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EXPLORING MARS: SOME “LESSER” PHILOSOPHICAL IMPLICATIONS

George Smith

geosmith@msn.com

ABSTRACT

Discovering a “second genesis” of life on Mars would have a momentous philosophical implication: that we inhabit a biological universe. But a number of “lesser” philosophical implications—or perhaps psychological ramifications—arise from Mars exploration as it is now proceeding: (i) the psychic colonization of Mars; (ii) the irresistibility of comparative planetology; and (iii) the expansion of our time-frame. Collectively, these ramifications lead to a heightened awareness that just as Earth is not privileged with respect to space (the Copernican Revolution), neither is it privileged with respect to time, i.e., it cannot be an abode of life indefinitely. It is something of a mystery that this heightened awareness of Earth’s finitude does not carry more philosophic weight in our 21st century world views. But it is clear that this heightened awareness can be considered both a philosophical implication of Mars exploration, and a motivator for further exploration of the planet.

A. THE SECOND GENESIS SCENARIO

Imagine that a microbe is discovered beneath the Martian surface in the near future. Further assume that careful chemical analysis produces clear and convincing evidence that this Martian life has had a separate origin from Earthlife. This is the much-heralded “second genesis” scenario, and its repercussions would be enormous.

Learning that prebiotic material has developed into living organisms at least twice, in our tiny corner of the universe alone, would suggest overwhelmingly that the process has occurred countless times in countless places, and that our universe is veritably rife with life. We would thus have an answer to a question which some believe is the single most overarching question of our time. In his Dibner Library Lecture in May, 2000, Steven J. Dick argued that our time is marked by two mutually-exclusive cosmologic world views, just as the 17th century was marked by the competition between geocentric and heliocentric cosmological world views. In our time, according to Dick, the overarching question is whether cosmic evolution ends in planets, stars, and galaxies, or whether it commonly ends in life, mind, and intelligence. In short, do we inhabit a physical universe, or a biological universe? If Mars exploration were to reveal a second genesis, the discovery would usher us irreversibly into a biological universe.

There are modes of understanding that seem so fundamental and far-reaching that we instinctively reach for a sonorous German word to capture the gravity of the occasion. Dick suggests *weltanschauung*, typically translated as “world view.” A *weltanschauung* is not merely an intellectual perception, but a framework that shapes the questions we ask and the actions we find worth doing. Cosmological/scientific ideas, according to Dick, are and should be at the apex

of a hierarchy of ideas that shape the *weltanschauung* that we in effect “live within”. Understanding that we live in a biological universe, in other words, would matter a great deal.

No doubt it would take some time for the idea that we inhabit a biological universe to fully infuse itself into our views of the world and ourselves. On the other hand, one can imagine some relatively quick reactions. Those who have subscribed to the view that life on Earth is probably a freakish and unique accident of chemistry would slip into an uncertain silence. Religious believers would passionately debate the implications, but most would probably move fairly quickly to accommodate the new knowledge. SETI (Search for Extraterrestrial Intelligence) researchers, smiling ear to ear, would begin busily preparing new funding proposals. And that mundane human experience of gazing up at a skyful of stars on a clear night would be subtly but irrevocably changed. The sense of quiet wonder and awe in the face of immensity would doubtless still be there. But mixed in with the familiar thoughts and sensations would be traces of a strange new feeling—an abstract and indefinable sense of relatedness.

B. BUT WHAT IS A “PHILOSOPHICAL IMPLICATION”?

This paper is mainly concerned with implications of Mars exploration that fall short of the second genesis scenario, implications which are less earthshaking, more understated. They are implications which enter into the prevailing *weltanschauung* far less dramatically, but help shape it nonetheless. Before discussing them, let’s first explore some possible meanings of that much-used but seldom-analyzed phrase, “philosophical implications.” Some might find this an overly abstract, sterile exercise. But if “philosophical implications” has been elevated to one of the categories of presentations at this conference, it deserves at least brief analysis. What do we really mean by this phrase”?

The “implications” part is fairly easy. We are concerned with what follows from or is implied by the results of Mars exploration. The harder part is the “philosophical.”

Conceivably, “philosophical implications” might mean implications for philosophy itself, in the way that “health implications” can be shorthand for “implications for health.” In a trivial sense, this would be quite plausible. One traditional view of philosophy is that it means rational investigation of, among other things, “natural philosophy”, i.e., the physical sciences. Discovering new things on Mars would add to the breadth and richness of our “natural philosophy,” and in this sense have philosophical implications.

But in non-trivial senses, it is less plausible to think that philosophy itself would be altered by whatever we learn from Mars exploration. Definitions of philosophy are many and varied, but often they boil down to this: systematic inquiry into fundamental aspects of the nature of reality (metaphysics), the justification of belief (epistemology), and the conduct of life (ethics). Even if Mars exploration produces wondrous results, it’s difficult to imagine that such results—which after all amount to empirical findings—could significantly alter our ongoing pursuit of metaphysical, epistemological, and ethical inquiry. Philosophically-inclined geologists poking around beneath the regolith of Mars, or for that matter of an extrasolar planet could they get there, would still have traditional questions of metaphysics, epistemology, and ethics to contend with, and to apply to their broadened empirical/observational realm.

So let's put aside the possibility that "philosophical implications" means implications for philosophy itself, and shift to the more plausible view that it means implications that are "philosophical" in nature. There is bad news and good news here. The bad news is that dictionaries will not be authoritative guides, because they reveal that "philosophical" has a proliferation of meanings/usages. The good news is that this frees us up to propose a set of meanings/usages that most accurately reflects what we mean when we speak of implications of Mars exploration that are "philosophical" in nature. Following are three plausible meanings:

- Extremely general: Mars exploration—and scientific-driven exploration generally—is highly detail-oriented. The knowledge gained from such exploration represents an accumulation of details over time. In contrast, the philosophical implications of such exploration work at a level of great generality. Sometimes they are in the nature of very large and sweeping "theories" or "hypotheses", and in such cases could be viewed as part of the scientific process itself.
- Human-centered: Mars exploration is primarily about Mars. Science in general casts a cold eye on all aspects of the physical world, including those with little relevance to human affairs. Philosophical implications, in contrast, are typically linked with human life, human "destiny," and human psychology. They often relate to a long-term vision of where we've come from, where we're going, and how we fit into the larger scheme of things.
- Related to "Why?": Science is masterly at explaining the "How?" questions in rich, quantifiable detail. But certain fundamental "Why?" questions, or questions of "purpose," are beyond its purview. These questions—typically non-quantifiable—take us into the realm of philosophy. Of course they also take us into the realm of religion, which articulates fairly detailed and elaborate answers to "Why?" questions. But philosophy, too, ventures into the realm of ultimate meaning and purpose.

Since each of the above captures something important, let's compound them and posit that philosophical implications of Mars exploration are *implications that are very general in nature, connected to human concerns, and often relevant to "why" questions*.

As a test of the adequacy of this working definition, how well does it accommodate the gold standard for a philosophical implication—the "second genesis" scenario? Concluding that we live in a biological universe rather than a physical universe would unquestionably be in the nature of a massive generalization. Secondly, it would connect to human concerns rather strikingly, by telling us that our biological essence is widespread in the universe, and moreover that there may even be alien intelligences out there to keep us "company" in the universe. Thirdly, it would be relevant to "why" questions, at least indirectly. The biological universe would not tell us anything specific about the purpose/destiny of humans or life in general. And in fact it might even weaken the notion that we have the higher purpose of stewarding or disseminating life. But at the very least the biological universe would require many traditional accounts of purpose or destiny—e.g., certain religious accounts—to make accommodations or reinterpretations.

Thus, the working definition of “philosophical implications”—implications that are very general in nature, connected to human concerns, and relevant to “why” questions—does indeed seem adequate in the case of the “second genesis” scenario.

C. THREE “LESSER” PHILOSOPHICAL IMPLICATIONS

We will now turn to some other philosophical implications of Mars exploration, ones I have termed “lesser” because they appear to be less dramatic and earthshaking than the “second genesis” (or “biological universe”) scenario. These “lesser” implications arise in a different way. Whereas the “biological universe” implication would burst dramatically into view in the wake of particular empirical findings, these “lesser” implications are understandings that gradually insinuate themselves into our minds as Mars exploration proceeds. They might more accurately be termed “philosophical/psychological ramifications” of Mars exploration. But they do indeed belong in this discussion, because they fit the working definition of “philosophical implications” that we arrived at above: implications that are very general in nature, connected to human concerns, and often relevant to “why” questions.

1. Psychic Colonization

We began colonizing Mars in the 1970s. A secure base was not established until the Pathfinder mission bounced down onto the surface in 1997. The human presence on the planet was considerably expanded in 2004 with the launch of the Mars Exploration Rovers, Spirit and Opportunity. We’ve now established bases both at Gusev Crater and at Meridiani Planum.

We’ve begun to amass a library of remarkable images of the red planet. The non-optical measurements of Mars may be of equal or greater scientific value, but the visual images have allowed us to psychically colonize the planet. They present us with a world of Arizonan outcroppings, whirling dust devils, pattered sand dunes, and a truly grand canyon. For many of us, the red-rubble landscapes of Mars are as real as the icy-white landscapes of Antarctica.

The probe’s-eye views from the Martian surface are particularly powerful. They bring us right down into the landscape, presenting us with views we would see if we were there. Unlike the stark shadow-and-illumination of the lunar surface, on Mars we recognize a sky, a horizon, and sometimes a setting sun on the horizon. The odd combination of the exotic and the familiar exerts a particular hold on many of us.

Granted, our experience of Mars is a rather thin, uni-sensory visual experience, devoid of sounds, smells, tastes, and direct physical impressions. On the other hand, Mars is such a fiercely inhospitable place that direct physical impressions are for the most part inconceivable. Ironically, the visual images—especially without any space-suited human explorers in the picture to remind us of the physical inhospitableness—may lull us into thinking we are more at home on Mars than we really could be.

Our psychic colonization of Mars is very different from our imaginary appropriation of fictional landscapes in literature or film. With fiction, we enter into a collaborative pact with the creator. We supply a willing suspension of disbelief, and in return expect the artist to supply a narrative

structure, rich imagery, and characters like ourselves. With Mars images, suspension of disbelief does not even occur to us, because we self-evidently are viewing the world of drab, unadorned factuality. Bleak rocky landscapes extend to the horizon. The sheer monotony reminds us that this is not a fiction, not a virtual creation, but a very real, “mundane” place. In fact, this is a world so devoid of characters and narrative structure that our imaginative impulses begin to take over, and we begin to personalize robotic rovers and even the rocks they inspect. However, this is a lighthearted game, played out with the deeper understanding that Martian landscapes have little to do with fiction or fantasy.

We carry out our psychic colonization remotely, from a safe and comfortable distance. This is of course quite different from what we can surmise will be the intense personal experiences of the first human explorers on Mars. We are necessarily insulated from much of the reality of real human presence on the Martian surface. Nonetheless, the vivid visual images exert an undeniable power over us. And how could we expect otherwise? With modern imaging and communication technologies, it has become a truism that visual images from places on the far side of Earth can powerfully effect how we emotionally connect with such places. The vivid images from Mars have an analogous effect. They gradually creep into our consciousness, draw us into the Martian landscape, and bring home to us the reality of another world. They help us to start taking psychic possession of Mars, to start “owning” its landscapes. As we repeatedly view the landscapes, it becomes progressively easier to imagine ourselves actually there. Psychologically, we are already becoming a dual-planet species.

2. Comparative Planetology

This inelegant mouthful of syllables—comparative planetology—conjures up a powerful idea: to understand our own planet, we compare it to others. We need to understand the geologies, atmospheres, and origins of other worlds if we’re to understand Earth.

Comparative planetology is Janus-faced: It simultaneously looks outward to examine other worlds, while looking inward to understand Earth. On the one hand, it seems to embody an expansion outward, a move into new territory. On the other hand, it ultimately is a devotion to “context”, and to learning how local circumstances fit into a much larger fabric. Extroversion and introversion are the two sides of this coin.

Comparative understanding is practically irresistible. We can analyze a single phenomenon or single system and come to a fairly sound understanding of its structure and how it works. But when we encounter what appears to be another, related phenomenon or system, we sense an opportunity to jump up a notch to a higher level of understanding. With two or more instances, we can move to a level of abstraction from which we begin to detect more fundamental forces that shape the particular phenomena or systems.

Comparative learning forces threshold judgments about precisely what two situations are worthy of comparison. Reasonable people disagree about what sorts of comparisons are most productive. To deeply understand the culture of modern Japan, is it more useful to compare/contrast Japan with the West, or with China? Comparative learning forces a threshold intuitive judgment about the mix of similarities and differences that will afford the richest basis for comparison.

Mars is proving to be a rich object for productive comparison with Earth. The two planets are terrestrial planets (i.e., solid, not gaseous), possess atmospheres, and are roughly similar in size and in proximity to the Sun. These basic similarities provide a solid framework for an analysis of the elaborate ways in which Mars and Earth differ. Of course, plenty of other useful comparative frameworks present themselves to planetary scientists and astronomers. Studies of Venus have been important in learning about the connection between chlorofluorocarbons and the ozone layer on Earth. Even Saturn's moon Titan, given its size and the chemical composition of its atmosphere, provides a framework for useful comparison with Earth. Moreover, the recent discoveries of extrasolar planets have drastically expanded the scope of comparison, leading us to compare entire planetary systems with our own solar system. But Mars remains temptingly close, and temptingly similar to Earth in basic ways. And we've barely begun to flesh out all the points of useful comparison/contrast. One can roam far and wide, but a case can be made that when it comes to productive comparative planetology, there's no place like Mars.

3. Stretching the Time-frame

Serious geologists either develop a special imaginative capacity, or become geologists because they possess it already: the ability to grasp timescales that are simply too large for most of us to meaningfully wrap our minds around. The same could be said of paleontologists, and perhaps anyone whose interest in "natural history" leads them to a detailed imagining of what Earth was like eons ago.

Mars exploration turns us all into imaginative geologists. The Martian landscape—almost Arizonan in some respects, and yet utterly different—forces the question, Why is Mars so un-Earthlike? We answer this question in the only way that seems plausible to us—by fast-backwarding into the respective geologic pasts of Mars and Earth. We assume the physical processes of erosion, warming, cooling, sedimentation, etc. work in similar ways, i.e., that the same basic laws of physics apply, albeit under differing conditions. And then we embark on the massively complex detective mission of finding out how these basic physical processes produced such different results in planets that are virtual neighbors in the solar system. We very quickly move all the way back to the origins of the respective planets, and speculate about the role of basic parameters such as planetary size and position relative to the Sun, and how these in turn may determine geothermal characteristics which in turn effect possibilities of volcanic activity, atmospheric conditions, etc.

True, people can and do become imaginative geologists without thinking about Mars. For some, a hike down into the primordial bedrock of the Grand Canyon forces a confrontation with vast timescales and ancient origins. For someone like writer John McPhee, author of *Annals of the Former World*, the mere sight of a blasted outcropping beside an interstate highway is probably sufficient. But for many of us, it takes a scene as dramatic and otherworldly as the Martian landscape to nudge us into the vastly expanded perspective of geological time.

The Martian landscape stretches our time frame in a new and compelling way. The Grand Canyon gives us isolated, suggestive clues, and asks us to imaginatively reconstruct an "exotic" Earth as it was eons ago. In contrast, a glimpse of the Martian landscape takes us directly into an "exotic" world in the present, an intact world with its own global integrity and coherence. The

Martian landscape challenges us to imaginatively reconstruct the combination of forces and processes, working over eons, that produced the strange planetary landscape that presents itself whole before our eyes. Perhaps this encounter with an “exotic” landscape that is nevertheless real and present before us acts to demystify the very notion of the “exotic”—to take some of the strangeness out of it. As a result, our heretofore hazy vision of an ancient, “exotic” planet Earth comes to seem more plausible, more real.

In trying to understand why Mars is so un-Earthlike, all roads lead quickly to the distant past. Why is Mars so much dryer than Earth? One hypothesis is that eons ago Mars was much more watery, but because of its relatively low mass and thin atmosphere, it gradually lost its oceans to evaporation. Another hypothesis—advanced recently by Jonathan Lunine at the University of Arizona—is that Mars was originally a “planetary embryo” that grew to its present size via the agglomeration of smaller asteroids and comets, bodies not possessing the water-saturated nature of the larger planetary embryos that combined to form Earth. But both hypotheses force us to take an imaginary journey back to the very origins of Mars and Earth. Indeed, the distant past is the only place we can possibly go for a scientifically convincing account of the geologically disparate landscapes of Mars and Earth.

Space exploration devotees, like devotees of realistic science fiction, are well-practiced in taking great imaginative leaps backwards and forwards. But for those less experienced in these areas, the vision of the Martian landscape presents a great new launching pad for the imagination. Having been pulled back to the origins of Mars and Earth billions of years ago, we come away with a sense of time that has been imaginatively stretched. And within this more capacious time frame, we are more able to envision Earth as a changing and evolving system, a physical entity existing in the realm of duration, a place with an explainable birth and a predictable death.

D. THE TEMPORAL COPERNICAN SHIFT

This paper has a simple two-step thesis: (i) Mars exploration creates certain tendencies and reactions in us—namely the three phenomena referred to above as psychic colonization, comparative planetology, and stretching the time-frame. (ii) These three tendencies, collectively, have a certain further effect. Psychic colonization encourages the idea that we could physically inhabit another world. Comparative planetology and the related stretching of the time-frame combine to give us a sense of planetary evolution over time, a sense that Earth is changing over geologic time, and will eventually be drastically different. Collectively, these perceptions work to give us a heightened awareness that Earth cannot be an abode of life forever.

This awareness qualifies as a “philosophical implication” in terms of the working definition we are using. Granted, it arises from Mars exploration in a different manner than does the second genesis scenario, in which a single empirical finding would suddenly trigger what is essentially new knowledge. The implication we are now considering, in contrast, arises not from new empirical knowledge but rather from a heightened consciousness of what has been empirically known for some time. But if Mars exploration helps bring to the fore an awareness that has not yet fully “sunk in,” surely one could call the awareness an “implication” of Mars exploration. More importantly, a heightened awareness that Earth cannot be an abode of life forever does indeed have the three characteristics required by our working definition of philosophical

implication. First, it is obviously very general. Second, it concerns humans, who are obviously part of the living world. Third, it does indeed deal with “why” matters, because it raises immediate questions about the purpose or destiny of humanity: Are we meant to flourish with the Earth, then disappear with the Earth? Or are we meant to pass on, in some form, to some other place?

As a convenient shorthand, I will call this heightened awareness that Earth cannot be an abode for life forever a “Temporal Copernican Shift,” an obvious nod to the Copernican Revolution. The heliocentric model of Nicholas Copernicus, first cogently presented in his 1543 work, *The Revolution of Celestial Spheres*, represented a drastically different way of viewing Earth. The Copernican Revolution moved Earth from a position of privileged centrality, and repositioned it in orbit around the Sun. Such a radical readjustment naturally took many years to become widely accepted. Some resistance was ideological, i.e., was grounded in respect for the authority of the Church, or in allegiance to the views of Aristotle. Some was grounded in the sheer difficulty of overlooking the apparent evidence of the senses. Even the best astronomer of the late 16th Century—Tycho Brahe—could only come to a “compromise” position, according to which Earth orbits the Sun, but the rest of the planets orbit the Earth.

The Copernican Revolution removed our sense of spatial centeredness. Earth is now no longer at the center of things. We no longer harbor a sense of specialness connected to spatial dimensions. How about the time dimension? Is there a sense of temporal centeredness—a sense of specialness connected to time? Put differently, how would Earth, and Earthlife, seem less special with respect to the passage of time? An obvious response is that we would feel less special with respect to time if we just happened to exist now, but not indefinitely. We’d feel less special if we have an acute realization that Earth’s existence is just temporary. Whereas the Copernican Revolution took us off our pedestal with respect to space, the Temporal Copernican Shift—the heightened awareness that Earth cannot be an abode of life forever—takes us off our pedestal with respect to time.

And of course the Temporal Copernican Shift is based on sound scientific understandings. Everything we now know about stellar evolution tells us that our Sun is now in its middle age, and in another 4.5 billion years will approach old age. And as it does, it will swell up to a Red Giant, and in the process slowly but inexorably vaporize the Earth—or in any case render it utterly uninhabitable.

Interestingly, it often seems that this knowledge has not truly “sunk in” yet. We don’t seem to have truly processed its force and implications. We tend not to go about comparing ourselves favorably to the benighted folks of a hundred years ago who apparently assumed Earth would be an abode of life forever. But why not? Why isn’t the fact of Earth’s finite lifespan something that matters more to us? (By “us” I mean people in general, not space and astronomy buffs, who are often highly aware of the finitude of Earth and Earthlife.) In short, why isn’t the Temporal Copernican Shift as philosophically weighty a matter to us as the Copernican Revolution? The following discussion will suggest some possible answers, and in the process explore the nature of the Temporal Copernican Shift.

(1) *It's still too soon.* Perhaps we simply need more time for the Temporal Copernican Shift (TCS) to sink in. It took many years for the Copernican Revolution to be widely accepted. But our knowledge of stellar evolution derives from multiple lines of evidence that converged in the early/mid 20th Century, and thus has been with us for many decades. Moreover, we supposedly move at an accelerated pace today, hence might be expected to disseminate and process new knowledge relatively swiftly. Finally, wouldn't the Copernican Revolution have "softened us up" in a sense, i.e., lowered our resistance to another sobering revelation?

(2) *Too remote.* Who can really care about events billions of years in the future? While this has undeniable force, couldn't something closely analogous be said of the Copernican Revolution? Whether Earth is orbiting the Sun or vice versa has little practical significance in our everyday lives. Nonetheless, the shift to a heliocentric worldview was obviously of immense philosophic significance. Immediacy and practicality are not relevant to philosophic import, especially for thinkers and artists and others who supposedly have their radar sensitively tuned to large and often abstract perceptions and cultural shifts. Matters involving humanity's destiny or place in the universe, by their very nature, tend to be highly removed from everyday affairs. But this certainly does not mean they don't vitally shape our world views.

(3) *Earth's fate is actually unclear.* Between now and the Sun's end 4.5 billion years from now, various natural phenomena could threaten Earthlife: a hotter-burning sun, asteroids or comets, super-volcanic eruptions, Earth's passage through regions of denser interstellar dust. True, we really don't know. And when we stretch out the timescale, Earth becomes an extremely dynamic environment—one that's dangerously unstable from the viewpoint of Earthlife. But unknown complications of this sort do not change the underlying philosophical implications. The ultimate "deadline" of about 4.5 billion years remains. The possibility of dire threats to Earthlife before then should if anything further stimulate TCS, i.e., further heighten our awareness that Earth cannot be an abode of life forever.

(4) *Humanity will do itself in relatively soon anyway.* We won't be around that far in the future, so the eventual fate of Earth is somewhat moot. A surprisingly large number of people suspect we will render ourselves extinct long before natural processes threaten Earth. Human-induced environmental destruction and/or nuclear holocaust are oft-cited means to our end. Those who espouse such fears sometimes evince a general pessimism about humankind that seems related to a sense of our "fallen" nature. However, even if such fears were to be realized and we suffered major human-induced catastrophes, it is not clear they could entirely wipe out—to the point of outright extinction—a supremely flexible and adaptable high-tech species like *Homo Sapiens*. Harder to imagine still is that human-induced catastrophes would cause the extinction of all other life-forms on Earth, including various extremophile microbes already habituated to forbidding physical environments. If Earthlife is going to persist, then the larger context for experiencing TCS persists. Nevertheless—and perhaps ironically—it is probably true that anxiety about relatively near-term human-induced environmental disaster can be a distraction from confronting the unavoidable long-term environmental disaster that awaits Earth and Earthlife. This may indeed help keep TCS from sinking in.

(5) *TCS is too damaging to our self-esteem.* The Copernican Revolution pushed us off center stage in a deeply humbling way. We don't need another such blow, thank you. We may be

spatially located off in the corner of an unremarkable spiral galaxy. But at least we can tend our own little garden with dignity, confident it will be ours forever. Of course, one could also argue that being depedestalized once makes the experience less obnoxious the second time around. More importantly, we Copernicans seem to have rather quickly developed new pillars for our self-esteem. In particular, we take comfort and indeed pride in the notion that we are tough-minded seekers of the truth, willing and able to rid ourselves of pleasing self-deceptions. This can help inoculate us against willful denial of TCS, or fear that it would be too unsettling.

(6) *TCS derives from a particularly nasty, thoroughly unpalatable idea. Our own lovable Sun, provider of light, warmth, and energy, will eventually snuff us out? Being pushed off center stage is one thing; being asked to embrace an unspeakable irony is another. It's unthinkable!* We've developed a refined appreciation for "poetic justice", and in theory can appreciate the symmetry of the Sun as both life-giver and life-destroyer. But being right in the middle of this particular cosmic poem does indeed make its justice less palatable. However, the point noted above—that we find self-esteem and pride in resisting willful denial and accepting unpleasant realities—surely applies here too, and suggests that TCS is not resisted merely because it derives from an idea that is simply too abhorrent. Moreover, we've arguably had more than a little prior habituation to notions of cosmic final destruction: Armageddon, the Apocalypse, and other accounts that in one form or other incorporate final cataclysmic battles and World-ending violence have long been part of our eschatological thinking.

(7) *TCS doesn't allow us the satisfaction of taking on the authorities, even symbolically. The Copernican Revolution required a courageous resistance to established authorities: the Church, Aristotle, Common Sense. But with TCS, what resistance is there to overcome?* It's true that no modern authorities, ecclesiastical or otherwise, are heavily invested in the notion of Permanent Earth. And as noted, traditional notions of Armageddon and the Apocalypse may even align with—if only impressionistically—modern scientific accounts of stellar evolution. In the case of TCS, therefore, we can't enact a struggle between enlightenment and entrenched authority, at least not as heatedly as was possible 450 years ago. On the other hand, TCS still must grapple with the authority of CommonSense, given that it asks us to try to identify with vast timescales. More to the point, even if a relative dearth of overt resistance tends to keep TCS relatively low-profile, the underlying issue—our heightened awareness that Earth is not temporally privileged—certainly remains with us.

(8) *TCS burdens us with a program of action. The Copernican Revolution didn't suggest anything specific about the future fate of humankind. But TCS does, so inevitably we're faced with the burden of imagining what can be done.* True, once we've been pushed off center stage by the Copernican Revolution, no obvious course of action presents itself. Induce the Sun to orbit Earth? Locate the cosmic center and try to get there? No, we simply make a mental adjustment, and carry on as before. But TCS, in contrast, implies something specific about our long-term future, and to this extent does suggest the beginnings of a program. At the very least, it conjures up a scenario in which Earthlife might outlive Earth. If so, what would we do? Where would we go? Nevertheless, it's not likely that many people—even those who consider such scenarios and wonder about these questions—would experience them as a present burden, one to be resisted. Moreover, even if TCS does conjure up a potential program of action, to this extent it at least provides us with an unburdening suggestion that we conceivably could devise an "out" to

the long-term predicament Earthlife may face. Such scenarios have indeed been imagined. For instance, in an exhilarating essay titled “Astrophysical Engineering and the Fate of the Earth” (in *Islands in the Sky*, John Wiley & Sons, 1996), Martyn Fogg explores how an advanced future civilization of astrophysical engineers might “pluck Earth from the Sun’s flames and preserve the planet intact as an abode of life long after its parent star has died.” Fogg sketches out three basic possibilities: “Earth Shift,” i.e., relocation of Earth to a place farther from the Sun; “Star Lifting,” i.e., tampering with the Sun so as to increase its life span; and “Solar Exchange,” i.e., hitching our Earth to a much younger star. Fogg’s essay is breathtaking in scope, and features some moving lyrical touches. But it’s not for the speculatively-challenged.

(9) *TCS lacks visuals. Nothing about it lends itself to pictures or diagrams. It fails to hit home because it remains a mere abstraction.* It’s certainly true that a spatially-based debate such as that between geocentrists and heliocentrists can be visualized in rich detail by means of drawings, charts, and even three-dimensional models representing heavenly bodies. And granted, we can’t similarly visualize something as abstract as a sense of Earth’s finitude. However, if a visual image is the classic way to represent spatial phenomena, we also have at our disposal the classic way to represent temporal phenomena: the story. A narrative—i.e., a series of events in temporal succession—is among other things a framework for experiencing and identifying with the passage of time. What sort of narrative must we create to emotionally connect with TCS? Given that the main characters are Earth and Sun, for starters we need a story that plays out over an extremely long time-frame, one vastly longer than the time-frame that circumscribes our daily human lives. This, of course, is why the “stretching the time-frame” associated with Mars exploration helps induce TCS. Stretching the time-frame helps us develop a narrative frame capacious enough to accommodate the story of Earth. In an interview, E.O. Wilson has remarked that, “We need to create a new epic based on the origins of humanity... It is just an amazing epic. If we somehow can formulate it correctly and honestly, it could be as inspiring as anything that traditional mythology now offers us.” One of the things that such a long-range view of the human past might inspire, of course, is a long-range view of the human future.

E. CONCLUSIONS

It is not clear why something as fundamental as what is herein called the Temporal Copernican Shift—an awareness that Earth is not specially privileged with respect to time—does not loom larger as a philosophical implication of modern scientific knowledge. Some combination of the factors discussed above is probably in play.

But what does seem clear is that Mars exploration acts to promote the Temporal Copernican Shift. Our tendency to use images from the Martian surface to psychically colonize the planet habituates us to the notion of living somewhere other than Earth. Our instinct to compare Mars with Earth induces us to move back and forth vast distances in time, stretching out our time-frame. This in effect expands our “narrative framework,” thereby helping to make it large enough to accommodate the story of Earth—from birth to death. The end result is the tendency to become increasingly conscious that Earth cannot be an abode of life forever.

Finally, it also seems clear that a “bootstrapping” effect is at work here: Mars exploration not only heightens the awareness of Earth’s finitude, but in turn is encouraged by it. For how can

someone with a heightened awareness that Earth will not be a home for life forever fail to grow curious about whether and how humanity and other forms of Earthlife might learn to live elsewhere?