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Toward an Ecological and Cosmonautical Philosophy

Joseph Kirby
Institute for Christian Studies
Toronto, Canada
jkirby@icscanada.edu

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Abstract

Beginning as pockets of anaerobic bacteria subsisting on geothermal energy on the ocean floor, life expanded first throughout the ocean, then over the land, and eventually came to cover the entire Earth. In this paper, I argue that human activity in outer space should be understood in the context of this progression: life as an exponentially expanding force of negentropy currently contained within the atmosphere of the earth, and human technology as a radical transformation whereby life becomes capable of expanding over this limit. With reference to the philosophy of Krafft Ehricke, I argue that this position represents a synthesis between deep ecology and technological civilization: as with deep ecology, human beings are seen as having duties toward life; however, these duties consist not only in protecting the biosphere, but also in developing techno-biological living systems capable of reproducing in the ambient matter of the solar system.

Introduction

It has become difficult, in recent decades, to make a convincing argument for the space program. Given the environmental catastrophe, cancer, war, AIDS, starvation, and all the troubles facing humanity *within* the biosphere of the Earth, it is hard to justify the apparently useless luxury of promoting human activity beyond it. To many, the vast sums of time and money necessary to fund such adventures would seem better spent fighting the suffering and injustice that continue to plague our civilization, our species, and increasingly, the fragile planet on which we live. Even an avowed advocate like Carl Sagan readily acknowledges this problem – none of the arguments commonly used to justify the space program actually works: profit motive arguments fail, because it would cost too much to transport goods to and from the gravity well of the Earth; the quest for increased knowledge cannot justify a specifically human presence

in space, because robotic missions could venture farther and discover more than fragile biological humans; arguments citing potential spin-off technological benefits do not work, because it would always be better to invest directly than wait for space technology to bear unforeseeable fruit. In regards to the argument that humanity could solve the population crisis by colonizing the void, Sagan observes that this would involve transporting 250,000 people per day off the Earth – a feat he wryly describes as "beyond our present capacity" (Sagan 1994, 274).

The most compelling argument Sagan can come up with for a human presence in space involves the threat of death: we know that an asteroid of sufficient size to destroy civilization collides with the Earth approximately every 200,000 years. This means that any intelligent species, anywhere in the universe, must eventually expand beyond the borders of its home planet or else face inevitable annihilation through extraterrestrial impact. In Sagan's words, our ultimate choice is "spaceflight or extinction" (Sagan 1994, 327). However, although this argument is scientifically sound, it remains politically and economically untenable. A threat that might occur once every 200,000 years will never be pressing in comparison to the short-term troubles that constantly beset us – such that, until the disaster finally strikes, each human generation will always feel safe in allowing the next generation to deal with it. While outer space might be necessary for the long term survival of civilization, it seems impossible to connect this long term good with the cares of present reality.

Despite his lack of politically expedient arguments, Sagan remains convinced that the space program is a human activity of supreme importance. Unable to articulate this importance in the language of practical benefit, however, he resorts to citing the intangible benefits that would supposedly accrue to a space-faring civilization: "human missions to Mars would provide hopeful prospects, rich in adventure, for the wanderers among us, especially the young" (Sagan 1994, 279); "Winning a foothold on other worlds whispers in our ears that we're more than Picts or Serbs or Tongans: We're humans" (281); "Planetary exploration satisfies our inclination for great enterprises and wanderings and quests that has been with us since our days as hunters and gatherers" (282). Essentially, Sagan is arguing that the space program can be justified only with the help of dreams and ideals, the glue that will pull our long term good into the horizon of our present concern.

If this is the case, however, if indeed a human expansion into space can be justified only with reference to ideals, then the choice of ideal becomes the critical factor in the success or failure of the argument. Cosmonautic thinking has persisted in making its appeal to the ideals of modernity – confidence in the nobility of exploration and growth, trust in scientific and technological progress, faith in human rationality to alleviate the human condition. These ideals, however, have been subjected to a withering critique over the last half century. For those who now reject the ideals of modernity, presenting space exploration as the culmination of modern civilization can ironically make it appear as an evil to be avoided, as opposed to a good to be worked toward.

This paper will address this problem, not as a cynical attempt to sell space flight to a new generation, but rather as reconsideration of the space program in light, specifically, of the critique that environmental philosophy levels against modernity. This will entail the articulation of the cosmonautical ideal in terms of ecological philosophy, which I will argue is a better way to understand the true significance of human extraterrestrial activity. I will begin by showing in more detail how current cosmonautical thought is still arguing from a modern paradigm, and then showing how these arguments appear in light of some of modernity's critics. I will then introduce the largely unknown philosophy of German rocket scientist Krafft Ehricke, who presents a vision of the space program not as conquering humanity colonizing a new frontier, but rather as the next phase of the evolution of life: as fish once crawled out of the oceans, as photosynthesis once enabled life to harness the energy of the sun, so does human technology enable life

to expand over the atmosphere, its current boundary, into the void of space. I will argue that this vision represents a proper synthesis between the aspirations of modernity and environmentalism, and further, that this represents the only sensible way to protect the long term integrity of the biosphere of the Earth in the context of a technological civilization.

Modern cosmonautical thinking and its critics

We have already witnessed Sagan justifying the space program with appeals to the glory of exploration, the dream of universal solidarity, the longing for greatness. A collection of essays from the same decade, tellingly entitled *Where Next, Columbus?*, contains a host of similar appeals. For example, Stephen J. Pyne justifies the space program as the logical extension of the noble heritage of European exploration: "the drive to explore […] was built into the genetic code of Western civilization, which had to explore to be what it was" (Pyne 1994, 18). Similarly, Walter E. Massey informs us that the space program is justified by our faith in science and technology, which supposedly is "so ingrained that it is difficult to imagine a time when people did not assume that, given an advance in science and technology, any given problem would yield a solution" (Massey 1994, 150). In a Russian book on the subject, philosopher Yuri Shkolenko argues that industrializing space might allow us to put giant reflector dishes into orbit, enabling us to turn the frozen North into a new bread-basket (Shkolenko 1987, 85). In a more recent work, Franco Malerba, the first Italian in space, tells us that space is "a new territory to be explored and conquered by humankind" (Malerba 2003, xii).

Like Sagan, these thinkers see space as the final frontier to be conquered by a triumphant humanity, the crowning achievement of the modern project. However, while these arguments might retain their force in a subculture already committed to the project, the wider culture has increasingly come to see these ideals as gross distortions of proper human conduct. For example, given the horrors of colonialism, arguing that the space program is the extension of the noble heritage of European exploration is unlikely to win support. Indeed, the same analogy has been used by eminent farmer philosopher Wendell Berry to denounce the space program, with the drive to set foot on the moon likened to the miscreant avarice that drove the slaughter of the aboriginal populations of the Americas: "we have invaded foreign lands and the moon with the high-toned patriotism of the conquistadors" (Berry 1996, 3). Similarly, given the environmental catastrophe currently ravaging the planet, talk about our "faith" in science and technology to solve any problem seems, to many, like blindness to the reality of our predicament. Indeed, much contemporary environmental thought has come to see the rapacious, exponential expansion of technological civilization over the Earth as comparable to the growth of a metastasizing cancer, mercilessly devouring an otherwise healthy body (see James Lovelock 2009, 232-33; Weigel 1995; Foreman 1991, 56-57). From such a perspective, faith in technology would be evidence of the hubris of modern humanity, propelling civilization over the precipice. Indeed, to someone who has come to see technological humanity as a cancer, the potential expansion of this civilization beyond the atmosphere might appear as nothing more than an extension of the blight into the as-yet-pristine environments of the void.

The problem is simple: advocates of the space program have continued to appeal to the dreams of an unreconstructed modernity, and these dreams have come to be seen by a large segment of the population as delusions used to justify and rationalize the exploitation and despoliation of the biosphere. For this reason, the more advocates of the space program attempt to sell their ideal, the more it comes to appear as an evil to be fought against as opposed to a good that should be pursued. In response, I will attempt to bring together the ideals of both cosmonautical and ecological thinking, not as a haphazard amalgam of two dichotomous ways of thinking, but rather as the logical unfolding of both. In fact, this way of thinking already exists, in the thought of Krafft Ehricke, as a forgotten branch of environmental

philosophy that emerged, and then receded, during the historical period when environmental concerns first broached the cultural awareness.

The resurrection of ecological cosmonautics

The insight that leads to Ehricke's philosophy already exists at a nascent level in much cosmonautical discourse. In the introduction to Shkolenko's *The Space Age*, for example, Russian Cosmonaut Vitaly Sevastyanov briefly mentions that the technology of rocketry "has enabled life to move out into another environment, that of outer space" (Sevastyanov 1987, 6). In *Pale Blue Dot*, Carl Sagan points out that our first baby steps into the solar system are "as momentous as the colonization of the land by our amphibian ancestors" (Sagan 1994, 403). However, in the work of these "mainstream" cosmonautical thinkers, this point is usually forgotten as soon as it is made, as a fringe consideration unworthy of emphasis or development. From the modern philosophical perspective within which these thinkers work, this forgetting is justified: the idea that human cultural evolution is relevant to the unfolding of life itself makes no difference if life's unfolding is not accorded any value. For environmentalism, however, this situation is reversed: the fringe consideration becomes the central pillar around which cosmonautical philosophy should be constructed.

In fact, from the late 1960s until his death in 1984, German rocket scientist Krafft Ehricke developed such a philosophy. Ehricke saw life as an exponentially expanding process that grew over all environments within its reach. Technology gave life the capacity to grow over the barrier of the atmosphere and infuse the matter in the Solar System as it had once infused the matter of the oceans and the land. Humanity was the medium through which this expansion became possible, and therefore bore responsibility for its success or failure. Furthermore, the only realistic way for a technological human civilization to come into harmony with the biosphere of the Earth was to expand beyond it, allowing for the Earth to be transformed into a garden at the center of an expanding technological ecosystem.

This perspective formed the core of an ecological/cosmonautical philosophy that straddled the intellectual terrain between modernity and environmentalism: unlike the modern paradigm, Ehricke's philosophy recognizes humanity as an aspect of the unfolding of life, and as having duties toward this unfolding; however, unlike environmentalism, this philosophy regards our duties as extending beyond the mere maintenance of the already extant biosphere. Instead, it proposes a radical evolution into an as-yet-unthinkable beyond. Ehricke sees humanity as having duties both to life as it is, and to life as it might become – both to life's preservation, and to life's radical expansion over the barrier that has held it back for the last few hundred million years. However, because Ehricke's position straddled the philosophical terrain across the modern and environmentalist paradigms, it was more or less ignored when he was writing, and has been more or less forgotten since.

Ehricke's argument requires a radical transformation of the way we conceive of technology. Modernity tends to see technology as the road toward human salvation, relieving the human condition by eliminating scarcity and satisfying human desire. Ecological philosophy, by contrast, tends to see technology as the road to perdition, bringing about the destruction of both the human soul and the biosphere. Ehricke's position exists outside this dualistic spectrum. Ehricke sees technology more in the mode of creation, the means whereby life gains the capacity to expand beyond the atmosphere. In short, rather than seeing technology as a mere means whereby human beings work to satisfy their selfish desires, or tragically strive and fail to do so, he sees technology as the next step in the evolution of complexity, a negentropic force that gives life the potential to grow into its next radius of activity.

Beyond even the evolution of life, Ehricke locates technology within the larger story of cosmic "complexification," or "negentropy," the process of cosmogenesis that has slowly transformed the initial cloud of hydrogen and helium that characterized our universe after the Big Bang into the infinite fractal complexity of the biosphere, the body, the human brain: stars form, grow old, then die, and through this process give birth to the rest of the periodic table in the furnaces of their cores; new stars form, orbited by planets composed of more complicated elements; these planets become the furnaces for new kinds of complexity – life, the cell, evolution, as an unending chemical reaction that cycles through 21 of the 92 naturally occurring elements; life eventually produces intelligence, which exudes a technological membrane formed of all 92 elements[1] of the periodic table. This brings us to the present day, when a technological metabolism of 92 elements has exploded through the biological substrate, giving rise to the terrible environmental crisis that is currently ravaging the planet.

Both Ehricke and traditional environmentalism understand the environmental crisis as caused by the interaction between technology and biology. However, environmentalism tends to see this crisis as a purely negative phenomenon, as absolute destruction of the good of life, which is equated with the good of the biosphere. Ehricke, however, while appreciating the horrors of environmental degradation, also draws our attention to a new possibility that has emerged, a new hope that becomes possible only in the context of such a crisis. Through technology, life gains the potential to grow across the void of space, and flow into fields of matter that have, up to now, been beyond its reach. In this way, the crisis represents not an unmitigated disaster, but rather the process through which life must pass if it is ever to gain the capacity to expand beyond its current boundaries.

Parallels between industrialization and photosynthesis

Ehricke draws an analogy between the current crisis, instigated by industrialization, and the evolution of photosynthesis. He argues that industrial humanity has become the catalyst for the "Second Great Crisis" to be faced by life in its evolutionary history, with the "First Great Crisis" having been prompted by the advent of photosynthesis some three billion years ago. Prior to photosynthesis, life was dependent upon chemical energy scrounged from geothermal sources on the ocean floor; with photosynthesis, it became capable of producing its own chemical energy from the energy of the sun, giving rise to the potential for a tremendous growth in organizational complexity. By harnessing a more generic source of energy, life grew over the barrier that had previously limited its expansion and came to exist throughout the oceans. Eventually, photosynthesis made it possible for life to encompass the entire planet, to become the biosphere that we now experience as the extent of the living world.

Besides granting life a vast and important new power, however, the advent of photosynthesis also constituted a terrible crisis. The waste product of photosynthesis, oxygen, was toxic to the anaerobic life that had predominated up to that point. While giving life the potential for much greater complexity, photosynthesis also produced a pollutant that threatened life's very existence. Ehricke describes primordial life as having had only three options in response to this crisis: either "give up and perish, regress to a minimal state of existence, or advance and grow" (Ehricke 2008, 253). Needless to say, life took the third path, which led to what Ehricke describes as the transition from the "First Earth" to the "Second Earth," from the initial emergence of life as anaerobic bacteria subsisting on geothermal energy, to the development and growth of a biosphere that could exploit the energy of the sun to cover the entire Earth with ever more complicated forms.

The Second Great Crisis has arisen through a similar extension of life's capacity, this time from a biological cycle of 21 elements to an industrial cycle that is capable of utilizing all 92 elements in its metabolic process. Like photosynthesis, the industrial cycle gives the living process the capacity to utilize

new kinds of matter and energy, which in turn allows it to expand beyond what had previously appeared to be an intractable limit to its growth. Ehricke further notes that photosynthesis allows life to use a resource (sunlight) that originates beyond the Earth, which makes it the first example of what he calls the "extraterrestrial imperative," now operating through human technology to expand life into extraterrestrial sources of matter.

These transitions, from anaerobic to aerobic and now from biological to technological, are periods of tremendous danger. In describing the transition from First Earth to Second Earth, Ehricke uses the image of a womb: the First Earth of anaerobic life was the womb in which the Second Earth, the proto-biosphere, grew. The First Great Crisis occurred when the umbilical connection between the two environments was cut, and the finite First Earth gave birth into what would, from that perspective, have appeared to be its own infinite beyond. Ehricke describes this same process as occurring now, between the Second Earth and what he sometimes refers to as "the Third Earth," sometimes as "the Technosphere." The biosphere and the technosphere continued to exist in relative harmony until the Industrial Revolution, which constituted the beginning of the crisis moment. Now, once again, life is faced with a tremendous choice: either die, regress, or grow outward once more.

For Ehricke, the correct response to the crisis is for the industrial metabolism to cut its umbilical connection to the womb of the Second Earth and grow into the void, where its tremendous power would no longer be lethal to the biological environment – similar to how a child, at first parasitical on the body of its mother, becomes independent of its mother when it is born, and later comes to protect its mother when it matures. Ehricke also makes an analogy with a household: unlike a pet, whose ultimate ecological goal is to find a stable ecological niche within the house of its master, a child is supposed to outgrow the household and establish a new one of its own. According to Ehricke, the proper role of humanity within the evolution of life is to act as a catalyst, producing a technological skin that will enable life to survive in the inhospitable environments that exist beyond the atmosphere.

The limits of environmental philosophy

In the discourse of deep ecology, the term "shallow ecology" is used to refer to an environmental vision that recognizes environmental degradation as a serious issue, but only insofar as it infringes upon humanity's continued prosperity and happiness. The term "deep ecology," by contrast, is used to refer to a vision that sees environmental degradation as bad not just because of its adverse effects on humanity, but also because life itself is being damaged. In contrast to shallow ecology's anthropocentrism, which focuses only on human concerns, deep ecology posits an ecocentrism that sees the proper goal of environmentalist thought and action as being to promote the good of life itself. The deep perspective further argues that the shallow perspective will ultimately be unable to respond adequately to the current predicament, a crisis so severe that only a thorough reorientation of our entire value system, toward a recognition of the inherent good of life, will be able to respond adequately to the dreadful situation that has been created and only continues to get worse.

Ehricke's philosophy is a kind of deep ecology. However, it is a deep ecology with a fundamentally different understanding of life. "Mainstream" deep ecology tends to equate the good of life with the good of the biosphere. From this perspective, human technological civilization appears to be an outright evil, directly contrary to what the deep ecologist posits as the source of goodness. For Ehricke, by contrast, the biosphere is not equivalent to life, but rather represents the current boundary of a potentially infinite explosion, which began in the periphery of volcanic vents on the ocean floors, expanded over this boundary to the edges of the oceans, then expanded over this second boundary to the edges of the atmosphere. Ehricke sees life, equipped with technology, as now poised to expand into the rest of the

Solar System, and human technological civilization as the medium whereby this expansion becomes possible. He is therefore able to recognize two distinct human duties to life: first, as has been correctly recognized by environmentalism, to protect life as it currently exists within the biosphere of the Earth; and second, as has yet to be recognized, to expand life beyond the biosphere by equipping it with a technological skin that will enable it to survive and reproduce in the dust of space.

Unfortunately, with the publication of such books as *This Endangered Planet* in 1971 and *The Limits to Growth* in 1972, environmentalism began to define itself against the modern idea of unlimited growth by arguing for a limit to growth, seeing the prospect of infinite growth, infinite progress, as one of the main sources of a destructive evil demolishing the biosphere. These works argued that exponential economic and industrial growth was no longer possible, given the inescapable limits of the Earth, so that the future success or failure of the human species no longer depended on growth, but now depended on whether or not it could be brought into accord with the fundamental limits of earthly existence. In the words of the Club of Rome, "if the present growth trends in world population, industrialization, pollution, food production, and resource depletion continue unchanged, the limits to growth on this planet will be reached sometime within the next one hundred years" (Meadows 1972, 24). This meant that, in contrast to the attitudes that had dominated the last few centuries of Western history, whereby infinite technological and industrial growth would supposedly bring prosperity and happiness to all, growth was now seen as leading to a terrible disaster unless drastic action was taken. Either humanity would choose "a self-imposed limitation to growth," slowly accommodating culture and technology to the absolute limits of the Earth's biosphere, or else we would be forced to accept "a nature-imposed limitation to growth" (Meadows 1972, 168-69), whereby nature itself would cull back the human population once the absolute limits were passed.

Generally speaking, both shallow and deep ecology have come to posit limits as the only sane course for human civilization to take. Ehricke, however, argues that the idea of a limit to growth only makes sense if the atmosphere of Earth is seen as the absolute barrier to the possible expansion of life. Once the atmosphere ceases to be seen as the absolute boundary of the expansion of the living process, technological civilization ceases to be analogous to a malignant cancer – as an exponentially expanding part of an otherwise integrated whole – but rather becomes, in line with Ehricke's reproductive metaphors, the pregnancy of the Second Earth, and the environmental crisis becomes the birth pangs of Gaia as she attempts to scatter the seeds of life into the inhospitable environments beyond the womb of the biosphere.

Ehricke accused those who advocated for the acceptance of limits of failing to distinguish between multiplication and growth. Multiplication would be the mindless reproduction of lilies across a pond, mold across a loaf of bread, grass across a field – a simple exponential increase in sameness. Growth, by contrast, "is the increase in knowledge, in wisdom, in the capacity to grow in new ways" (Ehricke 2008, 252). Extrapolating from multiplication, it appeared to nascent environmental philosophy that there were absolute limits – the edge of the pond, the crust of the bread, or the atmosphere of the Earth. However, Ehricke argued that it was the very pressure created by life pushing up against its limits that would prompt an evolutionary leap, which would allow life to grow across what previously appeared to be unsurpassable. Thus had life developed photosynthesis in order to spread beyond the geothermic vents that had first provided its metabolic energy; thus had life developed a water-tight skin to enable it to carry the ecosystems of the ocean onto the arid continents; and now, thus was life developing a technological skin that would allow it to cross what would otherwise be an insurmountable obstacle.

Ehricke acknowledged, in other words, that the conclusions of Falk and the Club of Rome would be perfectly valid if the barrier of the atmosphere was absolute. If it was indeed impossible for life to grow

over the atmosphere, then humanity would have no choice but to adapt to the limits of the biosphere, whatever sacrifices this took. However, looking at the history of evolution, he was struck by the fact that, time and time again, when it appeared as though life had hit an absolute barrier, it grew into some radically new form, and thereby relativized whatever limit had previously appeared to be insurmountable. According to Ehricke, this is precisely what is happening now – like lilies over a pond, humanity has multiplied to the limits of the carrying capacity of the Earth; what is required now is a qualitative growth, whereby the carrying capacity of the Earth will no longer be the absolute variable against which humanity, and life itself, is forced to measure its activity.

This meant that, for Ehricke, the development of technology, and space technology in particular, was more than just a contingent whim of the superpowers. The space program was "consistent with the logic of evolution, […] a serious natural phenomenon, not a superficial fad" (Ehricke 2008, 252). Rather than trying to justify the exploration and colonization of space in terms of the modern paradigm of technological progress leading to increased human happiness, Ehricke justified it with reference to the direction of life's growth. It is this change in emphasis, from a paradigm that places humanity at the center to a paradigm that sees humanity as a part of the living process, that allows his philosophy to be classified as "ecological" rather than "modern." However, while modern civilization might have been wrong to define all value in terms of satisfying human desire, and environmental philosophy perfectly right to endeavor to expand human concern to include the good of life as well – environmentalism defined the good of life in terms of the biosphere, rather than in terms of the evolutionary process that created it. Ehricke argued that, while the biosphere legitimately had to be protected as part of the good of life, the particular human duty was to allow the process of evolution, currently working through industrial civilization, to give birth to a technological ecosystem that would eventually span the Solar System.

Ehricke's "Extraterrestrial Imperative" can be compared to Falk's "Ecological Imperative," which Falk argued had to replace the modern imperative to grow and expand (Falk 1971). Falk's Ecological Imperative implied that there was a fundamental conflict between the biosphere and industrial civilization, and humanity had to realize this, and bring industry back into accord with the overriding concerns of life itself. The Extraterrestrial Imperative, by contrast, implied that the conflict between the biosphere and industry was a temporary one that could be solved by allowing industry to grow beyond the atmosphere. This meant that the Extraterrestrial Imperative was not just a new justification for the complete demolition of the biosphere in the name of industrial expansion; instead, the only way to truly protect the biosphere was to allow the new industrial metabolism of the Earth to expand into an environment more suitable to its needs, where resource extraction would not entail the destruction of life, and the excretion of industrial waste would not entail the desecration of ecosystems. However, this expansion into the void was not merely to protect the biosphere – the expansion was a good in itself, the action whereby humanity would harmonize with life, no longer defined merely as the biosphere, but also as the force of evolution that had created it.

Ehricke's ultimate critique of the ecological philosophies of Falk and Meadows was that, if these ideas came to predominate, if human beings actually tried to bring their culture into harmony with the biosphere, then the biosphere would inevitably be demolished. As he wrote in 1974, the prospect of "a mankind endowed with cosmic powers but condemned to solitary confinement on one small planet" was an apocalyptic nightmare (Ehricke 2008, 226). Given the nature of life, the nature of technology, and the nature of humanity, Ehricke argued that the proposals of Falk and Meadows were basically impossible, and all radical attempts to put these ideas into practice were bound to fail. The only possible way to protect the health of the biosphere, given the reality of industrial civilization, was to "make the Earth the garden spot of this solar system" (Ehricke 2008, 238), in the context of an expanding industrial ecosystem drawing the resources necessary for its metabolism from the dead worlds beyond the limits of the Earth.

Cosmogenesis and the human will

If Ehricke is correct, then the premise of books like *The Limits to Growth* and *This Endangered Planet*, as well as all environmentalism that calls for the industrial metabolism to adapt to the constraints of the biosphere "is fundamentally, evolutionarily, and naturally wrong" (Ehricke 2008, 255). Humanity is not supposed to adapt its activity to the cycles of the biosphere – this would be equivalent to arguing that photosynthesis should have stopped pumping poisonous oxygen into the atmosphere, that life should have remained as anaerobic single celled bacteria scraping a meager existence from the heat of volcanic vents. Rather than adapting to the limits of the biosphere, humanity should expand beyond it, carrying the living process outward on an odyssey to other worlds. Furthermore, it is in our response to this crisis that humanity will "prove or disprove itself as an evolutionary success or dead end" (Ehricke 2008, 255). In other words, Ehricke does not see this next phase of evolution as occurring through some kind of automatic logic. Its success or failure depends entirely upon the will of the creature through which it has become possible. Humanity must *decide* to follow the Extraterrestrial Imperative, and it is upon this choice that the future evolution of life depends.

Certainly, ecological thought that takes its cue from the idea of limiting growth also speaks about a choice upon which life's future hangs in the balance; however, the choice is usually posited as between the acceptance or denial of fundamental limits, which in concrete terms usually entails a call for regaining control over rampant technological and industrial growth, and sometimes a call to reject technology altogether. By Ehricke's account, however, these are not the terms of the choice: technological evolution is not the result of a human decision. It is an extrapolation of the laws of negentropy, which have been operating in the universe even prior to the beginnings of life. For Ehricke, thinking that human civilization could un-choose technology would be equivalent to thinking that humanity could legislate against the law of gravity. The choice is not whether to accept or reject technology, but whether or not to work toward allowing this technology to expand out of the womb of the biological Earth, into a sphere of activity more suited to its power. In the coming centuries, if this decision is made properly, Ehricke envisages the gradual emergence of a poly-global, three dimensional civilization, as the next evolution of both human civilization and life itself, as the final unification of human history with the history of life from which it had (apparently) been sundered.

There are two fundamental difficulties that this project might face: first, humanity might fail to recognize the true nature of its crisis, thinking of life as fundamentally constrained within the bounds of a finite Earth; second, humanity might simply not care about its duties to the process of evolution, either because it continued to conceive of its existence as consisting of nothing higher than a raw drive to satisfy individual desire, or else because it decided that life itself was fundamentally without value, not worth the trouble of allowing to exist in a larger region of the universe. The first problem stems from a failure of imagination, a failure to realize that the biosphere does not in fact represent the full extent of life's potential, a failure to distinguish between growth and multiplication. The strength of Ehricke's philosophy is that it shows us, first, that the notion that human beings have duties toward life entails both protecting the biosphere and giving birth to the technosphere, and second, that it is both futile and self-defeating to continue to posit an absolute opposition between industrial civilization and life. Given the logic of these arguments, it seems that anyone who already agreed that humanity has duties to life would be compelled to agree that part of this duty entails allowing life to expand into the void. This means that, in the long run, the second problem, the problem of the will, is a far graver threat than the first.

This second problem can manifest itself in two ways: first, one could argue that it is irrational, or even impossible, for individual humans to act contrary to their own selfish interests; second, one could argue

that life is suffering, an evil that the universe would be better off without. By the logic of the first expression, which amounts to a philosophical defense of absolute selfishness, it would be absurd to care at all for the fate of life after one's own demise. This position was actually taken by economist Lester Thurow in a book published in response to *The Limits to Growth*. In an essay in this book, Thurow argued that it is irrational to concern oneself with the fate of future generations, and accordingly we should not bother sacrificing our own present enjoyment in order to benefit our descendants (Thurow 1973, 141). Such an attitude would find it impossible to justify a multi-generational mission to seed the dust of space with living form.

Schopenhauer, arch-pessimist of the philosophical tradition, provides a direct expression of the second failure of will. Concerning the rationality of biological reproduction, he writes the following scathing criticism:

> If the act of procreation were neither the outcome of a desire nor accompanied by feelings of pleasure, but a matter to be decided on the basis of purely rational considerations, is it likely the human race would still exist? Would each of us not rather have felt so much pity for the coming generation as to prefer to spare it the burden of existence, or at least not wish to take it upon himself to impose that burden upon it in cold blood? (Schopenhauer 2004, 11-12).

For Schopenhauer, a rational appraisal of the true nature of life, entirely divorced from the will, would result in a judgment against life, and a decision to work for the annihilation of life as nothing more than the meaningless perpetuation of suffering. For Ehricke's expansion to be possible, however, this same rational will would have to make the opposite decision: decide that life was good, and then decide to undertake the work and sacrifice that would be necessary to spread life into the as yet inert matter of the void. Basically, imbuing matter with the fire of life, changing it from dust into composites of bone, flesh, and brain, into conscious living beings who were born, suffered, grew old, then died – this change would have to be seen as worth all the suffering that came with it, both in terms of the tremendous amount of work necessary to bring it about, and in terms of the pain that would be infused into what is now unformed and unfeeling lumps of stone. Speaking poetically, humanity would have to agree consciously with the words of the God of Genesis, who judges the reality that he has made to be good – and based on this judgment continues the process of creation.

Based on these three possible failures – lack of imagination, lack of altruism, or else rejection of the value of life itself – Ehricke sees humanity as facing a threefold choice: death, stagnation, or growth. If human beings decide, with Thurow, that it is irrational to care about anything besides oneself, or with Schopenhauer, that life viewed rationally is nothing more than meaningless suffering – then the expansion of life will indeed stop, and evolution understood as radical growth will end with the limits of the biosphere. If, by contrast, human beings decide against these thinkers, and see life as indeed meaningful, but still fail in their powers of imagination, continuing to see the Earth as the absolute and final barrier to life's expansion, then life will remain locked on the Earth, and regress into stagnation and slow ecological disintegration. If, however, we decide that life is indeed worth living, and if we also make the leap of imagination entailed by Ehricke's vision, then we might succeed in giving rise to the three-dimensional technological ecosystem posited by his thought: a living process grown out of its biospheric womb, steadily changing the solar system from a dead collection of matter into industrial ecosystems teeming with cybernetic life. Not confined to the finite Earth, humanity would finally be able to attain the resources necessary for industrial metabolism in ways that would not compromise the biosphere. In that case, the Earth itself could flourish, as a garden world at the center of an expanding technosphere, as the Eden from which humans implicitly exiled themselves when they first ate from the tree of knowledge –

and industrial civilization could continue, as the endless work that would be necessary to survive and flourish in the unbearably hostile deserts that exist everywhere outside the walls of the atmospheric womb.

From pessimism to possibility

As we observe the history of the last forty years, we cannot help but note that neither Ehricke's ecological philosophy nor the ideas of those who advocate for limits have progressed in any real practical way. Certainly, the rhetoric arguing for the necessity of change has increased in intensity, but this has taken place against the backdrop of an ever increasing rate of industrialization. The gap between what is seen as necessary and the reality that increasingly contradicts this necessity has given rise to ever more apocalyptic descriptions of the consequences of failure. Gwynne Dyer's *Climate Wars*, published in 2008, is a telling example of this genre. According to this book, in addition to the deaths of hundreds of millions of people due to the famine, drought, mass migration, and war that the now virtually inevitable rise in the Earth's temperature will cause, if temperatures rise enough to halt the ocean currents between the equator and the poles, we might even bring about something called a "Canfield ocean." In this event, the anaerobic bacteria normally locked safely beneath the ocean's floor, as archaic leftovers from Ehricke's First Earth, begin to pump massive quantities of hydrogen sulphide into the atmosphere, bringing death to all life that depends upon oxygen to breathe (Dyer 2008, 220-32).

Whether the science behind Dyer's apocalyptic claims is right or wrong, his work can be seen as an example of the cultural pessimism that Ehricke foresaw as logically necessary once limits became the paradigm through which we attempted to respond to the ecological crisis. Recognition of the exponential expansion of the technological system, combined with the recognition of the finite space in which this system can expand, necessarily leads to some vision of apocalyptic destruction. Ehricke describes this realization as "the emotional crisis" of our time (Ehricke 2008, 227). We have come to realize that the Earth is finite, and in light of this realization it appears as though we must change our ways. If such change comes to appear impossible, then some sort of apocalyptic extinction appears inevitable, not as the asteroid that Sagan foresees slamming into the Earth every 200,000 years, but as the consequence of pressure building up in a container without any possibility of escape.

There are, however, two ways out of this dilemma: either the system must cease to expand, or the available space must cease to be finite. So far, almost all our thinking has been directed at negating the expansion of the system, and when this thinking fails to find a solution, we descend into despair. Ehricke is perhaps the only thinker to direct his attention to the second term – he negates the finitude of the space in which this expansion occurs. For the last forty years, environmentalism has focused on containing the expansion, unaware of the neglected possibility. Meanwhile, cosmonautical philosophy has persisted in thinking of technology and science as triumphs of the human intellect, with space as the next frontier to be colonized by humanity, unaware that when it comes to extraterrestrial expansion, human history and living evolution become one and the same thing. It is not so much the autonomous human will that explodes across the void. It is life itself that makes the journey, with humans as the medium whereby living complexity becomes capable of the next great expansion of its scope.

Once again, life is not the biosphere; the biosphere is merely the current extent of life's expansion. In the womb of the biosphere, the technosphere has come into existence – just as photosynthesis brought oxygen into the cycle of life's metabolism, so has technology extended life's reach to all 92 elements of the periodic table. For Ehricke, the Earth is now pregnant with human technological civilization, as the First Earth was pregnant with photosynthesis – and as photosynthesis allowed life to colonize the entire surface of the Earth, so will industrial technology allow life to grow into the ambient matter of the Solar System.

The human task, in the context of this great crisis, is two-fold: balance within the biosphere, and expansion beyond it. Failure in either task – and we have certainly been failing for the last few decades – may indeed result in the fulfillment of some of the dreadful prophecies that are obtaining ever more prominence in our collective consciousness.

Conclusion

Forty years ago, Ehricke was already arguing that environmentalism, insofar as it sought harmony with the cycles of the biosphere, was ironically helping to bring about the very crisis it hoped to avert. Ehricke basically agreed with Falk and the Club of Rome, and with the environmentalist movement that takes its cue from them, that there is simply no way for a technological metabolism, utilizing all 92 elements, to exist in harmony with a biosphere that cycles through only 21. However, he did not believe that it is possible to stop the development of this technological metabolism, as it is in line with the cosmic laws of negentropy that produces atoms from the fusion reaction in stars, chemicals from the combination of atoms, biology from chemicals, and technology from biology. The only motion, in light of this reality, is forward and outward, not as the next debacle in the horrible history of human conquest, nor as a new frontier to pollute in a vain quest for technological happiness – but as the action whereby humanity, up to now parasitic upon the biosphere, finally realizes that it has been in harmony with the life force all along. Through the expansion of life, humanity becomes the medium through which this great explosion finally gains the power to transcend the atmosphere and infuse even more of the universe with the beautiful diversity of living form.

I hereby submit Ehricke's "ecological cosmonautics" as a serious contribution to the debates surrounding not only the human destiny in the void, but also the human future on Earth itself, the way we conceive of ourselves as part of the unfolding process of reality. I submit that this vision deserves serious reflection not only from those who are already moved by dreams of a technological future, but also by those moved by dreams of preserving our collective biological past. Indeed, to state the matter as strongly as possible, I submit that something like this view is the correct way to think about these problems. It is my hope that this paper will provide the spark for a new round of debate concerning the nature of life, biology, humanity, and technology – and that this debate might give birth to the will necessary not only to preserve what is left of the biosphere, but also to allow the flower of living form to bloom outwards once more, into the dormant fields of the extraterrestrial night.

Note

1. Technically, the oft-cited figure of 92 naturally occurring elements understates the case. Uranium, with its 92 protons and electrons, has the highest atomic weight of any element found naturally in any significant amount. However, even without human activities such as nuclear tests, the Earth's crust contains minute traces of some elements with higher atomic weights.

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