Other Worlds: The Cultural Significance of the Extraterrestrial Life Debate

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ABSTRACT

The extraterrestrial life debate has greatly influenced science, popular culture and both secular and theological worldviews. Today it comprises a non-anthropocentric worldview of its own, here termed the "biophysical cosmology." This cosmology is still unverified, but if extraterrestrial intelligence is discovered, the cultural impact of the debate thus far will have been but a minor prelude.

One of the most pervasive cultural influences of astronomy has been the idea that life forms, perhaps far superior to our own, may exist beyond the Earth. This idea may be tied to the gods and goddesses of ancient myth and to the spiritual/celestial beings of religion or it may be, as some have suggested, a manifestation of an emotional need for imaginary beings [1]. What is certain is that we live in a time when the search for extraterrestrial life surrounds us. The Viking landers have shown that, down to the level of parts per billion, no organic molecules exist on Mars—at least at the two landing sites. The first planets beyond our solar system have apparently been irrefutably confirmed around a pulsar, and the Hubble Space Telescope has recently reported numerous planetary systems in formation in the Orion region [2]. The flagship radio search for extraterrestrial intelligence (SETI) was funded and then precipitously canceled by the U.S. Congress, yet continues in a variety of forms around the globe [3]. Reports of unidentified flying objects (UFOs) and alien abduction abound, the latter now championed even by one Harvard professor [4]. In short, from the halls of science to popular belief, extraterrestrials are a part of our culture, even if our attitudes toward them have been ambiguous.

The intriguing history of the debate throughout the nineteenth century is now well known [5]. Here we concentrate on the twentieth century [6], outlining how the extraterrestrial life debate has played an important role in both scientific and popular cultures, as well as in shaping our worldview.

Cosmic Evolution and the Cultures of Science

In assessing the cultural significance of the extraterrestrial life debate, we should not overlook what it tells us about one of the main elements of our culture: science itself. We cannot discuss here the full scope of the scientific approach to the problem, which has been exemplified by several authors [7] and a voluminous literature now encompassing many fields; we mention here only two general aspects of the scientific debate.

First, the extraterrestrial life debate points out, as no other scientific controversy does so sweepingly, how completely the concept of cosmic evolution has triumphed in Western civilization. Indeed, much of the twentieth century debate may be seen as a test of cosmic evolution, or the idea that matter and life are naturally evolving throughout the universe. Percival Lowell understood at the beginning of this century that the solar system was evolving; his vivid picture of a dying Mars whose inhabitants were desperately trying to distribute their water resources epitomized a solar system constantly subject to change [8]. The failure of the Viking landers to detect even organic molecules on Mars was a setback to the cause of cosmic evolution. But optimists pointed out that this result applied to only one planet; they had faith that outside the solar system were innumerable other planets, a faith only recently supported by the confirmation of pulsar planets—hardly the kind the extraterrestrial optimists were seeking. But if planets could form around pulsars, they argued, planets could form anywhere, and on these planets, they believed, chemical and biological evolution had occurred. Despite numerous experiments in prebiotic biology in the four decades since the pathbreaking experiment of Miller and Urey [9], this belief is still far from certain. The only way to know for sure, many scientists believed, was to observe, and this is what SETI was all about. Its aim was to test for the ultimate product of cosmic evolution: intelligence.

Since 1961, the idea of cosmic evolution has been encapsulated in the famous Drake Equation [10]:

$$N = R^* f_p\, n_e f_l f_i f_c\, L,$$

where each symbol on the right side of the equation represents a factor on the way to the number of communicating civilizations in the Galaxy (N). The first three factors are astronomical, estimating respectively the rate of star formation, the fraction of stars with planets and the number of planets per star with environments suitable for life. The fourth and fifth factors are biological, estimating the fraction of suitable planets on which life has developed and the fraction of those life-bearing planets on which intelligence has evolved. The last two factors are social, estimating the fraction of cultures that are communicative over interstellar distances and the lifetime (L) of communicative civilizations. The uncertain-

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Fig. 1. Cover of "A Signal from Mars. March and Two Step," by Raymond Taylor. Published in 1901, during the height of the Martian canals furor, the composition is an example of music inspired by the question of extraterrestrial intelligence.

ties, already shaky enough for the astronomical parameters, nevertheless increase as one progresses from the astronomical to the biological to the social. Depending on whether you are an optimist or a pessimist, the number of civilizations in our galaxy may be estimated at 100 million or 1, the latter number representing our own Earth. (If the pessimists are not careful, they will prove that life does not exist on Earth!) But the significance of the Drake Equation was not that it gave any definitive answer, nor even that it was a tool around which an uncertain discussion could focus, but that it was the very embodiment of the concept of cosmic evolution. This was a concept that the United States National Aeronautics and Space Administration (NASA) SETI program wholeheartedly embraced as a unified research program [11]. Although that program has now lost its federal funding, cosmic evolution from the Big Bang to intelligence is still the guiding idea for astronomical research. SETI, I would suggest, even more than the controversy over terrestrial biological evolution that forms a subset of cosmic evolution, has spread this attitude of cosmic evolution into popular culture.

Second, a salient characteristic of the extraterrestrial life debate in the context of science is that it shows that there is, in fact, no monolithic scientific culture such as the one C.P. Snow defined more than 30 years ago in his writings contrasting science with the humanities [12]. The attempts to demonstrate cosmic evolution show—again, more clearly than any other scientific controversy has—the many different approaches that scientists take to solving problems and the many ways they interpret evidence until, in the end, some form of consensus is reached. Percival Lowell believed he had evidence for intelligent constructions on Mars; Peter van de Kamp believed he had evidence for a planetary system around Barnard's Star [13]; and evidence of the building blocks of life in meteorites and interstellar clouds has been used differently by different scientists to draw conclusions about the likelihood of extraterrestrial intelligence (ETI). The contrasting approaches and claims of those who proclaim the likelihood of extraterrestrials and of their opponents, who believe that extraordinary claims require extraordinary evidence, demonstrate that science does, in fact, consist of many cultures.

Nowhere are these cultures more evident than in the UFO controversy, which a majority of scientists have refused even to discuss, while others have concluded that the elusive lights in the sky might be spaceships piloted by extraterrestrials. The difference in scientific attitudes toward UFOs—the difference, say, between J. Allen Hynek [14], who came to believe that UFOs were an important new phenomenon after overcoming initial skepticism, and Harvard Observatory Director Donald Menzel [15], who believed they had prosaic explanations—are extremely interesting as a means of probing what science is all about. Both were scientists, and very good ones at that, but they had very different approaches toward UFOs and drew very different conclusions about them. These two approaches, I would suggest, are at opposite poles of a whole spectrum of cultures of science, a spectrum whose origin, nature and dynamics deserve further study.

Popular Culture: UFOs, Science Fiction and Cinema

Illuminating as the extraterrestrial life debate is for an understanding of the triumph of the concept of cosmic evolution and the nature of science and its many cultures, it is clear that its significance goes well beyond the relatively parochial boundaries of science. The idea of extraterrestrials clearly fascinated a wide audience as early as 1686, when

Bernard le Bovier de Fontenelle's *Conversations on the Plurality of Worlds* appeared. As Crowe and Guthke have shown [16], extraterrestrials have been the subject of prose and poetry from the seventeenth century onward.

Still, no one could have foreseen the extent to which the idea would pervade popular culture by the twentieth century. Some of this was triggered by events in science, especially Lowell's theory. The idea of a signal from Mars inspired the popular imagination in a variety of realms ranging from music (Fig. 1) to technology. No sooner had radio been invented than its pioneers, including Tesla and Marconi [17], were suggesting that we should listen for signals from Mars. Even Menzel, an avid amateur radio fan, could not resist exploring the idea in an article in the magazine *Short Wave and Television*. The same article included the opinions of Lee de Forest and Nikola Tesla and the following editorial comment by Hugo Gernsback: "the question of radio communication with distant planets still holds supreme charm for all red-blooded radio experimenters" [18].

But it was in science fiction that the alien came alive. In 1897, H.G. Wells brought the invading Martian into literature with his *War of the Worlds*. In the same year, the German Kantian philosopher Kurd Lasswitz ushered in a more benign Martian in *Auf Zwei Planeten* (On Two Planets) [19]. In an enormous number of works since then, the alien has become a standard theme of science fiction, used for a variety of purposes. The alien has evolved from the beings found in the predictable but immensely popular space opera adventures of Edgar Rice Burroughs to the philosophical beings of Olaf Stapledon to the subtle and almost ethereal creatures of Bradbury's *Martian Chronicles* (1950). C.S. Lewis, in his space trilogy beginning with *Out of the Silent Planet*, used the alien theme in defense of Christianity [20]. In short, during the first half of this century, aliens helped man explore traditional themes from a new and less parochial perspective. One sees in cosmic and theological alien literature a pattern of search for a higher truth and wisdom, whether embodied in Stapledon's *Star Maker* or in a variety of other superior beings. Throughout it all, one also sees the terrestrial theme of good versus evil played out across the universe. During the second half of this century, the career of the alien dramatically accelerated. Along with the elaboration of old themes and the invention of new ones, there was an increasingly intimate relationship between science and science fiction. Not only did scientists more frequently use fiction to speculate about alien contact, but science fiction also influenced many who actually became involved in scientific programs to search for extraterrestrials [21]. The scientifically informed alien fiction of Arthur C. Clarke, Fred Hoyle, Stanislaw Lem, Hal Clement and Carl Sagan, among others, lent a credibility to the subject that it had not had in the first half of this century [22].

In the emotionally intense and visually stunning media of cinema and TV, the alien followed an evolution similar to its development in science fiction, progressing from the unsophisticated aliens of early 1950s films to the mature and mysterious aliens in Arthur C. Clarke and Stanley Kubrick's *2001: A Space Odyssey*. In the late 1960s, the primary mission of the starship Enterprise in the popular TV show "Star Trek" was to seek out new civilizations. In the 1970s, aliens played central, if very different, roles in the *Star Wars* trilogy (1977–1983) and in *Close Encounters of the Third Kind* (1977). In the 1980s, the movies *ET* and *Alien* evoked powerful emotions in representations of alien nature that, once again, were at opposite extremes. Evidence of the appeal of the alien theme is provided by the fact that *ET* was one of the most popular films of all time.

Close Encounters elaborated an idea of the alien that was pervasive in popular culture: that of the UFO, which eventually led to an incredible spinoff in the form of the alien abduction craze. Although the first wave of UFO sightings came in 1897—the year that the novels of Wells and Lasswitz appeared—the alien was only a minor theme in these fictions and the UFO question remained dormant for 50 years. I find it an amazing historical fact that, while Lowell's canal controversy raged over the decade following 1897, the UFO controversy did not. Even while invading spaceships were the occasional subject of the developing science fiction of the time, no one seriously suggested that they were really in the skies of planet Earth. Only in the post–World War II era of nuclear uncertainty, beginning in 1947, did UFOs catch on and embark on a career that has now lasted for 50 years. In my opinion, this is a clue to their real nature, which is most probably to be found in the human mind rather than in an objective (much less an extraterrestrial) reality.

EXTRATERRESTRIAL LIFE AS WORLDVIEW

The extraterrestrial life debate has had an overarching influence that transcends both science and popular culture and goes even beyond the concept of cosmic evolution. The idea that abundant life exists in the universe is more than another theory or hypothesis; it is sufficiently comprehensive to qualify as a worldview. Since, according to SETI advocates, it is testable, it is a scientific worldview perhaps best described as a cosmology. Because it combines the characteristics of the biological universe with those of the physical universe, it may most accurately be termed the "biophysical cosmology" [23].

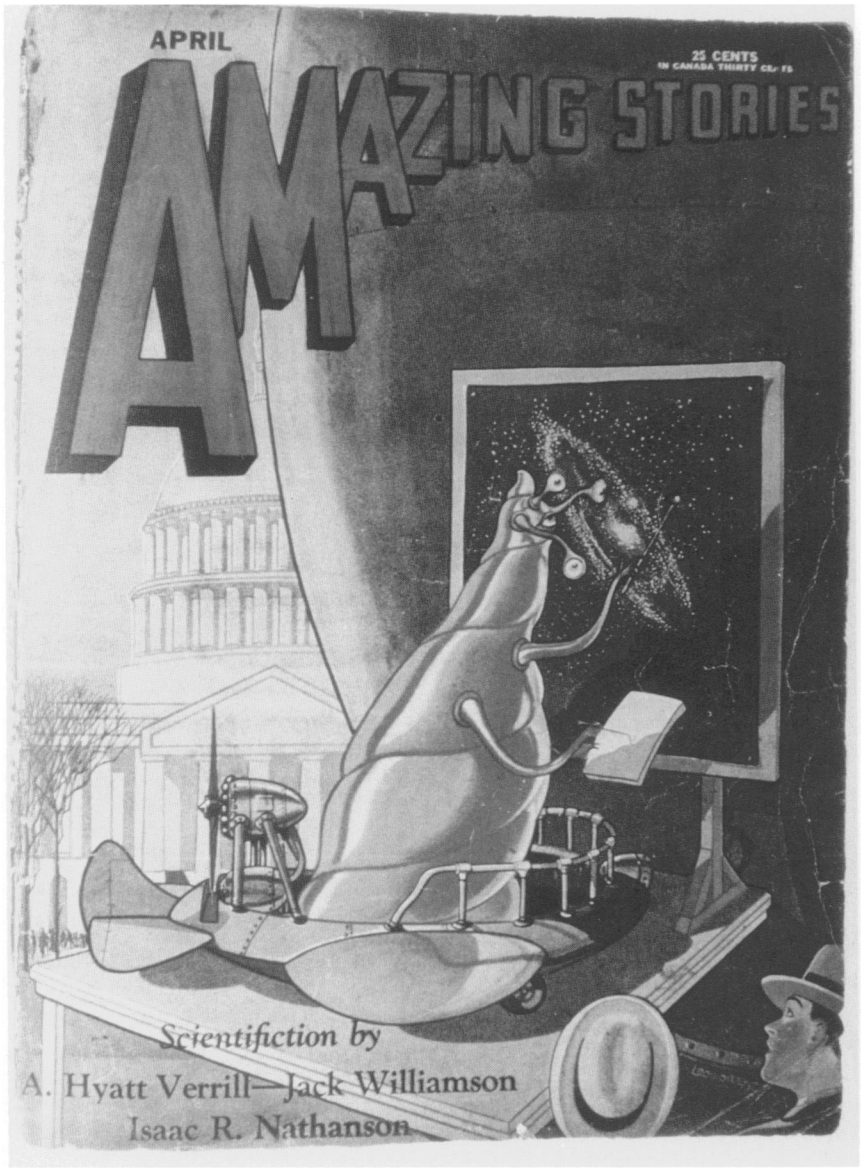
Like other cosmologies, the biophysical cosmology makes claims about the large-scale nature of the universe: most importantly, it claims that life is one of its basic properties. Adherents believe that life is not merely an accidental or incidental property of the universe, but an essential one. The biophysical cosmology incorporates many assumptions, not least that life is an inevitable outcome of cosmic evolution. SETI pessimists emphasize that life is unlikely to have evolved elsewhere in the universe. Some evolutionary biologists, including Ernst Mayr at Harvard, agree, but others, including Mayr's Harvard colleague Stephen Jay Gould, concede only that *humanoid* life is unlikely throughout the universe [24]. One of the cultural effects of the ETI debate is therefore that it brings to the fore this argument over the contingency of life, as well as many other fundamental themes.

Like all cosmologies, the biophysical cosmology redefines the place of humanity in the universe; it is in this biological sense that the extraterrestrial life debate may be seen as the last battle over anthropocentrism. This battle is evident in discussions of the elegantly misnamed "anthropic principle"—the idea that the universe is so finely tuned that it must be made for man. In my view, this concept is really an extension of the "biocentric principle" enunciated by Harvard biochemist L.J. Henderson in 1913 in connection with the fitness of the environment for life [25]. The argument that the universe is fit for life is really an argument in favor of extraterrestrial life, and only by using other arguments can the biocentric principle be converted to an "anthropic" one, as it has been in the work of physicists J.D. Barrow and Frank Tipler [26]. In my

view, we need to separate the idea that life is bound up with the fabric of the universe from the idea that mankind is central; in other words, a biocentric principle makes sense to me and an anthropic principle does not.

Finally, in speaking of ETI as worldview, I should mention its impact on religion and theology—an impact that has very deep roots in the Western tradition. The problem was recognized already in the fifteenth century, in relation to the reconciliation of Christianity with the Aristotelian doctrine opposing a plurality of worlds. By that time, most Christian theologians agreed that God could create other worlds. But if this were the case, they wondered "whether Christ by dying on this earth could redeem the inhabitants of another world." The standard answer was that he could, because Christ could not die again in another world [27]. For Copernicans of any religious persuasion, the problem was a thorny one that extended beyond specific religious doctrine. Despite Scriptural objections raised during the seventeenth century, by the early eighteenth century the concept of extraterrestrial life was incorporated into natural theology. In a history that should interest those studying the theological implications of an actual discovery of extraterrestrial intelligence, during the nineteenth century some theologians rejected Christianity, others rejected the plurality of worlds and still others found ways to reconcile the two [28].

Fig. 2. Leo Morey, cover of the April 1930 issue of *Amazing Stories* magazine. The illustration embodies the ambiguities of the concept of alien contact: although it appears to show an alien teaching us the secrets of the Galaxy, it was used to illustrate a story entitled "The Conquest of Earth," by Isaac R. Nathanson. From Lester del Rey, *Fantastic Science Fiction Art, 1926–1954* (New York: Ballantine, 1975). *AMAZING Stories* is a registered trademark of TSR, Inc.



During the twentieth century, theological explorations of the implications of extraterrestrial contact have been sporadic, peripheral and never raised to quite the same level of substantial debate as in the previous two centuries. Nevertheless, in Christianity, the doctrine of Incarnation has remained a central focus of discussion and the consensus has been that a discovery of intelligence beyond the Earth would not prove fatal to the religion or its theology. The most substantial theological discussion of the subject was given by the Roman Catholic priest Kenneth Delano in his book *Many Worlds, One God* [29]. The author's position was that any person with a religious faith that included "an adequate idea of the greatness of God's creative ability, of humanity's humble position in the universe, and of the limitless love and care God has for all His intelligent creatures" should not be afraid to examine the implications of intelligence in the universe. Delano quotes with approval Alice Meynell's lines:

> in the eternities
> Doubtless we shall compare together, hear
> A million alien Gospels; in what guise
> He trod the Pleiades, the Lyre, the Bear [30].

Although Delano made it clear that Catholic opinion was not unanimous, he certainly reinforced the prevalent idea in Church doctrines of flexibility toward a discovery of extraterrestrials. The same flexibility was expressed in a study of religious implications of the problem for other religions [31]. However, this flexible attitude of the world's religions toward extraterrestrials was not shared by some external to those religions, who predicted that the world's religions would not be able to survive extraterrestrial contact [32]. This is obviously a subject in need of much further debate.

PROSPECT

It is clear that we have only touched the tip of the iceberg in discussing the cultural significance of the extraterrestrial life debate. Given the passionate debate inspired by the mere possibility of extraterrestrials, one can only imagine the reaction to an actual discovery. Only within the last several years has a more serious interest arisen in the "cultural aspects of SETI" (CASETI). The most important effort has been a series of

workshops sponsored by NASA in 1991–1992, in which a group of about 20 historians, scientists, behaviorial scientists and government policy experts discussed the implications of an actual contact [33]. One of the many insights to emerge from these discussions was that, while historical analogues must be used with caution, they might still be very useful. In particular, the reception of worldviews such as the Copernican and Darwinian and the effects of cross-cultural terrestrial intellectual contacts (as opposed to physical cultural contacts) such as the transmission of Greek knowledge via the Arabs to Western Europe in the thirteenth century might well serve as guides to thinking about the effects of contact with extraterrestrial civilizations.

The nature of the reaction will undoubtedly depend largely on whether or not there is a receipt or exchange of information. Such an exchange is, of course, problematic, considering the distances involved and how different alien intelligence may be from ours. But if somehow message decipherment were possible, it would give new meaning to the long-sought goal of objective knowledge, as aspects of terrestrial and extraterrestrial intelligences were compared. The search for such knowledge—perhaps even for wisdom—has been one of the major themes of science fiction (Fig. 2) and remains one of the driving forces behind SETI.

In raising such hopes, we are indulging in an age-old search for our place in the universe. Our hope of finding extraterrestrials is, in a sense, ironic; as Rabbi Norman Lamm has written in this context, "Never before have so many been so enthusiastic about being so trivial" [34]. History has already prepared us to some degree for the discovery, to the extent that many would be surprised if intelligence were not found beyond the Earth. Still, nothing can prepare us totally for an actual discovery, compared to which the historical debate over possible extraterrestrials will probably have been a minor prelude.

References and Notes

1. Robert Plank, *The Emotional Significance of Imaginary Beings: A Study of the Interaction Between Psychopathology, Literature, and Reality in the Modern World* (Springfield, IL: Charles C. Thomas, 1968).

2. Alexander Wolszcan, "Confirmation of Earth-Mass Planets Orbiting the Millisecond Pulsar PSR B1257+12," *Science* **264** (1994) pp. 538–542. C.R. O'Dell, Zheng Wen and Xihai Hu, "Discovery of New Objects in the Orion Nebula on HST Images: Shocks, Compact Sources and Protoplanetary Disks," *Astrophysical Journal* No. 410 (1993) pp. 696–700.

3. For an overview of SETI programs and related research, see G. Seth Shostak, ed., *Progress in the Search for Extraterrestrial Life* (San Francisco, CA: Astronomical Society of the Pacific, 1995).

4. John E. Mack, *Abduction: Human Encounters with Aliens* (New York: Charles Scribner's Sons, 1994).

5. Michael J. Crowe, *The Extraterrestrial Life Debate, 1750–1900: The Idea of a Plurality of Worlds from Kant to Lowell* (Cambridge, U.K.: Cambridge Univ. Press, 1986); Steven J. Dick, *Plurality of Worlds: The Origins of the Extraterrestrial Life Debate from Democritus to Kant* (Cambridge, U.K.: Cambridge Univ. Press, 1982); Karl S. Guthke, *The Last Frontier: Imagining Other Worlds from the Copernican Revolution to Modern Science Fiction* (Ithaca, NY: Cornell Univ. Press, 1990); Stanley L. Jaki, *Planets and Planetarians: A History of Theories of the Origin of Planetary Systems* (Edinburgh: Scottish Academic Press, 1978).

6. See Steven J. Dick, "Plurality of Worlds," in N.S. Hetherington, ed., *Encyclopedia of Cosmology: Historical, Philosophical and Scientific Foundations of Modern Cosmology* (New York and London: Garland Publishing, 1992) pp. 502–512; and Steven J. Dick, *The Biological Universe: The Twentieth Century Extraterrestrial Life Debate and the Limits of Science* (Cambridge, U.K.: Cambridge Univ. Press, 1996).

7. Joseph S. Shklovskii and Carl Sagan, *Intelligent Life in the Universe* (San Francisco, CA: Holden-Day, 1966); Donald Goldsmith and Tobias Owen, *The Search for Life in the Universe* (Reading, MA: Addison Wesley, 1992).

8. Percival Lowell, *Mars* (London: Longmans, Green and Co., 1895).

9. S. Miller, "A Production of Amino Acids Under Possible Primitive Earth Conditions," *Science* **117** (1953) pp. 528–529; S. Miller and H.C. Urey, "Organic Compound Synthesis on the Primitive Earth," *Science* **130** (1959) pp. 245–251.

10. J.P.T. Pearman, "Extraterrestrial Intelligent Life and Interstellar Communication: An Informal Discussion," in A.G.W. Cameron, ed., *Interstellar Communication* (New York: W.A. Benjamin, 1963) pp. 287–293; F. Drake, "The Radio Search for Intelligent Extraterrestrial Life," in G. Mamikunian and M.H. Briggs, eds., *Current Aspects of Exobiology* (Oxford, U.K.: Pergamon Press, 1964) pp. 323–345.

11. Steven J. Dick, "The Search for Extraterrestrial Intelligence and the NASA High Resolution Microwave Survey (HRMS): Historical Perspectives," *Space Science Reviews* **64** (1993) pp. 93–139; J. Billingham and J. Tarter, "SETI," in J. Rummel, M. Ivanov and V. Kotelnikov, eds., *Space Biology and Medicine*, Vol. 1 (Washington, D.C.: American Institute of Aeronautics and Astronautics, 1993).

12. C.P. Snow, *The Two Cultures and the Scientific Revolution* (Cambridge, U.K.: Cambridge Univ. Press, 1959).

13. Peter Van de Kamp, "Astrometric Study of Barnard's Star from Plates Taken with the 24-inch Sproul Refractor," *Astronomical Journal* **68** (1963) pp. 515–521.

14. J.A. Hynek, *The UFO Experience: A Scientific Inquiry* (Chicago, IL: Henry Regnery, 1972).

15. D.H. Menzel, *Flying Saucers* (Cambridge, MA: Harvard Univ. Press, 1953); D.H. Menzel and E.H. Taves, *The UFO Enigma: The Definitive Explanation of the UFO Phenomenon* (New York: Doubleday, 1977).

16. Crowe [5] and Guthke [5].

17. "Radio to Stars, Marconi's Hope," *New York Times* (20 January 1919) p. 1; Steven J. Dick, "Back to the Future: SETI Before the Space Age," *The Planetary Report* **15**, No. 1, 4–7 (1995); Nikola Tesla, "Talking with the Planets," *Collier's Weekly* **26**, No. 19 (1901) p. 4.

18. D.H. Menzel, "Can We Signal Mars by Shortwave? The Possibility of Interplanetary Communication," *Shortwave and Television* **406** (1937). Hugo Gernsback was the editor of the magazine, and the quotation is from his brief editorial comment.

19. H.G. Wells, *The War of the Worlds* (serialization, 1897; book, 1898) in *Seven Science Fiction Novels of H.G. Wells* (New York: Dover, 1934); K. Lasswitz, *Two Planets*, Hans H. Rudnick, trans. (Carbondale, IL: Southern Illinois Univ. Press, 1971).

20. *A Princess of Mars*, published in novel form in 1917, was the first of Burroughs's John Carter series, with *The Chessman of Mars* (1922) and *The Swords of Mars* (1936) considered among the best. Three of Olaf Stapledon's works especially embrace the alien theme: *Last and First Men* (1930), *Star Maker* (1937) and *The Flames* (1947). Modern editions of *Last and First Men* and *Star Maker* have been published (New York: Dover, 1968). Ray Bradbury's *The Martian Chronicles* (New York: Doubleday, 1970) was first published in 1950; C.S. Lewis's *Out of the Silent Planet* (New York: Macmillan, 1965) was first published in 1938.

21. David W. Swift, *SETI Pioneers* (Tucson, AZ: Univ. of Arizona Press, 1990).

22. Among the classics of these science fiction writers emphasizing the alien theme are Arthur C. Clarke, *The City and the Stars* (New York: Harcourt, 1956), *Childhood's End* (New York: Ballantine, 1953), *Rendezvous with Rama* (New York: Ballantine, 1973) and *2001: A Space Odyssey* (New York: New American Library, 1968); Fred Hoyle, *The Black Cloud* (New York: Harper, 1957); Stanislaw Lem, *Solaris* (New York: Berkeley Publishing, 1970); Hal Clement, *Mission of Gravity* (Garden City, NY: Doubleday, 1954); and Carl Sagan, *Contact* (New York: Simon and Schuster, 1985).

23. Steven J. Dick, *The Planetary Report* **9** (1990) pp. 13–17.

24. Stephen Jay Gould, "SETI and the Wisdom of Casey Stengel," in *The Flamingo's Smile: Reflections in Natural History* (New York: Norton, 1985); E. Mayr, *The Growth of Biological Thought: Diversity, Evolution and Inheritance* (Cambridge, MA: Harvard Univ. Press, 1982) pp. 583–584; E. Mayr, "The Probability of Extraterrestrial Intelligent Life," in Edward Regis, Jr., ed., *Extraterrestrials: Science and Alien Intelligence* (Cambridge, U.K.: Cambridge Univ. Press, 1985) pp. 23–30.

25. L.J. Henderson, *The Fitness of the Environment* (Cambridge, MA: Harvard Univ. Press, 1913).

26. J.D. Barrow and F. Tipler, *The Anthropic Cosmological Principle* (Oxford, U.K.: Oxford Univ. Press, 1986).

27. Steven J. Dick, [5] Chapter 2 and pp. 43, 88, 198 (note 48); Grant McColley and H.W. Miller, "Saint Bonaventure, Francis Mayron, William Vorilong, and the Doctrine of a Plurality of Worlds," *Speculum* **12** (1937) p. 388.

28. Crowe [5] and Dick [5].

29. K. Delano, *Many Worlds, One God* (Hicksville, NY: Exposition Press, 1977).

30. Alice Meynell, "Christ in the Universe," *Poems* (New York: Charles Scribner's Sons, 1913).

31. M. Askenazi, "Not the Sons of Adam: Religious Responses to ETI," *Space Policy* **8** (1993) pp. 341–350.

32. Roland Puccetti, *Persons: A Study of Possible Moral Agents in the Universe* (London: MacMillan, 1968).

33. J. Billingham et al., "Social Implications of Detecting an Extraterrestrial Civilization: A Report of the Workshops on the Cultural Aspects of SETI," *SETI Institute Preprint* (Mountain View, CA, 1994).

34. N. Lamm, "The Religious Implication of Extraterrestrial Life," in A. Cannell and C. Domb, eds., *Challenge: Torah Views on Science and Its Problems* (New York: Felheim Publishers, 1978).