarding the growing possibility of detecting extraterrestrial life produces changes in nonscientific parts of societies, and how these changes influence the level and orientation of human efforts to continue the search in the future. The very search for extraterrestrial life affects societies, but imagine what would happen to them if ET life was actually verified beyond doubt! Astrobiologists would be elated should such a reality occur. At this point, astrosociologists would be put to task to determine how this discovery affects societies, their social groups and subcultures, and various individuals. While this scenario clearly points to the need for astrosociology at some future point in history, such an outcome should not be necessary to justify its development.

For the purposes of this essay, astrosociology focuses on how astrobiologists produce new knowledge *and* how this knowledge affects society. This focus includes practical uses of astrobiological discoveries and how discoveries impact on a particular society's larger culture, its subcultures and its social structures. Astrobiologists *should* find interest in astrosociological research because they conduct their research within a society; and more specifically, within a supportive organization within their society. Like all of us, they do not work in a vacuum. On an abstract level, the impact of their work on society is relevant as contributory to the existing knowledge base. That alone should suffice. Scientific and technological applications of their work in other areas are much more tangible. On a more practical level, the impact of their work on society also relates to their funding level in the overall scheme of priorities. No matter how one chooses to view it, the relationship between astrobiology and astrosociology is significant and therefore deserves attention. Astrosociology provides a context for astrobiology; that is, a social/cultural orientation for an important area of study within the physical sciences. The astrosociological implications of astrobiology demand that astrobiologists take advantage of what astrosociologists can offer them.

Please consider the following question. Based on the foregoing arguments, how can we continue practicing space science and engineering without input from the social and behavioral sciences, the humanities, and the arts (represented by the field of astrosociology)? Human behavior becomes much more critical to our efforts as we move farther into the vastness of space. We must find ways to compel each of the relevant sciences to work together as a comprehensive whole. It is my belief that astrosociology can serve as the catalyst and common denominator making a multidisciplinary field possible. While it will not focus on the same exact pursuits relevant to making discoveries within the physical sciences, it will focus on how these

discoveries and their related ideas affect society. In addition, astrosociology will ideally contribute to the areas involving human social organization so as to (1) improve the outcomes of space missions and (2) demonstrate the importance of space science and exploration to society. Currently, this social reality eludes us.

It remains important for both astrobiologists and astrosociologists to recognize that each of their fields corresponds to one side of a two-sided coin. Each side must be willing to turn over the coin in order to reveal the other side and thereby gain a more comprehensive perspective common to both as represented by the entire coin. Otherwise, astrobiologists along with all space scientists and engineers will continue to conduct their work and affect societies in the process, but no one will fully understand either the characteristics of their influences or how to take advantage of this missing knowledge for the benefit of all levels of social reality, from the lives of individuals to entire societies and civilizations, and even humankind as a species. In closing, another question comes to mind: Can we afford to operate within the limited constraints of the status quo or should we take advantage of *both* sides of that conceptual coin?

Notes

1. This paper was presented at the CONTACT 2006 Conference at NASA Ames Research Center in Mountain View, California.
2. See the Gallup Poll website. The URL is: <http://poll.gallup.com/>.
3. Photograph from NASA website entitled *Mars Exploration Rover Mission*. Retrieved on 12/26/2005 (<http://marsrovers.jpl.nasa.gov/home/>).
4. Photograph from website entitled *Extremophiles: Life in Extreme Environments*. Retrieved on 12/26/2005 (<http://www.ibiblio.org/astrobiology/index.php?page=origin07>). Additional examples of extremophiles include life found: (1) in Mono Lake (a highly alkaline environment), (2) in Yellowstone's Sylvan Springs (sulfuric acid), (3) within caves (deep underground in harsh conditions), (4) within Antarctic ice sheets (including Lake Vostok), and (5) thriving on highly radioactive control rods in nuclear power plants.

5. Photograph from website entitled *Astrobiology: The Living Universe on the Evidence of ET Life* page. See McKay et al. (1996) in references section below. Retrieved on 12/26/2005 (<http://www.ibiblio.org/astrobiology/index.php?page=exobio02>). Photograph from NASA.
6. Simulation from website entitled *SolStation.com* on *51 Pegasi* page (copyright by Tomislav Stimac). Retrieved on 12/26/2005 (<http://www.solstation.com/stars2/51pegasi.htm>). (Planet is simulated below based on data by Seville).
7. This artist's conception depicts the "Earthlike" planet with its home star in the distance and provided from the Space Telescope Science Institute (STScI). Story retrieved from the STScI website on 01/26/06 (<http://hubblesite.org/newscenter/newsdesk/archive/releases/2006/06/>).
8. Photograph from NASA website. Retrieved on 03/10/2006 (http://www.nasa.gov/mission_pages/cassini/multimedia/pia07762.html).
9. Photograph from NASA/JPL-Caltech *Spitzer Space Telescope* website. Retrieved on 12/26/2005 (<http://www.spitzer.caltech.edu/Media/releases/ssc2004-07/ssc2004-07b.shtml>).

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