BIOETHICAL CONSIDERATIONS AND PROPERTY RIGHTS ISSUES ASSOCIATED WITH THE DISCOVERY OF EXTRATERRESTRIAL BIOLOGICAL ENTITIES
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IMPLICATIONS FOR POLITICAL POLICY IN THE CONTEXT OF FUTURES STUDIES

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Dedication

This dissertation is humbly and sincerely dedicated to life, wherever, whatever, and whenever it may be…

Acknowledgments

We stand on the shoulders of giants, and any worthwhile enterprise grows from the efforts of others. Jake Dunagan, a now-graduated fellow student of Futures Studies at the University of Hawaii, wrote in the Acknowledgments section of his dissertation, *Politics for the Neurocentric Age*, “When a non-scientist wades into the water of science, it can be dangerous.” The opposite is equally true. As a biologist, entering the world of political science was daunting -- a new language, culture, history and perspective on how we attempt to make sense of the world and the Universe, create something useful and, hopefully, better. Many have helped me in that transition. Jim Dator introduced me to Futures ways of thinking over 25 years ago. He ignited a curiosity that led me to return to school and has encouraged me for the past five years to always look beyond horizons. Kathy Ferguson guided me to the cliff of political theory and gave me a push -- a terrifying experience for a biologist, but she was at my side for the duration and was instrumental to my education. Debbie Halbert mapped a path for me through the thicket of intellectual property rights and its relationship to concepts of the ownership of life. Kim Binsted took me in a very different direction, showing me the diversity of space science and the practical side of the space industry. She also encouraged me to spend two weeks in the freezing mid-winter at the Mars Desert Research Station in the high desert of Utah. The experience gave me a brief glimpse at a possible future on another world and an opportunity to reflect on my project in such an inspiring setting. David Duffy, in addition to being a valued friend, helped me keep one foot in biology while stretching science to its possible limits, that dangerous ground where science and philosophy blend and become one. I am amazingly fortunate.

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ABSTRACT

Although the search for extraterrestrial life is a priority for NASA and other space programs, no government has policies addressing either the bioethical or property rights issues that would quickly evolve from such a discovery. This dissertation employs methods of political futures studies to examine the interrelatedness of bioethics and intellectual property rights as they might apply to extraterrestrial life, broadly defined, and proposes policy to guide the effort. Included are discussions of biological taxonomy and the related history of largely Western bioethical philosophy and concepts of life as property. It argues that these tend to arbitrarily discriminate among organisms and allocate bioethical regard based on histories of cultural practice that are inappropriate when applied to extraterrestrial entities. Commercial and scientific research interests in extraterrestrial life also have the potential to devalue bioethical regard. The political context of outer space is discussed as an appropriate stage for expanding bioethical standards based on justice and nonviolence that could potentially be applied on Earth. Theoretical work of John Rawls and others provides guidance on how the interests of extraterrestrial life as well as future generations and post-human life might be represented. Contemporary political instruments regarding management of the biological resources of global commons areas, such as the Antarctic Treaty and the International Law of the Sea, are assessed as models for creating policies to guide extraterrestrial biological discoveries within the frameworks provided by the Outer Space Treaty and the Moon Agreement.

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ACRONYMS AND ABBREVIATIONS

100YSS	100-Year Starship Study
ABS	Access and benefit sharing
AI	Artificial intelligence
AT	Antarctic Treaty
ATS	Antarctic Treaty System
BCE	Before Common Era (i.e., BC)
bya	Billion years ago (billion years before present)
CBD	Convention on Biological Diversity
CCAMLR	Convention on the Conservation of Antarctic Marine Living Resources
CHM	Common heritage of mankind
CNES	French Space Agency
COPUOS	UN Committee on the Peaceful Uses of Outer Space
CPB	Cartagena Protocol on Biosafety
CRAMRA	Convention on the Regulation of Antarctic Mineral Resources Activities of 1988
DARPA	(US) Defense Advanced Research Projects Agency
DNA	Deoxyribonucleic acid
EEZ	Exclusive Economic Zone(s)
ESA	European Space Agency
ESA	Endangered Species Act
ETBE	Extraterrestrial biological entity or entities (including both extinct and extant extraterrestrial life and the ecosystems and landscapes critical to their existence)
EU	European Union

FY	Fiscal year
GMO	Genetically modified organism (though artificial means, such as gene splicing and other technologies)
ICC	International Chamber of Commerce
IDA	International Depositary Authorities
IGC	Intergovernmental Committee on Intellectual Property and Genetic Resources, Traditional Knowledge and Folklore
IGY	International Geophysical Year (1957-1958)
IP	Intellectual property
IPR	Intellectual property rights
ISRO	Indian Space Research Organization
ISA	International Seabed Authority
ISS	International Space Station
IUCN	International Union for the Conservation of Nature
JPL	Jet Propulsion Laboratory
km	Kilometer
LOS/LOST	United Nations Convention on the Law of the Sea Treaty
LR	Labeled release experiment (conducted as part of the Voyager mission to Mars)
MAA	Manufacturers Aircraft Association
NAS	US National Academy of Sciences
NASA	National Aeronautics and Space Administration (United States)
NEPA	National Environmental Policy Act
NGO	Non-governmental organization (private organization or similar non-government group or party)

OST	Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (a.k.a., Outer Space Treaty)
PhRMA	Pharmaceuticals Research and Manufacturers of America
PPV	Public-private venture
PR	Property rights
PTO	United States Patent and Trademark Office
R&D	Research and development
rad	Absorbed radiation dose
RNA	Ribonucleic acid
SCAR	Scientific Committee on Antarctic Research
SETI	Search for Extraterrestrial Intelligence
SSB	Space Sciences Board (of NAS)
TK	Traditional knowledge
TRIPs	Agreement on Trade-Related Aspects of Intellectual Property Rights
UDHR	(United Nations) Universal Declaration on Human Rights
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNOOSA	United Nations Office for Outer Space Affairs
US	Unites States of America
USPTO	United States Patent and Trademark Office

USSR	Union of Soviet Socialist Republics
UV	Ultra-violet radiation
v.	Versus, as cited in legal proceedings of plaintiff and defendant (e.g., Cain v. Abel)
WIPO	World Intellectual Properties Organization
WTO	World Trade Organization

CHAPTER 1
INTRODUCTION

One of the big opportunities of space – indeed one of its major reasons for space settlements – should be to imagine, invent, create, and re-create new forms of everything.

James Dator – *Social Foundations of Human Space Exploration* (2012, 66)

1.1 Premise, scope and goals

The advent of technologies enabling the search for extra-terrestrial biological entities provides a rare opportunity to reconsider our ethical, economic, and philosophical relationships with non-human life, broadly defined. Such relationships have the potential to be relatively free of many of the constraints that have framed and limited associated philosophies and policies regarding terrestrial life in the past.[1] But the temporal window available for these reconsiderations is closing. From the instant such extraterrestrial entities are discovered onward, opportunities to craft enlightened protocols and policies less biased and confined by predominantly utilitarian and exploitative motives will diminish rapidly. The substantial advantages of novelty will be lost.

How are we to act in our search for extraterrestrial entities? How are we to respond should our searching prove fruitful? And how do we achieve those goals?

This dissertation terms members of the extraterrestrial class under consideration as "extraterrestrial biological entities" (ETBE) as opposed to using more common terms such as "life" or "living organisms."[2] The term is more inclusive and broader in scope. It is especially employed to aid in breaking the tendency to compare (and thus classify or rank, both taxonomically and philosophically) new forms encountered with what is familiar here on Earth. Such comparisons would likely be misleading and prejudicial in that:

- ETBE have yet to be discovered, existing definitions of "life" and "organism" that were written specifically for Earth and solely as a result of observation of Earth's life may be challenged as inaccurate or misleading (Hazen 2007, 242). For example, there are still numerous references in current literature that all life, extraterrestrial as well as terrestrial, must be limited to carbon-based forms (Greenberg 2001). The reasoning is that carbon is the only element with an atomic structure capable of forming the variety of complex organic compounds required for the cellular and biochemical structures and metabolism required. However, while there are strong arguments for why silicon-based forms would be biochemically difficult, it is premature to state that it would be impossible given

[1] "Terrestrial" is used throughout to denote Earth and Earth's environment and resources (both dry and aquatic), including living organisms and actions specific to the planet.
[2] The abbreviation ETBE will designate both singular and plural forms (i.e., it will represent both "entity" and "entities").

the range of environments likely to be found in the Universe (Bennett and Shostak 2007).[3]

- ETBE includes evidence of extinct and dormant forms and their possible biochemical and metabolic products. Also included are landscapes with biological components. On Earth, these are frequently so closely interwoven with life itself that the two, life and ecosystem, may be indiscernible; one often blends with the other. This may prove especially true in the context of the unknowns of novel extraterrestrial worlds.
- The definition of "life" here on Earth varies widely; there is no general agreement as to a comprehensive list of what is required for an entity to be considered alive. We are finding life thriving in habitats and at environmental extremes that a few decades ago were believed lethal to all life, such as hot springs with temperatures to 131 C (267 F); over 1.5 km (over 1 mile) deep in African mines and in mud from the bottom of the Challenger Deep, a depth of over 10.6 km (6.5 miles); in extremely acidic and alkaline environments; and under kilometer-thick Antarctic ice (Sullivan and Baross 2007; Wolfe-Simon, Blum et al. 2010)[4] Autotrophic microbial ecosystems have been discovered living inside of rocks (Wilson 2002).[5] *Deinococcus radiodurans* is a bacterium that can survive the absorption of 1-million units of radiation (rads), a dose 1,000 times that which would kill a human. What we currently believe to be the limits of life may be challenged as we develop the technologies to expand our search for it on Earth (e.g., deeper in the Earth's crust).
- Lastly, ETBE, as used in this dissertation, is purposely limited to considerations of non-sapient forms unless expressly included.[6] While data generally do not exclude the possibility that there may be or has been non-sapient life on other bodies in our Solar System, save Earth there is no evidence pointing to the past or present existence of sapient life.
- The ethical issues that may emerge regarding the effect of extraterrestrial sapience on humans are beyond the scope of this dissertation. While true that what may be discovered could closely resemble Earth's life, we cannot afford to make that assumption prior to discovery. We must remain open to the amazing novelty of what we may find and resist the temptation to assign judgmental classifications through such statements as, "it is just a bacterium" or "it is a primitive form of

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[3] One of the attributes of carbon that makes it especially useful in biochemistry is that its structure allows it to bond with four other atoms simultaneously. This allows the element to form a great variety of different compounds and structures in addition to allowing both the stronger and weaker bonding that is essential for metabolism and cellular energy transfer. Silicon is the only element that is relatively abundant on Earth that also allows four bonding points. However, silicon's bonds are weaker than those possible with carbon, so compounds formed are more fragile. And, as anyone familiar with silicon lubricants and coatings knows, there are problems with it interacting with water. Lastly, while carbon can readily bond to exist in a gaseous state (e.g., carbon dioxide) at temperatures that allow liquid water, silicon cannot. In that carbon-based organic molecules (such as amino acids) have been detected within meteorites, there is proof that such molecules exist off of Earth.

[4] *Pyrolobus fumarii*, a bacterium, can reproduce at 112^{0}C (235^{0}F) and ceases growing at its lower limit of 90^{0}C (194^{0}F) (Wilson 2002). The green alga *Dunaliella acidophila* is able to survive and reproduce at pH 0, an acidity close to that of 10% hydrochloric acid (Rothschild and Mancinelli 2002)

[5] SLIME (Subsurface Lithoautotrophic Microbial Ecosystems)

[6] The relevance of the definitions of sapience and sentience, however, are challenged.

life."   That comparative approach serves only to diminish the entity's status in its own world and distort our ethical consideration of its existence (Haynes 1990).

The United States National Aeronautics and Space Administration (NASA) has pledged that the search for extraterrestrial life is a high priority among their programs (NASA 2003; Bertka, Roth et al. 2007; Boss, Young et al. 2008; NASA 2010). The Obama Administration has announced goals of a human presence on Mars and missions to asteroids (Chang 2010). In addition, the policy emphasis on space flight as a predominantly government initiative is decidedly shifting toward private commercial ventures (Borenstein and Chang 2010).[7]

Current efforts to seek ETBE and assess its probability employ several methodologies.

- Seeking signs of more technologically advanced entities is a priority mission for the Search for Extraterrestrial Intelligence Institute (SETI). Using primarily radio telescopes, SETI listens for patterns and anomalies among radio and other electromagnetic wave frequencies not likely generated by natural systems (e.g., not emitted by a pulsar). Like our own radio, microwave and other transmissions, if detected from outside our Solar System they would be indicative of technological development and, therefore, provide evidence of past or present intelligent life (Harrison 1997; SETI 2012).[8]
- All known living systems on Earth modify their chemical environment. It is reasoned that should biological processes be occurring elsewhere in the Universe, similar signature changes would be evident (Lovelock 1965; Lovelock 2000). These would include alterations of atmospheres which may be detectable through remote sensing and analysis. Whether ETBE may be intelligent or not is irrelevant to such changes; Earth's atmosphere was dramatically modified by life long before the appearance of intelligent vertebrates. A significant argument against life existing on Mars and other planets within our Solar System today, for example, is that the composition of their atmospheres does not demonstrate the expected characteristics of life (e.g., presence or relative proportions of atmospheric gases that cannot be explained through abiotic/geologic processes).
- Direct biochemical testing and microscopic observation for traces of life through probes and robotic missions, such as the recent 2012 Mars Science Lab and its rover "Curiosity."
- The planet-finding mission of the orbiting Kepler telescope is to identify planets circling stars outside our Solar System. Data may identify those planets that have conditions (such as temperatures within a specific range) that may permit the development of life as we know it (e.g., temperatures that allow for liquid water).

[7] In February 2010 Charles Bolden, NASA Administrator, stated that NASA "will accelerate and enhance its support for the commercial spaceflight industry to make travel to low Earth orbit and beyond more accessible and more affordable."   (Bolden 2010).   The US Space Act of 1958 states that the nation shall "seek and encourage to the maximum extent possible the fullest commercial use of space" (Hearsey 2008, 157).

[8] Since radio and other electromagnetic radiation may take millions of years to reach Earth, the intelligence originally developing an directing transmissions may no longer exist.

> Kepler is not searching for life directly, but for planetary conditions that may be favorable for hosting life.

Although there has been considerable ongoing dialogue among public and private groups regarding the social and philosophical impacts of the discovery of ETBE, neither NASA nor other space-faring nations (e.g., Russia, Japan, India, and China), consortia of nations (e.g., European Space Agency [ESA]) or any international regulating entity (such as the United Nations [UN] and the treaties it manages) has policies regarding either bioethical consideration of ETBE or protocols for addressing issues related to intellectual property rights (relevant to bio-prospecting and patenting) should such life be discovered (Des Marais, Allamandola et al. 2003).[9] This deficiency generates a range of critical yet unresolved issues:

- At what stage of recognition or hierarchical taxonomic classification does bioethical consideration of our impact on ETBE seem worthy or pertinent? Given that what might be discovered may be very different from life as we know it on Earth, can it be assumed, for example, that if an extraterrestrial organism is the size of a terrestrial bacterium that ethical consideration should match that we afford bacteria here on Earth (i.e., none)? Would our adverse impacts on such an organism be without ethical consequence?
- Can it be presumed that allowances and protocols for patenting ETBE, their products or processes would be identical to, say, US regulations governing the patenting of bacterial life or genetically modified higher organisms on Earth, or is a reconsideration of the concept of the ownership of life warranted? How might existing terrestrial models (such as bioprospecting in Antarctica and within other global commons) provide guidance? Likewise, how might profits or other benefits flowing from the discovery of ETBE be distributed, or should that be a requirement at all?
- How are bioethical concerns and property rights related? By extension, how might they be reconciled in the context of ETBE?
- How might an ethical concern for a biological entity yet to be discovered provide a conduit for evaluating and redefining our ethical relationship with terrestrial organisms and the greater Universe?
- How might such a discovery affect our obligations to future generations?

Many may consider such questions trivial or purely academic exercises, philosophical thought experiments or puzzles confined to theological debate *if* it is assumed that the chances for discovery of ETBE are extremely small -- that the existence of alien life borders on fantasy. As such, most popular discussion of the issue has been largely confined to science fiction and has not been taken seriously. It has been difficult to consider such forms in the context of possible alternative futures and even thornier to consider the impact of their discovery on the mundane laws regulating intellectual property rights. Recently, however, discoveries in astrobiology, planetology, cosmology, and other fields related to our knowledge of space (such as evidence indicating the past

[9] Personal conversation with Jeffrey Nosanov, NASA space law and property law specialist (Ames Research Center), 2011.

and current presence of extraterrestrial liquid water and proof of the existence of extra-solar planets[10]) have elevated the potential that ETBE may have existed or may still exist in our Solar System and beyond (Matson 2012). Consideration of ETBE's possible status within our various governing and regulating instruments as well as in our philosophies is due.

1.2 Structure

This dissertation draws on four areas of study to propose a framework for international political policies addressing both bioethical and intellectual property rights issues associated with the search for and potential discovery of ETBE:

1. Astrobiology – The study of (1) the origins and variety of life on Earth, (2) the conditions under which it has evolved, and (3) how knowledge of Earth's life can guide the search for past and present extraterrestrial life.
2. Intellectual property rights (IP) – especially the patenting process as applied to life and biological products (life patents). Issues of the extension of patenting protocols to ETBE, their products and processes are unresolved. In consideration of the likely scientific and commercial value of such a find, the discovery of ETBE prior to establishing uniform policies may be economically and politically chaotic. Protocols found in legislation, treaties and related instruments for managing intellectual property rights regarding biological resources in Antarctica, the deep ocean floor and other areas of the global commons provide especially useful models for crafting regulations for ETBE.
3. Bioethics – The application of ethical theory to relationships among humans where health and biological processes are at issue (especially those generated by modern forms of technology, such as genomics, fertility interventions, and end-of-life decisions) and between human and non-human life (in part, sometimes referred to as animal ethics). Bioethical consideration regarding the search for ETBE has been cursory, at best. In that what may be discovered may represent an entirely new form of life never experienced by humans, it is argued that applying standards applicable to Earth's organisms may be ethically indefensible.
4. Political Science and Futures Studies[11] – Graham T. T. Molitor posed that all problems and opportunities we experience in the present at one time did not exist (Molitor 1977). Emerging issue analysis is a recognized method within futures studies for identifying emerging technological, social, cultural, political and other issues that are potentially problematic and proposing alternatives to avoid them or mitigate their outcomes. Conversely, foresight techniques can be used to identify preferred possible futures and plan on how to reach them. Here, the issue is the rapidly emerging industry of space. Among the prominent missions within that industry is the search for extraterrestrial life and its exploitation for scientific and

[10] Kepler has identified as nearly 2,400 extra-solar "candidate" planets (bodies circling stars other than our Sun that may potentially be classified as planets) with 77 confirmed as planets (http://kepler.nasa.gov/). While some are not likely candidates for ETBE (e.g., ambient temperatures exceeding the limits of many organic compounds), others may afford more temperate environments.

[11] Futures is presented in the plural (futures vice future) unless used to describe relative time (e.g., this is my future home). The plural, futures, recognizes that there are an infinite number of possible futures and that to refer to *the* future implies we have no control or choice, that it is fixed.

commercial gain. (Other missions include (but are not limited to) tourism, mineral exploitation, military uses, communications, energy, and medicine.)

The most useful work regarding futures balances art and science. Lacking either, it is diminished (de Jouvenel 1967). And while too much dependence on empirical science can be stifling and a disincentive to creativity, imagination and art without factual underpinning tends to fantasy and provides little for planning the realization of preferred futures. The "truth" of scientific "fact" can sometimes be ephemeral, but rigorous application of the scientific method can assist in keeping the process honest and receptive to new thought. And finally, although fantasy and the supernatural certainly have their social and cultural uses and can have a dramatic effect on our perception of futures, as tools they are generally not additive to serious futures work and can be distracting if not destructive. Outer space, in both its physical and philosophical contexts, provides an ideal balance of fact and uncertainty allowing imaginative construction of alternative futures.

There are three significant, if not essential, advantages provided by approaching this issue through futures studies. First, space exploration and the potential for the discovery of ETBE are clearly futures projects; we have just started on this journey and it may be decades or centuries before we discover alien entities. Or, we never meet them at all. Second, this dissertation is broadly interdisciplinary. It draws on astrobiology, ethical philosophy, and patent law under an umbrella of political science in the context of international relations and bureaucratic policy. It addresses emerging space businesses, their concerns and constraints. And third, by its very nature futures studies fosters a high degree of creativity that is lacking (and possibly discouraged) in many other fields. It invites speculation and innovation.

It is not anticipated that the considerations proposed in this dissertation will be adopted outright by any governing entity, but it is hoped an initial expression will highlight the issues' urgency, stimulate discussion and aid in highlighting bioethical and property rights conflicts. A legal solution to the property rights implications of ETBE is not attempted; that would be better addressed by a law school, a legal practitioner or one well versed in international trade and related economics. Rather, suggestions provided may create opportunities to insert such concepts as ethics, justice, and nonviolence as place-holders into the discussion, elevating their status within intellectual property rights and challenging the concept of "property" through futures analysis. If the concept of ethical justice is but a footnote in work to follow, planting it within the context of policy will hopefully make it more difficult to subsequently ignore. And while any work in this dissertation may ultimately be legitimately and convincingly argued away, an explanation of why ethical treatments are irrelevant will nonetheless make its inclusion worthwhile.

1.3 Timeliness of the issue

> *We can imagine the chaos that might result if astronauts discovered life on Mars while they were on the surface and there were no international guidelines or protocols for dealing with such a situation.*
>
> Mark Lupisella (1997, 92)

Whereas in the last half of the 20th century the US and the USSR/Russia were the only entities initiating serious space programs, the field has grown to include other nations and private commercial enterprises, as well. For example, the Indian Space Research Organization (ISRO) is planning to launch geosynchronous satellites in 2012 and is planning manned flights within the decade (Clark 2012). They have also negotiated a contract with Russia for acquiring a Soyuz spacecraft that would be used by India for space tourism (The Hindu 2009). The People's Republic of China has already launched terrestrial and lunar satellites, placed humans in space, plans to land robotics on the Moon and retrieve samples in 2017, and has announced their intention of placing humans on the Moon in 2024. Regardless of whether or not these projected missions are overly optimistic, they demonstrate a high degree of resolve.

As the number of spacefaring nations grows, addressing ethical and property rights issues may become more complex as the application of new technology enabling exploitation grows more sophisticated, efficient and profitable.[12] The longer unresolved bioethical issues and the uncertain status of intellectual property rights laws remain, the more difficult they will be to adequately settle.

Within the past few years, conclusive proof of the presence of water ice within the top few centimeters of the surface of Mars (outside of its polar ice cap) coupled with other evidence supporting the potential for Mars to have (or have had) life have fueled the next stage of exploration of that planet.[13] In 2007, NASA proposed that an astrobiology research lab be sent to Mars in 2016 and that orbiting telescopes be launched to "discover the origin, structure, evolution, and destiny of the universe, and search for Earth-like planets" (NASA 2007). The Mars Space Laboratory was launched in late November 2011 and successfully landed in August 2012 to begin its task of searching for evidence of past or present life there. If successful, we may have proof of extraterrestrial life within a few years or possibly sooner. Elsewhere in our Solar System, the identification of vast quantities of water under the ice of Jupiter's moon Europa and Saturn's Enceladus and, more recently, verification of abundant molecular oxygen in Europa's sub-ice ocean and atomic oxygen on Enceladus have also spurred speculation (Greenberg 2008).

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[12] The November 2009 report prepared for the White House Office of Science and Technology by the Review of Human Spaceflight Plans Committee recommends slowing the U.S. space program, with a focus on lower orbital flights as opposed to missions that include sending people to the Moon or Mars (Augustine 2009 p120).

[13] NASA's Mars Phoenix Lander, 2008, conclusively proved the existence of water ice 5 centimeters below the surface (http://phoenix.lpl.arizona.edu/index.php).

As expressed by NASA and the ESA, the search for existing or extinct extraterrestrial life is a priority of these programs (Des Marais, Nulth et al. 2008). The chances for discovery of present or extinct ETBE in our Solar System and galaxy are no longer remote and it may be more of a matter of when rather than a question of if (DiGregorio, Levin et al. 1997; Bennett and Shostak 2007). Where there have been ethics and intellectual property (IP) policy discussions, they appear unfocused and, at times, contradictory. For example, Christopher McKay (a leading NASA planetary scientist and astrobiologist) has stated that humans have an *obligation* to modify the environment of an extraterrestrial body should life be discovered there in a depauperate or declining state with the purpose being to "benefit" that life (McKay 2001; McKay and Marinova 2001). Citing a human *obligation* to ETBE is clearly a statement of an ethical position demonstrating an intent that could have far-reaching policy implications. One person's opinion, in this case, certainly does not represent a national or international objective, yet McKay's position, professional standing, and numerous publications have the potential to influence bureaucratic priorities. McKay, however, stated the need for coherent policy.

Our diverse bioethical relationships with terrestrial forms of non-human life have evolved over millennia and are expressed in innumerable theological and secular sources. But the instant of first discovery of ETBE will be brief. How humanity chooses to shape that initial encounter will reign as one of the most pivotal and studied events for millennia to come. As NASA's Mark Lupisella aptly wrote, "How we react to this kind of discovery (extraterrestrial life) will define who we are as a species" (Lupisella 1997, 89). Although many predict that such an event would be one of the most significant scientific events in human history, should the discovery be precipitated or immediately followed by violence (through death or mutilation of the organism and possible devastation of its populations) without ethical forethought and rigorous justification, it will evidence little philosophical advancement. Compounding this immediacy, human relationships with extraterrestrial entities established at our first encounter have the power of precedent; after discovery, they will become increasingly difficult to alter as special interests become entrenched, bureaucracies calcify to match terrestrial protocols and priorities, procedures grow routine and opportunities to effectively critique diminish.[14] This will be especially true if such entities have significant commercial in addition to their predictable scientific value. Resulting issues of ownership via patenting would be compounded considering that the discovery may be shared among competing national and private interests. Accordingly, discussions of the relationship of intellectual property rights to extraterrestrial biological discoveries are included in this dissertation.

[14] This process of relaxing standards designed to protect ETBE has already begun. For example, NASA's earlier sterilization protocols for craft sent to extraterrestrial bodies (e.g., Mars) have since been reduced (in terms of maximum number of bacteria allowable per unit of volume or surface area of spacecraft). Predominant thought within NASA is that it was too expensive to achieve the higher degrees of sterilization required for previous missions and that contamination is "inevitable." Further, NASA contends that should there be a future need to remove such contamination, it will be "relatively easy" (McKay 2009). McKay may be underestimating the difficulty of removing a biological entity, especially one on the bacterial scale, once it has become established in an open environment with potential subsurface niches (Kramer 2009).

The potential (even if extremely small) for extraterrestrial discoveries allows such ethical reconsideration relatively free of many of the constraints that have framed and limited our analyses throughout our many histories. As expressed by Tae-Chang Kim and Allen Tough, "Fresh perspectives can lead to innovative actions," and life on Mars or elsewhere would certainly provide such perspective (Kim and Tough 1994, 17-54). It is critical, therefore, that we address the ethical issues that will rapidly evolve from such a find prior to that event, for from the moment of discovery forward there will be immense political, commercial and perhaps even theological pressures that may steer us away from a more enlightened and consistent ethical policy (Bertka, Roth et al. 2007, 242; Dick and Launius 2007). "We can imagine the chaos that might result if astronauts discovered life on Mars while they were on the surface and there were no international guidelines or protocols for dealing with such a situation" (Lupisella 1997, 92).

Should our future explorations determine that the Earth is the only venue within our Solar System to have ever supported life, the issues addressed in this dissertation will still have value. The practice of ethics evolves through practice and hopefully improves when challenged by unique circumstances. The potential for ETBE, whether discovered or not, may provide a spark that generates productive bioethical dialog.[15]

1.4 Summary of observations and conclusions

- Predominant Western bioethical standards over past centuries have been founded largely on both the utility of the species under consideration and their degree of taxonomic relatedness to humans. The prejudices adherent to such drivers have contributed to the general failure to achieve ethical ends, namely, to enlighten human consciousness, further environmental justice and set nobler standards that serve to strengthen the human community and aid in mutual moral growth. It is doubtful if ethical relations among humans will be improved in our diversity of futures without also providing ethical consideration to a much wider circle of non-human species, whether terrestrial or other, and their habitats. ETBE provides the opportunity to break the cycle of restrictive ethics.
- Preexisting links between culturally established bioethical standards and the ownership of living resources have been substantially weakened or broken with the invention of intellectual property rights as propagated through patent law. The codification of the ownership of life and life products through patents and similar instruments creates hierarchies influenced by commercial value which, in turn, temper ethical regard. Should contemporary policies regarding life patents be extended to ETBE without consideration of the uniqueness of such entities, we will have missed an opportunity to reconsider and improve that relationship.
- While there have been many benefits afforded by research and subsequent technological advances due to space exploration, the overwhelming impetus for such activities to date in the US has been the advancement of national prestige and the maintenance of actual and psychological military and economic

[15]Recognition of the potential for chemical pollution to affect air, soil, water and life (e.g., as described in Rachael Carson's 1962 *Silent Spring*) had a similar dialog-generating effect on environmental ethics during the last half of the 20th Century. The positive changes that debate precipitated have been profound.

dominance. Recent trends in the privatization of space exploration and exploitation shifts those motives to ones based more on sustaining continued-growth capitalism and less on patriotism and empire-building (although the three are closely related) (Marshall 1995; Smith 2010). As such, it is likely that policies regarding space will be increasingly directed at maximizing and managing profits and reducing and spreading liabilities. These trends may inhibit ethical approaches to exploitation in manners similar to those experienced during the period of European colonial expansion; they serve to widen the gap between the wealthy and the poor on a global scale (Diamond 2005).

- Existing structures for international management of the resources of areas such as Antarctica and the international seabed have their weaknesses, but they provide sound models for designing protocols for guiding the exploitation of extraterrestrial resources, including biological resources. Key to space exploration is the recognition that it represents a globally shared resource, and, as such, a portion of profits derived from exploitation must effectively be used for the benefit of both terrestrial and extraterrestrial commons.
- ETBE (as defined in this dissertation) do not include sapient beings capable of directly expressing their needs and desires. How, then, might one provide them representation? Theoretical work of John Rawls and others offer approaches to give ETBE "voice." I propose a trust be established to represent the interests of ETBE even before we are aware of their existence.
- Glenn Paige has called for actions fostering political systems at all levels that no longer support or otherwise permit killing people in any circumstance (Paige 2000, 2009). He envisions that such "nonkilling" would gradually become institutionalized, eventually entering all cultures on a global scale. It represents not only a noble futures project but, I believe, an achievable one. This dissertation speculates on the positive effects of expanding the concept of nonkilling to include all life, including possible ETBE, in our futures.[16] Nonkilling followed by nonharming provides goals for measuring bioethical progress free from qualifications for ethical consideration such as sentience and sapience. While such a condition will not likely be achieved any time soon, it represents an ideal toward which we can strive.

Whether or not extraterrestrial biological entities are discovered in the coming few decades is both speculative and, in fact, irrelevant to this dissertation. What is critical is how we react to the event.

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[16] Most would not agree with extending ethical consideration to all species, including pathogens (Duffy 1989). This is addressed in Chapter 7.

CHAPTER 2
ASTROBIOLOGICAL FOUNDATIONS AND THE ISSUE OF BIOLOGICAL BOUNDARIES

Where the telescope ends, the microscope begins.
Which of these has the grandest view?

Victor Hugo- *Les Miserables* (1862)

It is the customary fate of new truths to begin as heresies and end as superstitions.

Thomas Henry Huxley - *The Coming of Age of the Origin of Species* (1882, 229)

I contend that the continued racial classification of Homo sapiens represents an outmoded approach to the general problem of differentiation within a species. In other words, I reject a racial classification of humans for the same reasons that I prefer not to divide into subspecies the prodigiously variable West Indian land snails that form the subject of my own research.

Stephen J. Gould - *Ever Since Darwin* (1977, 231)

2.1 Premise

Hypotheses of chemical evolution plausibly allow for the emergence of life on Earth and possibly elsewhere as testable alternatives to speculations of spontaneous generation, theology-based supernatural explanations and other mythologies. Demonstrations of the exchange of genetic materials among many disparate organisms and viruses[17] and possibilities of endosymbiosis support a conclusion that Earth's organisms are more blended than discrete -- boundaries genetically blur and can become indefinite and imperceptible. As such, it becomes increasingly difficult to effectively argue that human life (or any other organism's) exists distinctly apart from other life and, by extension, from the inanimate. We share ancestry and phylogeny. It follows that in defining less conflicting bioethical standards, it is critical to recognize that the schism that has historically divided entities worthy of our ethical consideration from those not worthy is a cultural and ideological one, not one based on any biological discrimination. The issue is compounded by conflicting definitions of what constitutes life. It is argued that most attempts to the present to define life serve more as tools employed to segregate according to cultural biases (Othering), thus inhibiting consistent and defensible ethical behaviors.

[17] Viruses are generally not considered living, thus are not organisms by accepted definition (Zimmer 1011a).

2.2 Life origins

2.2.1 Chemical evolution

The oldest known fossils of life on Earth date to 3.4 to 3.47 billion years ago (bya). Discovered in sandstone in Western Australia, these single-celled, tubular micro-fossils represent the earliest physical evidence of life (Wacey, Kilburn et al. 2011). Chemicals indicative of life have been identified from within rocks dated to 3.5 to 3.8 bya. These dates are especially significant in that they support the contention that life appeared on Earth relatively quickly during the few hundred million years after the cessation of the Late Heavy Bombardment 3.85 bya (Bennett and Shostak 2007). Prior to this cessation, frequent and violent collisions with meteors heated the surface of the Earth well above any upper tolerances of life processes we know of, vaporizing water and melting surface rocks. Organic molecules associated with life would not likely have survived unless they were in protected, remote locales.

There are two predominant methods for researching early life and its origins. The first is reductionist, studying currently existing life, tracing its ancestry back through the fossil record and attempting to identify the oldest known forms. While this is a useful approach for paleontology and was the standard approach for several centuries, it is not as helpful for investigating life prior to the appearance of organisms with body structures capable of fossilization. A second approach begins with presumptions of the possible environmental conditions of prebiotic early Earth, water chemistry and gases present in the atmosphere, temperature regimes, available micro-climates (for example, deep ocean thermal vents), unique energy and organic compound sources and other factors descriptive of that period.

The pioneering works of Alexander Oparin (1894-1980) and J.B.S. Haldane (1892-1964) are largely considered the beginning of the scientific study of abiogenesis, the process of the emergence of life on Earth from inorganic compounds (Clark 1968; Deamer and Fleischaker 1994).[18] Their theorizing (later termed the Oparin-Haldane Hypothesis) was unique in that they contemporaneously, yet independently, hypothesized that life on Earth may have begun as a result of interactions among non-living, inorganic precursors under environmental conditions believed to have existed on Earth during its first half-billion years.[19] Especially original within Western science was their position that at root there was no fundamental difference between the living and nonliving, that they represented two components of a continuum of growing chemical and organizational complexity (Clark 1968).[20]

[18] Although there were certainly predecessors -- Redi and Pasteur for their clinical observation and experimentation, but also the more theoretical work of Edmond Perrier in 1920, who also postulated the emergence of life from chemical processes (Cerceau 2008).

[19] Oparin published in Russian in 1924, with Haldane publishing similar conclusion in 1927 in English. At their first meeting in 196,3 both acknowledged that at the time of their publications they had worked independently without significant knowledge of the other's efforts. It is unlikely that Haldane knew of his work until Oparin's 1938 English publication of *Origin of Life* (Sullivan and Baross 2007 p 41).

[20] Belief in the continuity of animate and inanimate is maintained by many indigenous belief systems although challenged by most branches of Judeo-Christian thought (i.e., the maintenance of a strict dichotomy, a boundary defining life as distinct from the inanimate).

While a radical idea for the time, theories of chemical evolution have grown to wider acceptance. Further, they maintained that such inorganic life-favoring processes need not be limited to Earth but could also occur wherever a suite of environmental conditions and molecular raw materials would allow a series of physical and chemical interactions to occur. This new paradigm in origins research was far from the spontaneous generation hypotheses of centuries before which were a product of flawed method and uninspired observation (e.g., that mice spontaneously arose from haystacks and that maggots were created from rotting meat).[21] Oparin and Haldane challenged the then-accepted position that life on Earth must have either (1) originated elsewhere in the universe and found its way to this planet (panspermia, which just defers the question of life's origins to some other venue) or (2) that it was the direct result of one of many creation myths of divine purpose and supernatural intervention, untestable and beyond the limits of scientific inquiry. They were notable in that their speculations and hypotheses could be scientifically tested. They, however, did not pursue such testing with any rigor. Thirty years later, Stanley Miller and Harold Urey did.

Miller and Urey collaborated in expanding and testing the Oparin-Haldane hypothesis in 1952 by roughly recreating what was believed (at that time) to be an early Earth atmosphere (methane, ammonia, hydrogen and water, a mixture notably lacking in oxygen) and adding heat and electrical energy (electrical spark, abundant as lightning during that epoch of Earth's history). The relatively simple experiment produced dramatic results within less than a week. From an inorganic environment, five amino acids were initially detected, dramatically supporting the Oparin-Haldane hypothesis -- complex organic compounds could be created from inorganic under the then-believed environmental conditions of early Earth (Miller 1953). Since then, more sensitive analyses of samples taken from the product of their 1952 experiment have identified 13 of the 20 amino acids associated with all terrestrial life. Readjustments in the inorganic gas mixtures have produced four of the deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) bases plus ribose (the sugar critical to RNA structure) (Ito, Shen et al. 2011).[22]

Over the past half-century since Miller's and Urey's experiment, advances in technology, geology, cosmology and other fields have permitted more accurate speculation on the possible composition and ratio of the components of prebiotic Earth atmosphere (specifically, the ratio of hydrogen to carbon dioxide and the mitigating effects on the synthesis of organic compounds of the rate at which hydrogen escaped Earth's early atmosphere) (Bennett and Shostak 2007). Miller-Urey employed a gaseous mixture with the higher concentrations of hydrogen they presumed present in early Earth atmosphere derived from interstellar matter, from the cosmic dust that coalesced to form Earth. All gases initially employed in their apparatus were hydrogen-rich, a defensible assumption

[21] Spontaneous generation hypotheses were generally disproved by the work of Louis Pasteur and his sterile techniques.

[22] As of July 2011, 8 DNA bases have been identified. In addition to adenine, cytosine, thymine, and guanine, the additional 4 include 5-methylcytosine, hydroxymethylcytosine, 5-formylcytosine, and 5-carboxycytosine. (Ito 2011)

at the time in that ninety percent of the matter in the material universe is believed to consist of the element. However, more recent work has speculated that most of Earth's atmospheric hydrogen would quickly be lost and replaced by an atmosphere of volcanic origin, low in hydrogen and more closely resembling Earth's present atmosphere but for the presence of oxygen (Kasting 1993). This revised composition did produce some organic compounds, but not the variety or concentrations of the 1953 experiment. Although their results have been significantly challenged, Miller-Urey continues to represent an important step by broadly challenging the then-existing predominant scientific thought and encouraging the new directions of research that followed.

With the emergence of the age of space exploration and NASA's stated interest in planetology and astrobiology in the late 1950s, chemical origins of life have been largely adopted as a foundational paradigm (Dick and Strick 2005). However, theories of panspermia, origins of life elsewhere in the universe finding its way to Earth to begin cycles of life here, cannot be disproven (Mautner 2004).

Deep ocean thermal vents may have provided another source of early organics and a possible site for chemical evolution to proceed. The combination of emergent gases such as hydrogen sulfide, high thermal energy coupled with the energy of reduced minerals, and concentrations of other inorganics potentially produced organic molecules associated with life (Corliss, Baross et al. 1981). During the Late Heavy Bombardment (3.9 bya) these deep ocean sites would have been more protected from the disruption of meteor impacts experienced on the surface ("impact frustration") and would have maintained more constant and cooler temperatures than the surface, providing more stable environments for the formation of the complex organic molecules required by life (Sleep, Zahnle et al. 1989).

Comets, interplanetary dust and interstellar media are also likely sources of organic molecules on early Earth; amino acids were identified from the interior of a meteorite collected at Murchison, Australia in 1969 (Kvenvolden, Lawless et al. 1970; Chyba, Thomas et al. 1990; A'Hearn, Belton et al. 2005). Similarly, a meteoroid that exploded over British Columbia, Canada, contained 3% by weight of a "complex suite" of organic materials, including molecules of "prebiotic interest" such as amino acids, nucleobases, pyruvic acid, citric acid, sugars and polycyclic aromatic hydrocarbons (Herd, Blinova et al. 2011). Additional analyses demonstrated that detection of the materials was not a result of contamination with indigenous organic compounds after the meteor had entered Earth's atmosphere; they are extraterrestrial in origin (Callahan, Smith et al. 2011).

As summarized by Bennett and Shostak, "all the building blocks needed to make life" were present on Earth prior to the emergence of living forms, supporting Haldane's and Oparin's hypotheses on chemical evolution leading to life" (2007, 200).[23] Given this

[23] Pyruvic acid ($CH_3COCOOH$) and water placed in a gold capsule produced tens of thousands of different molecules within two hours. "So the argument here is that you can go from very simple ingredients, the kinds of things that would be available on a primitive planet or moon, and in any environment you can imagine, if you put energy in the system, you will see an explosion of biomolecules" (Hazen, in Bertka et al. 2007, 34).

proof of prebiotic organic molecules, a required next step in chemical evolution is their concentration to a degree allowing denser physical proximity, interaction and the formation of polymers (larger chain molecules). It has been hypothesized that this may have happened within crystallized silicate clay layers at the molecular level (Cairns-Smith 1985). The charged nature of silicate clays may have aided in both concentrating and organizing ionized amino acids on charged "scaffolds." Other possible sites for concentration are flocculation points in areas such as tide pools, intertidal zones and evaporation ponds once the sterilizing effects of bombardment had ceased. In addition to concentration, it has been demonstrated that pre-biotic lipids (also products of the Miller-Urey apparatus) exposed to desiccation and rehydration (as would be experienced in a tidal pool or flat, for example) aid in the formation of multilayered structures that capture organic solutes (Shew and Deamer 1985). A series of these drying and wetting cycles leads to encapsulation and the formation of lyposomes, a possible precursor to a cell membrane. In laboratory trials, enzymes, so entrapped, were both encased by a lipid bi-layer formed during repeated desiccation cycles and were effectively protected from molecules outside the layer that would normally denature them. In effect, it was demonstrated that with concentration and a series of dry/wet events, a bi-layer lipid capsule will form and entrap other molecules, establishing a unique internal environment (Chakrabarti, Breaker et al. 1994; Walde, Goto et al. 1994). Similarly, investigations have demonstrated that drying cycles contribute to the linking of abiotically produced amino acids to form proteinoids (protein-like structures). When heated in the presence of sterilized lava, the amino acids not only produce proteinoids but encapsulate, forming microspheres that clump into chains (Fox, Jungck et al. 1974).

RNA can be produced from inorganic compounds under conditions similar to those found on early Earth and some forms are autocatalytic, able to both abiotically link and catalyze their own replication (Gilbert 1986). Abiotic experimentation has produced RNA strands of 100 base pairs in length that function as enzymes (ribozymes) and mutate with subsequent replications; they evolve (Margulis 1998, 81; Bennett and Shostak 2007, 201). There is strong evidence that the molecules so created more efficiently exploit the resources available to perpetuate their replication (Overbye 2011).

No one has suggested that any of these stages marks a specific point of emergence of life. There are certainly challenging and highly complex steps in the structural development of living cells and metabolic processes yet unknown. However, at such a point in chemical evolution where inorganic compounds have become organic, have concentrated, are encapsulated in semi-permeable membranes and carry reproducible data in the form of RNA or DNA, the question of the definition of life becomes more critical.[24] The debate over the point of the emergence of life, as currently defined, is not new -- neither are a range of considerations regarding chemical evolution. "Evolution is not a theory for us chemists; it's what molecules do when they have the property to replicate and transmit information from parents to progeny" (Overbye 2011, A1). Vernadsky (1863-1945)

[24] Announcement was made in 2010 of the successful insertion of a partially artificial genome into a bacterial cell, creating a new organism. This further challenges traditional definitions of life and its modes of creation. However, while the inserted material was synthetic, the host cell was not (Venter, Gibson et al. 2010).

described living matter as “animated water,” an insightful and perhaps prescient perspective on life (Kandel 2003).

2.2.2 Origin scenarios

There are several scientific possibilities regarding the origins of life on Earth and (possibly) extraterrestrial sites.

- Singular Earth genesis: Life emerged and developed on Earth and only on Earth. This is the predominant paradigm of most current investigations of the origin of life (such as the work of Oparin and others previously discussed) because that is the only avenue of experimentation available until extraterrestrial life is found. At such a time the focus of research will expand. If life originated here it would likely be restricted to our Solar System. However, such a scenario assumes that life does not exist elsewhere, and while we may be able to make such a determination for our Solar System within the coming few centuries, it would say little regarding the possibilities of life existing in another solar system within or outside our galaxy. It will likely be impossible to ever state with assurance that life exists only on Earth; to do otherwise would be proving a negative.
- Extraterrestrial genesis of life on Earth: Life emerged at some extraterrestrial location and arrived on Earth as the result of meteor impact, debris from a passing comet or asteroid, panspermia (that life exists or existed elsewhere and propagates through space) or any other action that would deliver life here.[25] We would share the same phylogenetic “tree” (Arrhenius 1980). For example, life emerged on Mars and arrived on Earth with a meteor of Martian origin.[26] As such, life on Earth would not necessarily be unique, at least not unique in our Solar System.
- Second genesis: Life emerged and developed on Earth, but life also emerged and developed independently at some extraterrestrial location. Earth’s life would not likely share the basic attributes or characteristics of a product of a second genesis and would, quite likely, be significantly different as a result of the serendipitous factors required for chemical evolution. These would include the peculiarities specific to Earth’s prebiotic environment, such as predominant minerals and inorganic nutrients, temperature, atmospheric composition, radiation, the presence and chemistry of liquid water, diurnal periodicity, seasonality, the effect of tectonic action on carbon recycling and a myriad of other factors. If evidence of a second generation is discovered, there may well be a third, fourth, or millions of other independent genesis events throughout the Universe.

The question of a “second genesis” will be critically important should extraterrestrial life be discovered within our Solar System because of its relative proximity. If that life

[25] Including premeditated alien “seeding” of Earth or what has been ingloriously called the “stop and spit” hypothesis (alien intelligence visiting Earth and contaminating the otherwise pristine and sterile environment). These will not be addressed in this dissertation but will be left to science fiction for elaboration.

[26] Meteorites have been collected and verified as being of Martian origin. Meteorite 84001, collected from Antarctica in 1984, was suspected of carrying fossil evidence of microbial life but the structures have been generally ruled as being of mineral, not biological origin.

shares little in common with Earth's life (e.g., does not employ DNA or RNA for genetic information coding and reproduction, exhibits left-handed amino acid chirality, is based on compounds other than carbon (e.g., on silicon), uses a predominant liquid solvent other than water, etc.) it would support the contention that life is likely abundant and dispersed in the Universe. If it is found that extraterrestrial life shares much in common with Earth's life and that there is strong evidence of a common origin, it would support panspermia hypotheses. The finding would not argue against ubiquitous life, but would challenge our concepts of origins.

As of August 2012, NASA's Kepler telescope mission alone has confirmed 75 extra-Solar planets, and the total of all planets that are candidates for confirmation is over 2,200.[27] Few exhibit the environment required for life as we know it, but the number demonstrates that planets and solar systems outside of our own are numerous.

2.3 The problem of defining life

> *Life must necessarily be based on Carbon and water, and have its higher forms metabolizing free oxygen.*
>
> Lawrence J. Henderson, Harvard University biochemist, 1912

> *I personally find this conclusion suspect, if only because L. Henderson was made of carbon and water and metabolized free oxygen. Henderson had a vested interest….*
>
> Carl Sagan (1973)[28]

In the realm of the biological sciences, disputes over the definition of life are further divided by camps favoring structural markers or architectures for life (e.g., an emphasis on the presence of a semi-permeable membrane) as opposed to metabolic evidence of life (cytoplasmic function) (Podolsky 1996). Both camps, however, seem consumed more with the descriptions of what life can do, its various functions, than what life is (Wicken 1987; Tsokolov 2009). The latter enters philosophical territory. However, the quest for a functional definition can be aided by taking two approaches, the first at the molecular, chemical and metabolic level and the second at the cellular and organismal level (Lahav 1999). But to address the ecological aspects of life, the relationship among organisms and their environment, an approach at definitions must recognize that no single aspect of life or even a few criteria are sufficient, that the whole, not the parts, defines life (Morowitz 2004). This more holistic process is termed autopoiesis.[29]

That said, a comprehensive definition of life is provided by Lahav (1999, 113):

> *Living entities are complex, far-from-equilibrium structures maintained by the flow of energy from sources to sinks. They are compartmentalized, organic,*

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[27] Extra-Solar planets are planets identified from outside our Solar System. They include all planets identified, including gas and rocky planets. Updated statistics at: http://kepler.nasa.gov/Mission/discoveries/candidates/

[28] As cited by Nadis (2006).

[29] Autopoiesis in this context is defined as the process of self-organizing and self-sustaining living systems, e.g., a cell that functions to maintain itself and produce more cells like itself is exhibiting autopoiesis.

homochiral entities[30]*, closely associated and communicating with their environment (including other life forms) and at the same time separated from it by a boundary (in extant organisms, a lipid bi-layer), and dependent in their activities on a continual flux of energy and matter through this membrane, from their environment. They can replicate, mutate, exchange matter and energy with their environment, and evolve, in processes that are catalyzed by a large arsenal of organic catalysts. The characteristics of most or all of these processes and molecules, as reflected by their chemical cycles, regulation, communication, complementarity, and rhythms, as well as potential life criteria of each organism, corroborate with the principle of continuity. Having evolved from inanimate matter, they constitute autocatalytic, evolvable, teleonomic organic systems that can transfer, store, and process information, based on template- and sequence-directed reactions, all of which characterize autopoietic entities*.

As cited by Lahav quoting Goddard (1958, 133), the key to a definition is determining "what is the minimum number of elements that we have to add to the non-living physical systems to have the minimum living system." However, a singular yet comprehensive definition is elusive even when limiting the discussion to biological criteria and processes only, and it remains doubtful there will be broad agreement while attempts to do so maintain their focus on specific limiting requirements and conditions.

The definition itself becomes an instrument of exclusion as opposed to an invitation to novelty.

Such scrutiny of life may well be driven by a variety of philosophical or possibly epistemological motives buried in the human penchant for categorizing that serves primarily, here, to segregate the animate from inanimate. Its purpose is to build and maintain foundational walls without which many histories of Western thought would need careful reexamination (as is argued in Chapter 3). Definitions are certainly not favorable for inclusion of the "gray areas" within the progression of chemical evolution to readily recognizable life that fits snugly within existing taxonomic classifications. Additionally, various disciplines (physics, biology, medicine, philosophy, cosmology, theology and others) have disparate needs, each dictating a unique set of defining criteria (Emmeche 1994).

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[30] Like many organic compounds, amino acids exist in either of two mirror image structures, arbitrarily labeled "left" and "right" chirality. Homochiral refers to the molecular property exhibited by all life on Earth (so far examined) whereby amino acids linked to form proteins are arranged in a "head to tail" fashion, requiring only the so-called left chiral orientation. The "right" structure, while abundant on Earth, is not found in any amino acids employed by life so far examined. DNA, however, is homochiral with the right orientation. The purpose for selection of "left" over "right" in amino acids is unknown, although it has been suggested that amino acids on interstellar media exposed to polarized light emitted by neutron stars would be altered to carry predominantly left chiral amino acids (Breslow 2009). Homochirality provides evidence of common ancestry among all life on Earth. The chirality exhibited by any extraterrestrial life will be of great interest. Note: As stated on page 132 in Morrison and Boyd's much-dreaded "Organic Chemistry" text, "everything, except vampires, has a mirror image."

To date, there is no universally accepted definition of life and a common definition would not necessarily be useful to most terrestrial studies (Chyba and McDonald 1995). From Aristotle (who defined life as the capacity to reproduce) forward, there have been many attempts, each with its own theological, biological, philosophical or other purpose. Lahav (1999, 117-121) lists 47 scientific attempts to characterize and define life and its hypothetical origin during the years 1855 to 1997. But the quest becomes especially critical to many when addressing the continuum of chemical evolution. At what specific point along the gradation between random inorganic molecules and a recognized form of life, such as a bacterium, does life emerge and how does the classification of both sides of that divide, living and non-living, affect our relationship with them?[31]

In the 1970s James Lovelock set out to help solve a problem of how to remotely determine if planets potentially supported life. His and the work of many others through the following decades have contributed to a perspective on planetology which views life on Earth as interacting with non-living components of the planet in a myriad of both negative and positive feedback loops that help to regulate climate and other attributes of a planet capable of supporting life. Termed the Gaia Hypothesis, it does not claim that the Earth is a living organism by common definitions, but rather that its many living and nonliving systems interact to create and moderate the atmosphere, hydrosphere, biosphere, and other phenomena (Lovelock 2000).

> *It is a relatively simple matter to distinguish between living and inorganic matter on Earth by biochemical experiments even though no formal definition of life in biochemical terms exists. Experience suggests, for example, that a system capable of converting water, atmospheric nitrogen and carbon dioxide into protein, using light as a source of energy, is unlikely to be inorganic. This approach for recognition of life by phenomenology is the basis of the experiments in detection of life so far proposed. Its weakness lies not in the lack of a formal definition but in the assumption that all life has a common biochemical ancestry.*
>
> (Lovelock 1965, 568).[32]

Lovelock later wrote that current definitions of life are limited and overly restrictive (2010, 192). His hypothesis and statements are in accord with the perspectives developed in this dissertation, that the living and non-living are not as easily teased apart and defined as most believe. However, Gaia has since taken on spiritual meanings verging on the theological, giving the Earth aspects of a living, if not conscious, organism (Jones 1989). This spiritual aspect of Gaia is beyond the scope of this dissertation.

2.4 The problem of defining organisms and species

A similar controversy continues on the "living" side of the chemical-to-life continuum where there exists an ongoing history of debate and readjustment regarding the taxonomy

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[31] By analogy, it is problematic in a similar way to define what constitutes a happy individual; where, on the continuum of miserable to euphoric does happiness specifically occur? The point is determined largely by the motive of the questioner and the concerns of the questioned.

[32] Lovelock may have spoken too soon. In 2012 Panasonic announced that it had synthetically duplicated the process of photosynthesis (sunlight + water + carbon dioxide produced sugar).

of organisms, their ancestries, degrees of relatedness and speciation itself. Classification systems are in a near constant state of flux that has accelerated with challenges to the concept of discrete species. When Aristotle listed names of 500 animals in the 3rd Century BCE (the first known attempt at such a catalog) he relied on empirical observation of the slice of the Mediterranean he experienced; they were the only tools at his disposal (Lennox 2001). But he recognized and accentuated unifying characteristics of the organisms in contrast to differentiations. For example, he grouped oxen, deer and cattle due to the presence of horns or antlers, a commonality, and animals possessing blood from those not (e.g., mussels and insects) as opposed to seeking only differences. Three hundred years later Pliny added hundreds to the list, including anecdotal reports of unicorns and mermaids and misinterpretation of fossils (e.g., dragons evidenced by sharks' teeth). Many others collated lists based on a range of differing criteria and methods. The mid-18th Century binomial system (*Genus species*) of Carolus von Linne (Linnæus) greatly formalized the process of taxonomic naming. Coupled with Cuvier's anatomical studies a few decades later, the more modern forms became conventional.

The International Code of Zoological Nomenclature recognizes a trinomial system including subspecies. In botany, Linne's *Species Plantarum* (1753) and many other works, notably including Asa Gray's contributions in botanical cataloging in the mid-19th Century, established a parallel system for plants (*Genus species subspecies*), but naming rules differ from those governing animals. Regardless, increasingly finer gradations below the subspecies level may include such groupings as variety, race, tribe, cultivar, and indicators of hybridization. But the critical consideration is that taxonomic classification is not fixed but is constantly adjusted as interpretations of a range of anatomical, distributional, ecological, biochemical, genetic and other data are reconsidered; relationships grow in complexity as finer and finer distinctions of difference are noted.[33] Since the Enlightenment the focus had gradually shifted from Aristotle's approach of seeking common traits to one of seeking differences, and by seeking difference, gradations carry down to the individual, and perhaps farther. Classification loses its purpose.

Advances in technology have facilitated our ability to detect differences among organisms previously inaccessible. Whereas Aristotle relied on empirical observation, we have access to increasingly more sensitive tools (e.g., light microscope and electron microscopy) and the benefit of newer schools of knowledge (e.g., comparative anatomy and biochemical analyses) allowing detection of distinctions previously unrecognized. With each incremental advance in our ability to discern, we have recognized increasingly subtle variation which begs additional descending and ever-finer classification categories. The most recent addition to the arsenal of analytical technology related to this process is

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[33] It can also be influenced by political or social agendas where the "science" of taxonomy is either of little importance or can be accomplished in more socially acceptable ways. A most notable example exists in the classification of humans. All are universally grouped into one taxonomic classification (*Homo sapiens sapiens*) without the subdivisions that would be common in other species. This is not a flaw in the system, but, rather, reflects the awkward political and cultural circumstances precipitated by further subdivisions (race, ethnicity, geographic distribution, etc.). Ethnicity can be a critical scientific factor (e.g., in diagnosing and treating some health issues), but means other than taxonomy are employed, such as simply stating ethnicity or race outside a taxonomic context.

the science of comparative genomics, mapping and sequencing genes from a range of species from bacteria to humans (Thieman and Palladino 2004). However, while the degree of identification of differences among organisms has peaked (for now) with genomics, carried to its ultimate this would yield the conclusion that all organisms, save, perhaps, bacteria and clones, are variants; all are genetically different. If classification were to be carried to this extreme, each individual organism with a distinctive genome would be "classifiable," diminishing the usefulness of classification systems. "The collapse of the doctrine of one gene for one protein, and one direction of causal flow from basic codes to elaborate totality, marks the failure of reductionism for the complex system that we call biology" (Gould 2001).

The problems of organism classification are compounded with the consideration of endosymbiosis, the hypothesis that a significant step in the appearance of eukaryotes (organisms with defined nuclei and organelles) was that rather than archaic bacterial forms developing such structures independently through Darwinian evolution, specialized bacteria merged to form more complex organisms in symbiotic partnership. Evidence of complex symbiotic relationships among unicellular organisms in the creation of more complex forms is provided by such communal associations as volvox and slime molds.[34] The concept of dissimilar but symbiotic bacteria fusing was first proposed by Ivan Wallin in the 1920s (1923), but more recent proof of the semi-independent chloroplasts of plant cells and mitochondria in animal cells, each maintaining DNA structurally separated by membrane from, and independent of, that cell's nuclear DNA remain the most convincing facts supporting endosymbiosis. The hypothesis holds that one archaic bacterial cell, lacking nucleus or organelles, is ingested by another cell. But rather than being digested it continued in a symbiotic relationship within the predatory cell (Margulis and Sagan 2002). This was not a singular event but occurred countless times throughout our early history and likely continues today. Modern eukaryotic cells of protists, animals, fungi and plants, then, represent the product of combinations of other organisms.

Each of us is a cooperative of about 1,000-trillion cells that we routinely think of as "ourselves." Yet, ninety percent of these cells are bacterial, representing an estimated 36,000 different organisms (Brill 2012). Human cells and bodies are perfused with trillions of bacteria without which we could not survive, and many have co-evolved with our species. Hardly foreign, bacterial DNA is constantly circulating within us, altering "our" DNA and challenging our identity as a singular organism. We and all other multicellular organisms are an amalgam of other living (and non-living, considering viral) forms interacting at the cellular level. "The world of life not only consists of independent species, but every individual of most species is actually a consortium of several species. The relations between larger organisms and microbes are infinite in number and in most cases make an indispensable contribution to both partners fitness" (Mayr 2002, xiv). This is just beginning to be recognized in Western medicine and promises new approaches to disease treatment. Viewed now as a "superorganism" as

[34] Volvox is a freshwater green alga within the genus *Chlorophyta*. In larger concentrations, they live independently as unicellular organisms. However, when in small numbers or stressed, the independent cells form spherical and elegant colonies of up to tens of thousands of cells and, when in such communities, function in many ways as a single organism.

opposed to a discrete biological entity, the "human body provides a complete new systems concept for managing human health at the clinically relevant whole body level. [This approach is] one of the most significant paradigm shifts in modern medicine" (Zhao, Nicholson et al. 2012).

As elegantly stated by Donna Haraway, "I love the fact that human genomes can be found in only about 10 percent of all the cells that occupy the mundane space I call my body; the other 90 percent filled with the genomes of bacteria, fungi, protists, and such, some of which play in a symphony necessary to my being alive at all, and some of which are hitching a ride and doing the rest of me, of us, no harm. …To be one is always to become with many" (2008, 3-4).

Since the invention of microscopes capable of recognizing bacteria, the predominant view has been that at best we host a variety of organisms in a form of symbiotic community within and on our skins and at worst a host of parasites and pathogens that must be aggressively held in check.[35] More recent research indicates that we and our microscopic fellows are more closely allied than that, extending beyond opportunistic symbiosis. Our internal bacteria evolved with us and in us, and the lines between their function and ours are blurred. Many bacteria mediate in favor of our health and demonstrate that in addition to crowding out less desirable and possibly mutually threatening bacteria by maintaining massive populations, they may release molecules that reduce inflammation or contribute in other direct ways to our mutual well-being (Dethlefsen, McFall-Ngai et al. 2007; Mazmanian, Round et al. 2008; Zimmer 2011b). "Simple mutations in the genome of one species caused it to adapt to the presence of the other, forming an intimate and specialized association. The derived community was more stable and more productive than the ancestral community" (Hansen, Rainey et al. 2007). Tube worms living on deep ocean thermal vents would not survive without symbiotic bacteria in their guts and have evolved specialized organs to house them (Nussbaumer, Fisher et al. 2006). "The resulting evolutionary changes can be so extensive that the association becomes essential to both host and microbe 'symbiont'. It is especially challenging to understand the complex exchanges between the partners and to work out which organism does what, as the partners cannot survive separately" (Stahl and Davidson 2006).

Margulis (1998, 111) writes of humans' strong symbiotic relationship with the trillions of bacteria each of us carries: "Without the other we do not survive," and Rosamond Rhodes, a bioethicist at Mount Sinai School of Medicine stated, "We used to think of ourselves as separate from nature. Now it's not just us. It's us and them" (Zimmer 2011b, no page number provided). Yet most (especially in the West) consider bacteria or any other organism within our bodies as foreign, as either pathogenic or parasitic "Others" to be attacked.[36] "Our symbiotic composite core is far older than the recent

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[35] The so-called "war on germs" (an example of Othering) is certainly the point of view nurtured by the manufacturers of sanitizing agents and antibiotics.

[36] Perhaps this attitude has developed because we only see and feel the products of bacteria that have overwhelmed our defenses (infection, diarrhea, etc.). Certainly, many of the products of the pharmaceutical and other industries that have profited from a "war on germs" have contributed to these

innovation we call the individual human. Our strong sense of difference from any other life-form, our sense of species superiority, is a delusion of grandeur" (Margulis 1998, 98).

Similar consideration of the difficulties, if not impossibilities, of teasing the individual from its environment for definition as a singular entity is provided by Fleischaker in *The Myth of the Putative Organism* (1991, 114):

> *The 'organism' is a fundamental and essential myth of Darwinian biology. In contemporary biology, the 'organism' is conventionally taken as a single discrete and autonomous individual – an observable, genetically-determined entity enclosed within a continuous structural boundary… This traditional organismic notion is totally inadequate to understand the very real complexity of living systems. In the non-traditional view… 'life' appears and persists not as a sum of multiple discrete entities, but as a single ecology.*

Consideration of the status of viruses provides another example of the reticence of mainstream scientific thought to consider life as a continuum. Inanimate and animate certainly have discriminating characteristics, yet they are not as easily segregated as traditionally held in the West. Although viruses carry genes, they are generally not considered to be living because they do not metabolize (do not take in nutrients or excrete waste products), are encased by a protein coat rather than a semi-permeable membrane, do not grow, and do not reproduce through division; they are not self-replicating (Moreira and López-García 2009). Rather, they replicate by invading living cells and inserting their DNA or RNA into the invaded cell's DNA. The host cell then replicates the virus's DNA/RNA until the cell erupts, spreading and perpetuating the virus. In 1992, however, a virus the size of a bacterium (subsequently named *Bradfordcoccus* -- two orders of magnitude larger than previously known viruses) was discovered inside an amoeba. Its genome contains over 1.1 million base pairs coding for over 900 genes, far more than was formerly believed possible in viruses. It also contains most of the proteins required for its survival (Frazer 2010). For comparison, *Borrelia burgdorferi*, the bacterium responsible for Lyme disease, contains approximately 853 genes (Thieman and Palladino 2004); humans likely have about 3 billion base pairs and circa 23,000 genes (Collins, Lander et al. 2004). New data suggest that viruses may have clearly been living organisms in their past but have evolved to their present form, the first demonstration of the possibility of a living organism evolving into a less complex form that is argued as non-living (Nasir, Kim et al. 2012).

The role of gene transfer between different species in their evolution has been documented (Clark and Warren 1979). Transmitted genetic material is incorporated with the recipient's DNA and is replicated and transmitted to future generations along with any phenotypic modifications in single-celled organisms and would be transmitted in

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perceptions. There are cultures that, while obviously unaware of bacteria prior to microscopes, have a more benign relationship with the observable organisms that they carry. In southern Ethiopia, for example, intestinal worms (*hamasho)* are believed essential to digesting food, that they assist by sorting foods, ensuring that they are sent to the areas of the body where needed. This belief made efforts at treating the population to eradicate the worms difficult due to cultural resistance (Vechiatto 1997).

sexually reproducing organisms where the genetic modification affects gametes (Heinemann and Sprague Jr 1989; Heinemann 1991). While commonly demonstrated among bacteria, it is also evidenced as a possible inter-Kingdom phenomenon detected through gene sequence analysis (Sprague 1991).

> *Eukaryotic transposable elements provide some of the best documented examples of the occasional horizontal transfer of DNA sequences between both closely and distantly related species. Although the mechanisms involved in such a transfer remain a puzzle, new ideas are beginning to emerge. The rapidly expanding number of reports of transposable elements that may have been transferred horizontally raises questions both about whether these elements are more prone to this mode of transfer than non-mobile genes, and about the possible evolutionary significance if such a difference is real.* (Kidwell 1992, 868)

The argument was more recently addressed regarding the status of viruses. As described in Section 2.4, organisms from bacteria to more complex forms share portions of genomes. If genomes are shared, however, where, genetically, does one organism stop and the other begin? This critical question of categorization becomes more complex when considering that most hold that viruses are not living, yet they insert their non-living genetic material into the target organism's nuclear material, thus replicating.

> *Drawing dividing lines through nature can be scientifically useful, but when it comes to understanding life itself, those lines can end up being artificial barriers. Rather than trying to figure out how viruses are not like other living things, it may be more useful to think about how viruses and other organisms form a continuum. We humans are an inextricable blend of mammal and virus.* (Zimmer 2011a, 92)

Zimmer continues, "Drawing a bright line between life and nonlife can also make it harder to understand how life began in the first place."

Xenotransplantation, the surgical implantation of one species' living tissue into a different species, provides another argument for abandoning the perception of discrete species. True, rates of rejection of such tissues are high without pharmaceutical suppression of the recipient's immune response, but one species can support another's tissues and organs. We blend. We do not have hard biological boundaries we once believed. Ongoing research on growing human tissue within or on a non-human host (e.g., growing human skin or an ear on a silicone template grafted onto the back of a mouse) has already proven to be possible. And artificial manipulation of embryonic stem cells from two different species to produce chimera has been demonstrated among many taxa, including humans and other primates (Tachibana, Sparman et al. 2012). In 2007, a sheep with blood that was 15% human cells and 85% sheep cells was produced. Numerous other chimeras have also been produced, including a human-rabbit embryo in 2003 which was subsequently destroyed after several days (Mott 2005).

Perhaps the most challenging technological development in our history of defining species as discrete entities is in the field of genomics. "The philosophical question of the definition of 'life' has increasing practical importance, as laboratory experiments approach the synthesis of life (as measured by the criteria of some definitions)" (Cleland

and Chyba 2002). In May 2010, Craig Venter announced he and his team had "built" a synthetic life form by "writing" DNA. The bacterium produced (*Mycoplasma mycoides* JCVI-syn 1.0) has a synthetic genome with over 1 million DNA base pairs (Gibson, Glass et al. 2010). Considering that manipulation of any base pair may result in novel phenotypes, the number of possible organisms is nearly limitless. Current taxonomic conventions may become a very inadequate tool for cataloging created life; new conventions will be required.

All of the above categories conspire to erode the concept of species as discrete and singular forms. Rather, we humans and all other life are, in large part, not separate from 'the other' but literally *are* the other. [37] Granted, in most cases such blending may be small, but that it exists alters the species-species relationship. This may be a difficult concept for many to readily accept in that it challenges Western paradigms of human identity that have existed for millennia. Yet evidence is abundant that a degree of interchange of genetic material among species is an ongoing process. That admission represents a significant step in appreciating the relationship of all life …at least all terrestrial life.

> *By the late twentieth century in United States scientific culture, the boundary between human and animal is thoroughly breached. The last beachheads of uniqueness have been polluted if not turned into amusement parks—language, tool use, social behaviour, mental events, nothing really convincingly settles the separation of human and animal. And many people no longer feel the need for such a separation . . . . Biology and evolutionary theory over the last two centuries have simultaneously produced modern organisms as objects of knowledge and reduced the line between humans and animals to a faint trace re-etched in ideological struggle or professional disputes between life and social science.* (Haraway 1991, 152)

2.5 Taxonomy and the creation of the Other – An issue of boundaries

2.5.1 A Western perspective

While seeking to demonstrate commonalities by grouping organisms exhibiting similar characteristics (e.g., all mammals produce milk, all birds lay eggs), classification systems conversely (and quite usefully) function to accentuate inter-group differences; they facilitate exclusion as well as inclusion. Both approaches are justifiably essential to a range of biological research. But recent technological advances, especially at the cellular, genetic, and molecular levels, have allowed the detection of distinctions among organisms with far greater precision. The seeming obsession with applying detection of divergent biochemical subtleties to classification abets a paradigm of divisiveness, of exclusion over inclusion.[38]

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[37] In the words of Walt Kelly's cartoon Pogo, "We have met the enemy [the Other] and he is us."

[38] In the "lumpers" versus the "splitters" realm among taxonomists, the splitters, aided by increasingly sensitive technology, appear to rule. Categories are subdivided, renamed, regrouped, and shuffled with regularity. Modern taxonomy is far from static.

In that variation is continuous among organisms, the dilemma that emerges is, where does one choose to draw the line that separates one group from another? At the systems ecology level, for example, a coarser gradation may be sufficient to address requirements for research and provide a workable vocabulary, a nomenclature which identifies groups in meaningful ways: a lion is different from a tiger. If seeking a blood donor, more selective discrimination and a different vocabulary are required (and desired if you are the recipient!). However, where there is an ethical component in how organisms are classed, motives of where to place lines of inclusion and exclusion may turn strongly cultural and political. An obvious case involves racial profiling in humans. While forensic guidelines referenced by various municipal legal entities have stated that racial identity can be determined with a degree of assurance through DNA analysis of crime-scene evidence, this has proven false. Yet the perception that race must be identifiable by such means if one has the appropriate (and currently existing) technology continues (Duster 2003; Duster 2006).[39]

Similar to the ethical implications of subdivisions purportedly supported by biological data regarding human racial profiling, our classification of non-human species and organisms assigns them a place along a scale of ethical consideration directly affecting our relationship with them (and, by extension, our relationship with ETBE as we shall see). "Our strong sense of difference from any other life-form, our sense of species superiority is a delusion of grandeur. We need to be free of our species-specific arrogance" (Margulis 1998, 98, 119). As we continue the trend to sieve for differences rather than commonalities, we distance ourselves from a shared biological universe and the adverse impacts of our exploitative actions become more palatable.

I pose that this condition is a rather unique example of defining -- of creating -- the Other, the defensive we/them divide employed to justify a range of adverse ethical practices. Here, the term "Other," as posed by Hegel, Foucault, Said and others, identifies the excluded, whether purposefully or without conscious intent(Foucault 1980; Said 1985). In its traditional cultural and sociological context, "Othering" is the process employed to gain or maintain social and political power by identifying some human entity (individual, group, culture, ethnicity, etc.) as subordinate, as apart from those perpetrating the denigration and benefiting from it. It is a pejorative that, at its worst, diminishes the humanity of the targeted group. Others are subject to a range of insults and injustices. At an extreme it makes them killable. The Other then serves as a societal or political foil, a target for social, political, economic, or other purposes.

In its common use, the process of creating and maintaining the Other is applied only to humans, but it has been recognized as equally applicable to human relationships with sentient animals, from our companion dogs and other emotion-bound species to the mammals we routinely eat and employ as labor (Derrida 1991; Haraway 2008). Critical

[39] Human racial classification schemes are based largely on learned cultural perspectives, what "we" choose to observe (most notably skin pigmentation). As Colin Kidd notes in the first chapter of *The Forging of Races* (2006), if one were to classify races based on the two common types of ear wax (wet/sticky and dry/flaky) rather than skin pigmentation, Black and Caucasian would be grouped together and Asians separately.

to this discussion, however, is that once the threshold of recognizing Othering as extending to non-human sentient species is reached, the question then becomes, why stop there? What rationale can be employed to counter such consideration when the same psychological and sociological motives for Othering humans apply? Defensive arguments routinely devolve to discussions of degrees of sentience, concepts of the ability of the Othered to respond as opposed to react to stimulus and similar semantics, and rather meaningless criteria such as, does the organism “feel pain” (Silliman 2006). These are hollow and meaningless largely by our admitted failure to be able to define their meaning in other than human terms and to both perceive such conditions and, subsequently, to measure them. They facilitate Othering of non-human life but they serve identical social and cultural purposes.

Herbert Spencer Jennings was widely recognized as a pioneering microbiologist during the first decade of the 20th century. In 1904, he wrote, “in these (microscopic) creatures the behavior is not as a rule on the tropism plan - a set-forced, method of reacting to each particular agent - but takes place in a much more flexible, less directly machine-like way, by the method of trial and error. This method involves many of the fundamental qualities which we find in the behavior of higher animals. …showing even in the unicellular organisms what must be considered the beginnings of intelligence and of many other qualities found in higher animals” (1904, 252).

The process of Othering has a long history of feeding the inconsistencies that flood our ethical philosophies. Creation of the Other is critical to justifying the maintenance of inequalities (Foucault 1980; Butler 1990). The question ‘*why* define and categorize life?’ becomes as pertinent as the definition and classification of life itself when considered in the ethical context of this dissertation. As Margulis states regarding taxonomic classification among living organisms, “We tend to label and dismiss anything once we assign it a category. Our classifications blind us to the wildness of natural organization by supplying conceptual boxes to fit our *preconceived* ideas” (emphasis added) (1998, 68).

Debating the specific point at which life "occurs" on the continuum of chemical evolution from simple pre-biotic and inorganic molecules to a *bona fide* living bacterium or its equivalent remains a matter of definition -- and that definition changes with the increasing ability to observe and measure that transition phase with ever-more discriminating technology. It represents a portion of the continuum, not a point, and it is highly influenced by the culture doing the defining (consider, e.g., animism[40]).

Rationales and motives for defining and labeling life become extremely pertinent in consideration of our future relationships with ETBE should we find it. As will be discussed in Chapter 7, seeking differences rather than commonalities among life contributes to a breakdown in the more holistic thinking required for nurturing coherent ethical policy.

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[40] Animism is the belief that there is little distinction between the animate and inanimate, between human life and other life, and that all have spiritual in addition to physical properties. The idea is not entirely foreign to predominant Western philosophies, including Christianity (American Heritage Dictionary 2006).

Our seeming need to require a defining boundary between the living and inanimate is another way to differentiate "them" from "us" (another example of manufacturing and naming the Other, with all its intents). Certainly, where we draw taxonomic lines on the life-side of that divide is purely a human invention (and, for many, an obsession that carried to its extreme is manifest in biological rationales defending racism and similar divisions that are social, cultural, economic and political in origin and motive, not biological) (Duster 2003). It seems, too, that where there is concern bordering on obsession regarding differentiation, it has risen from some imbedded fear.[41] Science is far from immune to such pressures.

Much of the reticence of those who fear “creating” life from inanimate biochemical parts may be based on abhorrence at a demonstration, albeit a tiny step, that we not only evolved from lesser primates but from interstellar dust. For some, ultimately deflating -- For others, exhilarating.

2.5.2 A Buddhist perspective

A predominant Western concern at the core of current research in developmental biology is defining the point at which animation began, the moment that life evolved from non-life. This would be measured in terms of a chemical process coupled with a likely time stamp (e.g., the year that this occurred on Earth). Those could then be compared with extraterrestrial data should life be found elsewhere in the Universe. For much of the West, this point in chemical evolution is scientifically and philosophically critical. The concern is not necessarily shared in other philosophies.

As the 14th Dalai Lama succinctly explains in *The Universe in a Single Atom*, “in Buddhism there is no substantive philosophical discussion on how living organisms emerge from inanimate matter. In fact, there does not appear even to be an acknowledgement that this is a serious philosophical issue” (Gyatso 2005, 111). The exact point of chemical evolution’s production of something that could be called living is irrelevant in the same manner that the point at which a weathering rock becomes sand is largely inconsequential. Both are the result of cause and effect over time. Drawing a line between rock and sand is as arbitrary in Buddhist thought as the line separating inanimate from living. But Buddhism still segregates. Here, the line is placed between sentient life and all else and the concern is defining where that transition to sentience occurs.

Western science’s reductionist approach is seeking to define life by detailing its simplest forms (the smallest, irreducible cog), those present at the time of original animation. Once that study is perfected there may only be a degree of technological sophistication that will forestall the “creation” of life *in vitro*; a major accomplishment with far-reaching implications for Western philosophy as well as science. It will represent a less dazzling result from a Buddhist perspective. The Buddhist focus is on alleviating suffering as a path to happiness; chemical evolution is of little consequence or concern.

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[41] Millions of people have been killed as a result of such fear, not to mention perhaps trillions of other organisms.

Rocks do not suffer; chemicals in the Primordial Soup do not suffer, the unicellular life they spawned does not suffer, plants and mushrooms and all non-sentient life do not suffer. None can aspire to be "happy" by seeking pleasure. They are classed together by that deficiency. Sentience denotes the ability to suffer and Buddhist concern begins there. The Abhidharma tradition in Buddhism defines 'life' as a product of consciousness, of sentience, and, therefore, life is limited to sentient animals.[42] "For (Western) biology, consciousness is a secondary issue, since it is a characteristic of a subset of living organisms rather than of all of life. In Buddhism, since the definition of 'living' refers to sentient beings, consciousness is the primary characteristic of 'life'" (113).

This limiting definition of life challenges what the Mars Science Lab and the rest of formal astrobiological programs are currently seeking and highlights a philosophical weakness in such pursuits. While the discovery of a living or extinct microscopic ETBE will certainly be extraordinary news regardless of philosophy, it will not have nearly the impact within a Buddhist epistemology as with a Western perspective.

But returning to the issue of the relationship between our perception and tendencies to categorize, Buddhist as well as Western traditions draw lines, whether separating animate from inanimate or sentient life from everything else. Both discriminations are aided by technology, and, as stated previously, as our abilities to detect life and our abilities to assess sentience grow more discerning, which entities will actually be determined to be ethically considerable will also change.

2.6 The problem of defining death

Death is not the opposite of life, but attempts at both of their definitions share some of the same complexities and attributes. As such, death provides another example of how scientific inquiry is framed and limited by perceptions rooted in culture.

Traditional Western definitions of death have been dependent on the ability of observation to identify various socially and culturally agreed-upon conditions. While detectable movement, respiration and heart beat were common and generally observable indicators separating the quick from the dead in most circumstances for past millennia, demonstrations of whole brain or brain stem activity are now standard in many industrialized cultures where the technology exists to measure such activity (Webb 1997; Roach 2003). Accordingly, the functional definition of *human* death varies with the financial ability and will to have access to monitoring technology, hardly a universal standard. Further, many would argue that the presence or absence of chemo-electrical brain function is irrelevant in the determination (Byock and Byock 1997). Adding to the uncertainty of a defensible definition, it is tacitly agreed by most Western health practitioners that one can be "brain dead," evidencing the degree of confusion on the matter by acknowledging outright that some organ systems can be "dead" while others survive. Like a definition of living, a definition of death largely becomes cultural and/or

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[42] The Abhidharma tradition dates from the 3rd century BCE to the present and is recognized as a significant account of Buddhist philosophy.

legal, not biological, where humans are the subject of the determination.[43] Reference to "brain death" or assignment to similar categories is reserved for humans; no such distinction is made for non-human life. Once outside the taxonomy of higher vertebrates, seeking a finer gradation of the definition of death likely would appear nonsensical to most. To inquire if there are similar gradations of death among, say, vascular plants or a starfish has not been addressed to my knowledge (and I would imagine securing funding would be difficult for such research).

That many of our cells can continue functioning after a legal or medical proclamation of death provides further support for the position that we are a consortium, a multiplicity of functioning cells, each with its synergistic function; we are not a singular entity. Death is a process, not a discrete point; cells do not die in unison and the trillions of surviving internal bacteria without which we could not survive may continue indefinitely, with many feeding off of the decomposition of the others. Should they be consumed by some other organism, they may take residence in the new host if the environment is conducive, flowing from being a vital functioning part of their now-dead former housing to continue their life with a new amalgamation of compatriots. What is not assimilated into a new life reverts to its organic molecular components. The cyclic flow of the inanimate and the animate continues -- dust to dust.

Consideration of Buddhist thought on death is pertinent in its contrast to this largely Western discussion. It directly reflects the previous theme on the question of discrete life as opposed to a continuum. In contrast to predominant Western philosophies, Buddhism holds that permanence is a fantasy (Wentz, Freemantle et al. 1975). All, including life, is impermanent, made of interacting and dependent parts and subject to change as a constant reality. And the parts are far from discrete Newtonian cogs and pulleys; they flow like ethers, one into the other. Addressing the Buddhist perspective on life and death, "even though something appears as a single and discrete entity – solid, stable, and permanent – it originated from and now exists in dependence upon the sum of its parts" (Coberly 2003, 67). As such, it is in concert with Margulis's endosymbiosis hypothesis. In Tibetan Buddhism, death is held as a process of spiritual transition through serial states of consciousness (*bardo thodol*) that can last 49 days after cessation of physical signs of life (detectable breathing and heartbeat) (Sambhava 1994). As stated previously, the motives of the definition of life can be as important as the definition itself.

The implications of motive are highlighted in Japanese traditions. Here, tradition holds that a person does not exist as an individual within a culture, but as an integral family member, community member, and member of society. Individuals are mutually dependent within the culture to a far greater extent than in the West. "In this society (Japanese), an act is 'good' and 'right' when it is commonly done, and it is 'bad' and wrong' when nobody else does it. Thus, outsiders to this ring of mutual dependency encounter ostracism" (Tanida 1996, 201). This results in a general lack of open discussion of issues, leading to multiple and sometimes conflicting ethical standards. For

[43] The legal position in the US is provided in the Uniform Determination of Death Act (1981) which holds that entire brain death, not brain stem death alone, will justify a legal finding of death. Other nations (e.g., England) have differing determinations, including brain stem death only as a determinant.

example, Tanida continues, "In Japan there is a public stance that euthanasia does not exist. On the other hand, there are certain decisions which have permitted euthanasia…. This may be because Japanese think that bioethics is subordinate to morality." What is outwardly stated and what is personally done may conflict. It is more difficult, therefore, to establish motives, especially for a Westerner.

But regarding euthanasia in Japan, outwardly it would be considered wrong because the living are very much a functioning part of the family and community regardless of their physical debilitation. Perhaps even further, they are not a 'part,' but 'are.' The spirits of *wa* (harmony), *amae* (dependence) and *taijisokuin* (great mercy) are expressed as strong components of the culture (Rothenberg 1997).[44] How these may affect potential ethical relationships with such foreign entities as ETBE is especially problematic. If the culture is prone to ostracism of the foreign, ethical consideration for ETBE will be diminished or perhaps disregarded. However, should there be a greater acceptance that all life is intimately related (carried to an extreme for the purposes of discussion, that we are all "one family"), then *wa* and *amae* may lead to *taijisokuin* and an inclusive, ubiquitous bioethic. Then again, as Rothenberg cites Fan, "Thus, for Fan, the crucial issue is 'the standards by which one system determines how morally right-wrong distinctions are to be drawn and [are] not the same across systems,' and that the two systems of Confucian ethics and of current Western ethics are so different and divergent that they are in fact not capable of being compared. (Fan 1997, 193). Fan concludes that 'most Westerners and most Chinese or Japanese can be defined as moral strangers to each other. (Fan 1997, 197)."

Regardless, in contrast to Asian concepts of impermanence, solidity and permanence are approaches based in Western thought and philosophical tradition. These, in turn, extend to the Western biological epistemology. This is not to infer that Darwinian evolutionary theory or thought on birth, maturation, and aging of organisms, for example, does not allow for change, but that in predominant Western philosophies life originates from life, species stand inviolate and solitary though interdependent, and life, at least human life, is held apart (and, in most Western religions traditions, is believed "everlasting").

2.7 Continuing problems of perception

The Parable of the Beast begins with an account of a research project regarding the life cycle of a cattle tick:

> *The eyeless female is directed to the tip of a twig on a bush by her photosensitive skin, and there she stays through darkness and light, through fair weather and foul, waiting for the moment that will fulfill her existence. …The metabolism of the creature is sluggish to the point of being suspended entirely. …The tick represents, in the conduct of its life, a kind of apotheosis of subjective time perception. For a period as long as eighteen years nothing happens. The period passes as a single moment; but at any moment within this span of literally*

[44] Rothenberg continues, however, that with increased exposure to foreigners and foreign cultures those characteristics are in decline. Japanese culture has been substantially Westernized, especially over the past two decades.

senseless existence, when the animal becomes aware of the scent of butyric acid (from a passing mammal) it is thrust into a perception of time, and other signals are suddenly perceived.[45] (Bleibtreu 1968, 1)

Western peoples are quick to accept human perceptions of linear time as a near-universal constant. It is frequently the only one we experience in conscious life.[46] Yet we almost intuitively know that our sense of time is strongly influenced not only by our life span and predominantly diurnal cycles but also by the time clues that increase our biological abilities to survive, such as ovulation and similar biological "clocks." It is adaptive. If our survival depended more on catching flying mosquitoes and less on selecting fruit of the right color, it seems our sensation of time would be extended, that we would discern more moments within each minute. In part, this time-perceptive state contributes to each organism's individually perceived environment, termed U*mwelt* by Jakob von Uexküll in various of his publications in the 1920s (Kull 2001). Briefly, U*mwelt* is the subjective world of an organism as mediated by the structural being or physiology of the organism. More recently, the paradigm presented by consideration of U*mwelten* has been joined with biosemiotics, application of semiotics (sign systems as studied in the humanities and linguistics) to living organisms in a biological sense, where organisms are considered complex systems of sign production, translation and interpretation (Emmeche and Kull 2011). "Semiosis (the action of semiotics – the ability to generate and receive signs) is what distinguishes all that is animate from what is lifeless" (Sebeok 1986, 15).[47] While there has always been information, life is the process of information in the form of signs (Petrilli and Ponzio 2005).

In his essay *Pandora's Box in Aftertimes*, Sebeok states:

The process of message interchanges, or semiosis, is held by many to be an indispensable characteristic of all terrestrial life forms. It is this capacity for containing, replicating, and expressing messages, of extracting their significance, that, in fact, distinguishes them more consistently from the nonliving – except for human agents, such as robots, that can be programmed to engage in quasi-semiosis – rather than other traits often cited, such as the ability to reproduce (e.g., mules or neutered cats do act as message sources and destinations, but none can reproduce). (1986, 153)

While it may initially appear overly theoretical and academic when considering definitions of life for space exploration, coupling these related concepts of time perception and semiosis *should* be recognized in the search for ETBE as extremely significant. Our robotic searches on Mars and elsewhere have been seeking life that fits our accepted terrestrial perception of time. Similarly, the nature and form of the *signs* of life to which we are attuned are our terrestrial signs. They are products of our terrestrial

[45] The work of Jakob von Uexküll is the source of this study and the 18-year life cycle it cites.
[46] Dream states, drug-induced hallucinations, yogic practices and similar methods to change time perception are well documented.
[47] This certainly changes the standard biological definitions to one inclusive of artificial intelligence, although I do not believe that was the intent.

experience. We might be speaking the wrong language; we might be seeking the wrong signs, referencing the wrong spatial and temporal scales.

For example, the Viking mission to Mars included sampling Martian soil for indicators of life. Isotope-tagged nutrients were added to the sample and the mixture was incubated for periods of several hours to several days. Gases within the crucible were analyzed for the tracers. Had such gases been produced, it would have been indicative of metabolic activity. Results were both inconclusive and contested (DiGregorio, Levin et al. 1997). While organisms found on Earth may have reacted within several days, the assumption that Martian life would respond in the same period of time demonstrates our tendency to assume *all* life follows predictable temporal patterns. It may not.

Bacteria have recently been discovered living in 86 million-year old sediments 30 meters below the deep seabed in the equatorial Pacific Ocean (Schippers, Neretin et al. 2005; Roy, Kallmeyer et al. 2012). Significant is that the rate of metabolism in these prokaryotic cells is so depressed that they may be hundreds or even thousands of years old. "These organisms live so slowly that when we look at it at our own time scale, it's like suspended animation, said Danish scientist Hans Roy, a biologist at Aarhus University and the lead author of the study. The main lesson here is that *we need to stop looking at life at our own time scale*" (emphasis added) (Achenbach 2012).

While the abyssal seabed microbes described above may very well accelerate their metabolism if provided supplemental nutrients (as was the Martian soil sample), how long that acceleration may take is unknown. However, it demonstrates that species may not share our perception of time. We should not make that assumption as we continue our search for ETBE.

2.8 NASA and the search for definitions of extraterrestrial life

In consideration of the difficulties and inconsistencies of definitions and descriptions of terrestrial life, one readily appreciates the dilemma NASA faces in its search for life on other worlds. What is being sought? How can life-detecting instrumentation aboard exploratory flights to Mars, Europa, Ganymede or elsewhere serve their purpose without such a definition? How will they know life when they find it? Much depends on who asks the questions -- aeronautical engineers, biologists, Buddhist philosophers, mining executives, or animists. Certainly, the search for life within the Buddhist tradition would be a much easier task. It would only require the search for sentience.

The definition prominent in NASA's Astrobiology Program is one suggested by Carl Sagan: "Life is a self-sustaining chemical system capable of undergoing Darwinian evolution" (Greenberg 2001, 452). At NASA's website (NASA 2006) they also cite the definition provided in *The Search for Life on Other Planets* (Jakosky 1998):

> *NASA scientist Jakosky defines being "alive" in general terms if the object 1) utilizes energy from some source to drive chemical reactions, 2) is capable of reproduction, and 3) can undergo evolution. Of course, this definition is subject to several complications. For example, fire can reproduce itself, contains heat*

> *energy, and uses biogenic elements (carbon, hydrogen, oxygen, nitrogen, phosphorous, and sulfur). And yet, fire is classified as a byproduct of non-biological chemical reactions in part because it cannot evolve. In fact, another definition of life by geologist Joseph Kirchvink emphasizes evolution as the only defining characteristic of living objects versus non-living ones. In short, the answer to your question is that <u>there is no answer</u>* (emphasis added).

NASA's acknowledgement of the problematic nature of the definition is refreshing in its honesty. But if a commonly agreed-upon definition of life on Earth cannot be stated, speculation as to what may be found off of Earth certainly cannot. Still, the search for extraterrestrial "life" goes on, the most recent effort being the November 2011 launch of the Mars Science Laboratory and its rover, Curiosity.[48]

A secondary problem with such definitions is that as various technologies' capabilities grow (predominantly the synergistic efforts of information processing, biological components employed in computing, cyborg capabilities and similar mergings of life with non-life), definitions will have to be tailored to meet political as well as philosophical needs (Kurzweil 1990; Kurzweil 2005). In 1975, the noted biologist J. Maynard Smith described life as "any population of entities which has the properties of multiplication, heredity and variation" (1993, 109). In 1975 that may have been sufficient, but advances during the last quarter of that century left it non-specific; it may as well have described many software programs. These, along with their hardware can evolve and adapt to new environments on their own; machines are capable of detecting and exploiting thermal differentials and chemical disequilibria and extract energy from those potentials; and reproduction does not appear to be much of a limiting factor when one considers the ubiquity and adaptability of computer "viruses." As the "them" of machines approaches the "us" of life, it will become more difficult to discern one from the other through definitions alone. To exclude today's and foreseeable near-future computers from consideration within the definition of life, greater emphasis has been placed on chemical systems and metabolism. However, I would argue that development of computers capable of orchestrating metabolism and systems deriving energy from chemical as opposed to predominantly electrical energy sources is certainly possible. Should they "evolve," the definition will have to be altered once again. Regardless, definitions will require constant readjustment as technology (and life) merge. There will likely be considerable social and cultural reluctance to accept any such unity without rancorous debate. As the merger of life and machine becomes routine, it will be more difficult to define where one begins and the other ceases. This will be especially true where biological cells and functions are made part of machines (using neurons, for example, as part of computer hardware and the reverse). Will these cells still be considered living? As with the previous discussion in this Chapter regarding the problem in defining the point where life emerged from inanimate chemical "soups," the definition will likely be a philosophical, legal, and cultural one more than an engineering issue. Motives of definitions will have to be challenged to determine if the definer just has to work ever harder to maintain a sense of the Other.

[48] Curiosity land on Mars in August 2012 with a mission of searching for signs of past or present life.

When applied to possible extraterrestrial life, certain factors provided in the definition cannot be assumed *a priori*. For example, Lahav cited homochirality of amino acids as a part of the requirement for life. It is true that all *terrestrial* life exhibits such sinistral biochemistry. But that appears more to demonstrate a common ancestry of Earth's life, the early-on chance selection of left over right which was then replicated to the present rather than a fixed requirement for life. Should we discover a clearly living entity on Mars or swimming in the sub-ice seas of Europa that employed only right-handed (or a mix of both right- and left-handed) amino acid chirality, would we determine that it was *not* living? Likely, no. Overly restrictive descriptions of life on Earth fail to accept the novelty of the unknown.

A practical problem in applying terrestrial biases to extraterrestrial life regards the requirement in most definitions of life for any candidate specimen to exhibit Darwinian evolution. Yet, for foreseeable space missions it would be impossible to determine that an entity is the product of variation attributable to evolution's selection process. To make that determination would require access to knowledge of its ancestry and details of its entire population, selection pressures, the range of genetic variability within its population and other data. For example, should an individual human (or rabbit, palm or microbe) be under some extraterrestrial intelligence's microscope, what evidence of Darwinian evolution would there be without a diverse population of other life forms from the site of collection or, better, a suite of ancestral forms, a fossil record, or other evidence of previous forms? As best as we know at present, individuals don't evolve; reproducing populations do. It appears an impossible task for any remote sensing rover such as Curiosity to make a determination on evolution.[49] The only solution would be to culture the specimen and observe how it genetically (if "genetically" is even an appropriate term to use on the unknown form) responds to a changing environment. The experiment would likely take a considerable amount of time and would clearly be outside the scope of any missions currently planned unless samples containing such life are returned to Earth for analysis.

A terran (pertaining to Earth) model of life is entirely appropriate <u>if</u> ETBE evolved with the same characteristics as Earth's life or shares a common origin with life here without substantial modification over the ensuing millennia, as would be possible if the biotic entities travelled from Mars to Earth, thus "seeding" this planet with Martian life, or the reverse.[50]

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[49] The demonstration of the ability to evolve appears to have been added to the list of prerequisites for life as a defensive measure to block admission of future sophisticated machinery and computers to the "club" of life. It would seem likely that as machines become capable of self-design and self-improvement, as envisioned in the "Singularity" described by Ray Kurzweil (2005) and Vernor Vinge (2008) additional caveats will need to be added to the list of life's requirements. When machines are capable of self-reflection – of being able to examine their own software and hardware and determine how to better function, then autonomously act to improve their architecture without direct human intervention – human control may become superfluous. Perhaps at that point computers will argue whether we are alive by their definitions.

[50] Microbes exposed to the conditions similar to riding within a meteor, including temperatures, radiation and the G-forces expected on acceleration and impact survived the ordeal, demonstrating that an interplanetary transfer may be biologically possible (Fajardo 2007).

The problem of life identification arose with NASA's Viking mission to Mars in the mid- to late-1970s. Although separate research packages designed to test for metabolic products of life were aboard the craft, data received remain disputed among the experiments' designers. While the official NASA position is that no life or life products were detected, one of the primary scientists, Gilbert Levin, still maintains that the results of his Labeled Release Experiment (LR) "more likely than not constitute an unacknowledged discovery of life on Mars;" "The Viking LR experiment detected living microorganisms in the soil of Mars" (DiGregorio, Levin et al. 1997, 303).[51] The official position of NASA is that no signs of life were detected by Viking (Klein 1978). However, instrumentation aboard the craft would have been unable to identify all of the specific criteria in NASA's definition of life, even if closely resembling Earth life. Any life that was more exotic or did not metabolize as bacteria do on Earth (or at a rate rapid enough to have been detected by the instrumentation) would not have been detected.

Recognizing the problem that life-detection experiments have been overly (if not entirely) geocentric, NASA commissioned the National Academy of Sciences (NAS) Space Studies Board to study the diversity of possible definitions of extraterrestrial life and speculate on the range of possible markers for life . As a starting point, they listed four criteria common to Earth's life (recognizing that the list is not exhaustive) (Sullivan and Baross 2007, ix):

- Terran life uses water as a solvent;
- It is built from cells and exploits a metabolism that focuses on the carbonyl group (C = O);
- It is thermodynamically dissipative, exploiting chemical-energy gradients; and
- It exploits a two-biopolymer architecture that uses nucleic acids to perform most genetic functions and proteins to perform most catalytic functions.

In that Earth life is the only proven model available, NASA's astrobiological search is presently directed at bodies with liquid water and the temperature regimes that state requires. Robotic laboratory capabilities are limited to sensors capable of detecting carbon-based organics and the metabolic products of life as found on Earth. But the NAS study concluded with the following observations:

- That it is possible for extraterrestrial life to exist in forms that are not encountered here on Earth. "The likelihood of encountering some form of life in subsurface Mars and sub-ice Europa appears high".
- That water need not be a limiting factor for life. Life elsewhere may employ solvents other than water for metabolism and as an intracellular transport medium. The report lists many compounds that are both present on extraterrestrial bodies and have freezing and boiling points that would allow them to be found in the liquid state. These include ammonia (Jupiter), ethane, formaldehyde, dihydrogen (contributing over 80% of the upper regions of the gas giants Jupiter, Saturn,

[51] The Labeled Release Experiment adds a measured amount of a radioactive nutrient solution to a (Martian) soil sample. The sample is incubated and any gases emitted through organic metabolism are tested for radioactivity. With Earth samples, the radioactivity is normally expressed within the carbon dioxide produced during bacterial metabolism.

> Uranus, and Neptune), and sulfuric acid (Venus). Life forms that used an alternative solvent might be overlooked in the search for life. It is also possible that extraterrestrial life might exist in a gas, vice liquid, medium. And while slow by Earth standards, life in a solid ice phase medium cannot be eliminated from consideration.

To properly define life, the subject of all the searching, requires that factors common to all life, terrestrial and other, be identified. Limiting the definition to what we can imagine as appropriate, even as broadly as suggested by the NAS report, may not suffice. Must it reproduce? Must it metabolize with solvents, even solvents other than water or some other polar compound, including gases and solids? What if an advanced entity has ceased evolving by choice, content to remain the being it is or has supplanted "natural" selection with artificial? There is no attempt here to offer such a definition, just a precaution that a deeper analysis of why we seem obsessed with a single definition needs serious thought. This becomes more critical when considering possible ethical relationships with the extraterrestrial entities we might discover. If our purpose is to clearly define how life on Earth is different, then a solid definition is warranted. If we seek unity with what we may encounter, definitions fall in importance and become impediments.

> *No discovery that we can make in our exploration of the solar system would have a greater impact on our view of our position in the cosmos or be more inspiring than the discovery of an alien life form, even a primitive one. At the same time, it is clear that nothing would be more tragic in the American exploration of space than to encounter alien life and fail to recognize it either because of the consequences of contamination or because of the lack of proper tools and scientific preparation.* (Sullivan and Baross 2007, 84)

CHAPTER 3
EVOLUTION OF BIOETHICAL THOUGHT IN THE CONTEXT OF EXTRATERRESTRIAL ENTITIES

For pure logic all axioms are arbitrary, including the axioms of ethics. But they are by no means arbitrary from a psychological and genetic point of view. They are derived from our inborn tendencies to avoid pain and annihilation and from the accumulated emotional reaction of individuals to the behavior of their neighbors. It is the privilege of man's moral genius, impersonated by inspired individuals, to advance ethical axioms which are so comprehensive and so well founded that men will accept them as grounded in the vast mass of their individual emotional experiences. Ethical axioms are found and tested not very differently from the axioms of science. Truth is what stands the test of experience.

Albert Einstein (1950, 114-115)

Why should our nastiness be the baggage of an apish past and our kindness uniquely human? Why should we not seek continuity with other animals for our 'noble' traits as well?

Stephen Jay Gould (1980, 261)

If you prick us, do we not bleed? If you tickle us, do we not laugh? If you poison us, do we not die?

William Shakespeare - *The Merchant of Venice* (1596)

The great fault of all ethics hitherto has been that they believed themselves to have to deal only with the relations of man to man. In reality, however, the question is what is his attitude to the world and all life that comes within his reach.

Albert Schweitzer - *Out of My Life and Thought, An Autobiography* (1933, 188)

3.1 Premise

The preceding chapter posits that known terrestrial life is not only deeply linked at a systems level but that organisms blend, one into the other, making distinctions among them at times both arbitrary and impermanent. Early forms of life and their prebiotic environments similarly may be difficult to differentiate. It follows that prescribing bioethical standards based on species- or organism-specific criteria is likewise problematic. Compounding this issue is that our ability to perceive organisms, assess their capacities and capabilities and assign or withhold bioethical consideration as a result of that analysis has, especially in the West, been increasingly enabled by technology for the past three and a half centuries.[52] With the expected increases in our technological power in the futures, it is likely we will continue to detect previously unknown attributes of many organisms, challenging our previous bioethical relationships with them.

Another factor confounding perception-based ethical metering is that while the foundations of predominant Western thought maintain that the practice of ethics is restricted to humans, it likely has evolutionary roots that may predate the earliest *Homo sapiens*. *H. neanderthalensis* exhibited facets of art and culture that, while primitive compared to Cro-Magnon, provide evidence of a degree of sensitivity and perception that may indicate the rudiments of ethical behaviors (James 1957). Modern humans are not necessarily alone in sentiments or behaviors such as altruism. Definitions of ethics within philosophy, however, tend to remain homocentric and narrow and the range of contemporary theories regarding ethics, morals, and related concepts of "rights" (human, animal, and now robot) has literally filled libraries.

While this dissertation makes no claim to conflate morals with ethics, their vernacular definitions are often arbitrary. For the purposes here, and in briefest terms, "morals" refer to culturally accepted standards and personal character; as stated in Plato's *The Republic*, "We are discussing no small matter, but how we ought to live." As James Rachels cautions in *The Elements of Moral Philosophy*, "It would be helpful… if we could begin with a simple, uncontroversial definition of what morality is. But that turns out to be impossible. There are many rival theories, each expounding a different conception of what it means to live morally, and any definition that goes beyond Socrates's simple formation is bound to offend one or another of them"(1986, 1). Rachels does state unequivocally, however, that to be moral one must guide one's conduct by reason while giving equal weight to the interests of affected others -- the minimum conception of morality. Others infer that there is little more to moral thought than convention: "Morality differs in every society, and is a convenient term for socially approved habits" (Pojman and Tramel 2003, 36). And, "The morality of an act is a function of the state of the system at the time it is performed." (Hardin 1968, 1246) citing (Fletcher 1966).

The Stanford Encyclopedia of Philosophy identifies three approaches to normative ethics: virtue ethics (relying on moral character), deontological (motivated by duties) and consequential (judging outcomes) (Hursthouse 2012). From these three tier sub-groupings such as medical ethics, bioethics and environmental ethics.

Bioethics (outside more human-targeted medical ethics) is mediated by our ability (and our desire) to detect what we choose to be redeeming qualities in non-human life, such as intelligence and evidence of altruism. Even where such qualities are detected, utilitarian biases frequently preempt ethical treatment, deflating any claims of virtue. As such, most bioethics outside of human-to-human actions is framed not on any singular truth but on fickle perceptions. It cannot help but be guided by ethical relativism. Encounters with

[52] Leeuwenhoek is credited with the invention of the microscope in 1674 and was the first to describe single-celled organisms. The technology of the microscope enabled our ethical judgment of that new, microscopic world.

ETBE will likely be, therefore, prejudgmental and biased to terrestrial norms and utilitarian motives.[53] This chapter argues for an alternative approach.

To be clear, ethical codes and standards are human social inventions as are moral codes and standards. They change and are relative to their cultures and times. As there are good laws and bad, there are poor as well as exemplary ethical and moral codes. But ethical *behaviors* need not necessarily conform to normative ethical codes. There is evidence of biological and evolutionary influences on ethical behaviors, supporting, in part, ethical objectivism. Regardless, the arguments for and against moral and ethical relativism are not the point of this dissertation; I cannot resolve that debate.

3.2 Pertinent foundations in traditional Western ethics

3.2.1 Matters of right conduct

The social and cultural role of enabling standards of human behavior seems innate and appears universal regardless of whether those standards were or are considered just, ethical, or moral. In the West, early thought on the origin of the standards of behavior can be traced at least to the 6th century BCE and the teaching of Thales, Anaximander and others. This is especially significant in that the period saw the shift from purely mythological/religious sources of standards to those produced by conscious reasoning; its roots may be biological (Jaynes 1976). There was recognition that principles were at work separate from the gods; there was order in the natural world and its analytical study could provide lessons applicable to human behavior.

Several hundred years later, Greek philosophers (most notably Socrates and Aristotle) were perhaps the first to formally explore and build on these ideas in depth in writing. How should people interact? What is justice? The overarching challenge, of course, lies in *who* defines how others "should" live and if or to what extent they are limited in making such determinations. In this realm of virtue ethics, where personal character is of extreme importance, virtue evolves as the motivation for right action (Reath, Herman et al. 1997).

3.2.1.1 Socrates

In Plato's *Euthyphro*, Socrates asks, "Is conduct right because the gods command it, or do the gods command it because it is right?" The dialogue continues with the consideration of two possible options.

The first answer posed by Socrates is that conduct is right only because it is commanded by the gods. It is unethical to kill other people *only* because the gods command it not be

[53] The range of sentiments is huge. One person I interviewed voiced that some are of opinion that the Bible infers that God expelled Satan from Eden to "other worlds," so it follows that such other worlds must refer to extraterrestrial worlds. Therefore, any life discovered on other worlds would have satanic origins. This does not bode well should that person be considering the ethical nature of our possible adverse impacts on Martian life.

done (Divine Command Theory). This begs the question, if the gods had commanded us to kill others on a whim, lie, steal or otherwise reverse other basic tenets of standard ethical behavior, would such actions then be ethical and "right"? Without there being any other reasoning, then, such commandments are arbitrary; killing is neither good nor bad, neither ethical nor unethical except as judged and commanded by a deity. Being arbitrary, the gods are tossing coins in their determination; one is as ethical as its reverse and killing, in and of itself, was not unethical prior to the command. As a result, the "doctrine of the goodness of God is reduced to nonsense" (Rachels 1986, 42). Further, much depends on just which god or gods one listens to, whether Zeus, Thor, Jehovah or Kali.

The second possible answer is that the gods command a behavior because, being wise, they know it is the *right* behavior, and its rightness exists *prior* to the command. It was unethical to kill on a whim prior to the gods' command. Accordingly, the command is just a restatement of a preexisting truth over which the gods have no control. The decisions are no longer arbitrary, but accepting such a position diminishes the gods' powers of ethical determination; they are just restating preexisting truths. While possibly infinitely wise, they are not the deciders of what is ethical or unethical and have no power to change them. They are merely reporters informing us of existing truths by way of commands, creating a tension between faith and reason. But if the gods do not determine right and wrong, ethical and unethical, who, or what, does?

3.2.1.2 Aquinas

With the beginning of the Christian era, the emphasis shifted from observation of nature and reasoning thought back to religious doctrines, standards and the supernatural. Nature became subservient to God; God was the source of all power and truth. The Church relied on Christian dogma to guide behavior through, in the early centuries, adherence to the absolute and unchallengeable "truth" of revelation.[54] This is well documented in the writings of Augustine in the 4th century and his assertions that the Church was the only path to truth, the singular arbiter of achieving a good and salvageable life after death. This did not imply that a greater understanding of the natural world would distract from knowing the divine as long as the studier recognized Church supremacy regarding any conclusions reached. But reason and empirical analysis were less damnable; to seek the divine by studying God's "work" as opposed to God's "word" was no longer necessarily heretical (Tarnas 1991).

Thomas Aquinas (1225-1274), his teacher Albertus Magnus and others held that neither of Socrates' postulates was acceptable.[55] In the resulting Theory of Natural Law they concluded that ethical decisions are based on the dictates of rational human thought, not on divine command. This seemingly removes ethical resolutions from a theological process, thus demoting the power of God (and, in the Christian world, the power of the

[54] Throughout, Church capitalized refers broadly to the Christian Church – Catholicism.
[55] Aquinas and Magnus are associated with Scholasticism, the 12-15th century school of thought that sought, in part, to reconcile the Greek approach to knowing and reason (especially as postulated by Aristotle and Plato) with Church dogma founded on revelation.

Church). Their rational fix was to maintain that (1) the Divine Command Theory has fatal flaws and God does not arbitrarily decide on issues of ethics; (2) God is rational, and because all persons (regardless of religious affiliation or belief) are created in God's image, humans are also capable of rational thought; and (3) God provided humans with the capacity for rational thought so that we could ponder ethical problems and arrive at rational (and thereby "right") decisions. Therefore, ethical decisions are the result of rational human thought. The role of the Church is, in part, to assist us in developing our rational thought to both reason the existence of God and to make rational (thus ethical) decisions, leading to rational (thus ethical) actions. Another self-described role of the Church is to provide the ethical directives (e.g., do not steal) to those who either have not developed their abilities for rational thought or don't have the time or interest to ponder such issues. According to Aquinas (and adopted in general Church theory), to act rationally *is* acting as a Christian, and *vice versa*. Here, we loop back to the basic premise, but view it in reverse: "To disparage the dictate of reason is equivalent to condemning the command of God" (from Aquinas' *Summa Theologica* (1274) as quoted in Rachels 1986, 45). Thus, the Church, as the representative of God on Earth, maintains supremacy in this realm as the arbiter of reasoned thought within the Church. But it concedes that ethical thought is a rational process and, like science, can run parallel to and independently of the Church.

In sum, according to the Theory of Natural Law, reason will inevitably lead to truth. As maintained by the Church, nothing discovered through the process of perfectly reasoned inquiry could possibly conflict with the Church since their tenets are founded on faith in a reasoning (and truthful) God. "Nothing that was true and valuable, even if achieved by man's natural intellect, could ultimately be foreign to God's revelation, for both reason and faith derived from the same source" (Tarnas 1991, 180). Right behavior and ethical actions are founded in reason -- reason is founded not just as a reflection of God's character but as a human ability *independent* of God (the gift from God). The uncorrupted human search for truth, therefore, ultimately leads to ethical actions without the need for divine intervention.[56]

3.2.2 Matters of bioethics

3.2.2.1 Animism, vitalism, mechanism and anthropocentrism

The earliest written accounts regarding the treatment of animals in the West come from Greek literature. The four predominant schools of philosophy regarding animals that emerge are animism, vitalism, mechanism and anthropocentrism (Ryder 2000, 17):[57]

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[56] However, should your rational process have led to a conclusion different from the Church's, it may not have been wise to advertise it.

[57] Ryder (2000) points to similar philosophies toward animals that were developing in the non-Western world. Hinduism and Buddhism did not employ animal sacrifice and promoted vegetarianism. Much of this approach is based on a consideration of reincarnation, but also springs from a general avoidance of violence. In Japan, Shinto also teaches reverence for nature. Teachings of countless indigenous cultures also serve to respect many categories of non-human life and nature.

- Animism – Most often associated with the teachings of Pythagoras (mid-6th century BCE), animism maintains that both humans and animals have immortal souls of the same kind that move among both through incarnations.
- Vitalism – As professed by Aristotle (384-322 BCE), this recognizes the interdependence of soul and body and that men and women are animals. In contrast to animism, however, vitalism places various organisms in a hierarchy, the *great chain of being*. Status within that chain is determined by the ability to be rational. Even among humans, social position was related to innate rational talents. Accordingly, slaves, while clearly human and able to experience pain, were less rational than free Greeks if only because of their status as slaves and thus could be ethically exploited.
- Mechanism – Both humans and animals were soulless machines and differed only in structure from the inanimate.
- Anthropocentrism – As taught by Xenophon (c. 430-354 BCE) and others, the world and all of its components were made for the pleasure of man. Only this school of thought maintained that humans were distinct from animals in every respect.

The early Aristotelian focus (if not obsession) on determining the degree of rationality of animals as prerequisite for higher status emerges again with later medieval Christian philosophy, most notably Aquinas. Sorabji remarks, "By and large, despite some opposing tendencies, my impression is that the emphasis of Western Christianity was on one half, the anti-animal half, of a more wide-ranging and vigorous ancient Greek debate" (1995, 204) This represented a watershed in Church thought, transitioning at many levels from a period where nature (the Fall as depicted in Eden) was viewed largely as adversarial to receiving Grace, to one that required entering the world (essentially, leave the Garden) and experiencing it to discover a pathway to God. Understanding nature's orderliness, its laws and sciences, was established as the goal of a rational mind. And, as man was created in the image of God and was thus provided a rational mind, he could seek such a path. Rationality would serve no purpose for animals, thus establishing the barrier between the two -- man distinct from animal.

Whereas Aristotle and the animists sought degrees of rationality among all animals (including humans), the later conflict with Church dogma was insurmountable and the search for a hierarchical ranking was abandoned as an impossibility. Man alone possessed the gift of rationality; animals do not. The line of thought persists. While seeking grace may have been forgotten as a motive (or, at least, openly stated as a motive), the schism between man and "animal" largely remains.

In *Primates and Philosophy*, Franz de Waal reminds us that "while it is true that animals are not humans, it is equally true that humans are animals. Resistance to this simple yet undeniable truth is what underlies the resistance to anthropomorphism" (2006, 65). He terms this reticence anthropodenial, the willful rejection that there are meaningful characteristics that humans and other animals share even though similarities are abundantly clear, as in the discussion of Descartes that follows. De Waal continues, "It reflects a pre-Darwinian antipathy to the profound similarities between human and animal behavior (e.g., maternal care, sexual behavior, power seeking) noticed by anyone with an open mind." Anthropomorphism has a bad reputation. It requires that we attribute to animals (and plants, and anything non-human) the "higher" human mental capacities, such as a sense of self, the ability to ponder the futures in a meaningful way and reflect on the mental states of others (a theory of mind). Denying a place for anthropomorphic discussion in behavioral (and ethical) work promotes Othering; animals do not think like us, therefore we owe them less.

3.2.2.2 Descartes

While the Church (and other institutions) had held power through dicta regarding the nature of matter and life in the biological sense for centuries, the "facts" of science were difficult to ignore or argue away, especially in the physical sciences as derived from experimentation and empirical mathematical analysis and modeling (although attempts to do so persist to today).[58] Revelation, intuition and divine command were rapidly giving way to experimentation and observation. Philosophical studies of morality and ethics were in recession as was the Church. "When philosophers shared a common set of religious assumptions, they could propound moral axioms as universal truths without paying much attention to the controversial nature of their axioms. The religious assumptions, however, are no longer shared" (Dorf 2002). As the power of directing thought shifted from the fracturing Church to more independent institutions (e.g., secular universities), the Church lost many of its philosophers and, for better or worse, many of its philosophers lost the Church. Newtonian mathematics and scientific progress in geology, biology, and chemistry hastened the split of ethical philosophy from religion. However, neither morality nor ethics are applicable to scientific analysis, and the Church maintained a high degree of hegemony in moral philosophy (MacIntyre 1981). The Church, however modified, restructured, and modernized was still *the* source for ethical thought and moral philosophy.[59,60] In addition, the Western world was becoming more strongly based in utilitarian principles.

Rene Descartes' (1596-1650) particular analyses of a number of issues involving the operation of the body have faded from popularity as they have been disproven. For example, his explanation that heat makes the blood circulate and that tiny particles in blood become "animal spirits" that physically cause appendages to move have been discredited as more detailed anatomical and physiological research has discovered more defensible (and logical) alternatives (Damasio 1994, 249-250). But the dualism of mind and body that he maintained is still evident in philosophical work and is applied when facts fail to provide an immediate solution. Except for his exemplary mathematics,

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[58] "Facts" is in quotes to indicate that facts are not absolutes, but commonly agreed conveniences enabling analyses, reasoning, and a broad range of social and cultural norms. While still indispensably useful, facts can sometimes have a limited shelf life.

[59] Present day ethical boards and councils almost without exception look to the clergy (Christian, Jewish, Islamic and other "mainstream" religious organizations) as a source for their membership, assuming them to be authoritative in ethical (and moral) issues.

[60] "Church" was at this point in history more accurately "churches," including late-Reformation factions, the very significant expansion of Western religions to the New World and Asia, coupled with Jewish moral philosophy that affected Western thought.

Descartes was not critical in his scientific analyses. It appears more that he started with conclusions and then sought justifications, and when scientific proof was not obtainable he inserted the supernatural.

Descartes' reasoning was likely strongly biased in its defense of theological dogma of that period and was not the product of more rigorous and challenging theorizing (Newmyer 2006, 67). Starting with the presumption of man's dualistic nature, that mind and body existed in separate universes, his attempts at experimentation were ludicrous. As stated by Grayling, his supposition that "all creatures other than oneself lack conscious experience, emotion and sensation, despite the intimate similarity of anatomy, environment and behavior" is not only erroneous but unfounded. It was irrational of Descartes and his contemporaries to think in these terms about animals (2005, 160). The thought that dogs and horses might have souls (and might accordingly go to a heaven, or a canine or equestrian version of heaven) seemed to them preposterous given that they had accepted the (perhaps equally preposterous?) premise that there are such things as disembodied souls in the first place. This reflected Aquinas from almost four centuries earlier, who maintained that as man was created in the image of God, we have no ethical obligation to animals except as our actions on animals affect our actions toward other men.[61] Descartes' reasoning followed that in lacking souls, dogs and other animals lack all that appertains to souls (conscious thought, experience, emotion and sensation) – and so could be cut open and experimented upon with impunity. His and many other scientists' and philosophers' approaches to relationships with non-humans were simple: the purpose of pain and pleasure was to instruct the soul; animals have no soul, *ergo* they are incapable of feeling pain or pleasure. This formed the basis of much of Western thought on bioethics as applied to non-humans for centuries (Sorabji 1995).[62]

The mind and the body do not exist in separate states to the degree or supernatural manner which Descartes and many others maintained, although that philosophy still influences our approach to non-human species. Significantly, it haunts our possible relationships with ETBE.

3.2.2.3 Locke and Hobbes

In Locke's *Essay Concerning Human Understanding* (1690) he sought to provide a logical proof that the mind predates history, that the mind was what existed prior to matter. As such, only a cognitive, though ethereal, being could produce something from nothing. Whereas matter can change form and produce other matter, matter cannot produce thought, thus the "primacy of mind."[63] This philosophical approach guaranteed the primacy of man over all other biological and inanimate forms, subjugating them to a

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[61] Similar reasoning is frequently applied today as a rationale for why animals should not be treated cruelly: those who do so are desensitized to similar cruelties perpetrated on other humans. The effect on the target animal is largely discountable.

[62] It is foreseeable that at some point in our futures physical pain may become optional. How philosophical arguments concerning the influence of pain on our spiritual lives change to adapt to this possibility will be interesting.

[63] But true to futurists' "never say never," it is arguable that matter may produce thought in coming years. To imagine such a circumstance is no longer the wild fiction it was during Locke's era.

lower status. To maintain a proper pyramid of ascendency that included an omnipotent deity at the apex, proposing a flatter organizational structure was unsupportive of "proper" relationships. Even such ennobled humans, however, were not elevated to some blissful condition but remained caged in lives, as Hobbes noted, 'brutish and short.' We lacked the innate socialization and finer natures that Aristotle viewed as *zoon politikon* (.a a political animal) centuries before, our species' ability to rise above, to form social and political unions to the benefit of all (well, perhaps some) participants. In Hobbes' world, socialization was not a natural condition but a state reached only by overcoming our truer natures, by "covenant only, which is artificial" (Hobbes 1991, originally published in 1651).

Arguments since Aristotle rested on the issue of whether or not animals were capable of reason; pain and suffering were only valued as a way of deducing their capacity to reason (Newmyer 2006, 66). And it was largely a theological question, vital only in its relationship to the possession and purpose of a soul, thereby related only to salvation in the realm of Christian thought. It ensured human primacy in the great chain of being.

3.2.2.4 Bentham

The philosophical discussion of extending bioethical consideration to non-humans significantly pre-dates attempts at anatomical justifications. Jeremy Bentham's (1748-1832) question regarding suffering is abundantly more generous in erasing the divide between humans and "animals" than his predecessors:

> *Other animals, which, on account of their interests having been neglected by the insensibility of the ancient jurists, stand degraded into the class of things. ... The day has been, I grieve it to say in many places it is not yet past, in which the greater part of the species, under the denomination of slaves, have been treated ... upon the same footing as ... animals are still. The day may come, when the rest of the animal creation may acquire those rights which never could have been withholden from them but by the hand of tyranny. The French have already discovered that the blackness of skin is no reason why a human being should be abandoned without redress to the caprice of a tormentor. It may come one day to be recognized, that the number of legs, the villosity of the skin, or the termination of the os sacrum, are reasons equally insufficient for abandoning a sensitive being to the same fate. What else is it that should trace the insuperable line? Is it the faculty of reason, or perhaps, the faculty for discourse?...the question is not, Can they reason? nor, Can they talk? but, Can they suffer? Why should the law refuse its protection to any sensitive being?... The time will come when humanity will extend its mantle over everything which breathes…*
>
> Jeremy Bentham (1748 - 1832) -- *Introduction to the Principles of Morals and Legislation* (Bentham 1988, 311)[64]

[64] From http://www.utilitarianism.com/jeremybentham.html

The final line is an especially sobering and prescient statement for that era.[65] It interjects the concept of rights to the "rest of the animal creation." It also clearly abandons the concept of the ability for an organism to reason as a rationale for establishing the "insuperable line."

But here too, while Bentham nobly assaults human conduct that causes suffering in other species, the sensation of pain that results in a condition of suffering is defined in human terms, a construct of how humans would suffer or respond to pain. This may help differentiate robins from rocks but it still presents considerable ethical difficulties regarding ETBE where the question of suffering may make no sense.[66] A snail will surely react when doused with salt, withdrawing into its shell and contorting its body. Does it suffer, or is it "just reacting?" Similarly, a paramecium will react when probed with a fine needle or dropped into acid; does it suffer? Is such a term appropriate, or is it just obfuscation that relieves us from having to consider the effect of the trauma on ethical grounds? By definition, pain and fear both cause suffering, so it follows that any species exhibiting these reactions suffers. While Bentham provides immense ethical progress from Descartes' nailing dogs to planks to examine their clockworks, answering Bentham's question still provides a "litmus test" designed for metering ethical consideration and can be employed as an Othering tool. It moves the "insuperable line" but does not erase it. Bentham's claim that "lower," non-sentient organisms are not ethically considerable lies in his interpretation they cannot *know* that they are being harmed and do not, therefore, have intrinsic value (Cockell 2005). By contrast, in *Animal Liberation,* Peter Singer suggests, "Those who want to be absolutely certain that they are not causing suffering will not eat mollusks either; but somewhere between a shrimp and an oyster seems as good a place to draw the line as any, and better than most" (1975, 178). Even Singer is drawing lines, but at least acknowledges it is an arbitrary process.

In the face of clear evidence that animals with relatively developed nervous systems (such as vertebrates) can physically suffer, Christianity has been slow to consider it as fact, and even when the fact is evident, changing human behavior to lessen that suffering has been slow to emerge. Pope Pius IX (1792-1878) forbade the founding of an animal welfare society in Rome because "human beings had no obligation towards lower creation" (Ryder 2000, 36). "Astonishingly late in the philosophical texts we find the first explicit statement that the pain and terror felt by animals is a reason for treating them justly" (Sorabji 1995).

3.2.2.5 Mill

Following on Bentham's utilitarianism, John Stuart Mill (1806-1873) continued the work of defining what might represent the "good" that would or could be measured under a

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[65] Bentham's statement of extending rights certainly adheres to James Dator's (Hawai'i Research Center for Futures Studies) "Second Law," which states, "Any useful idea about the futures must (at the time) appear to be ridiculous" (http://www.futures.hawaii.edu/).

[66] I am making the assumption that rocks do not have sensation. There is no evidence I know of that they do. True, this is facetious, but it points to the ignorance that because we cannot perceive something it must not exist.

utilitarian model.[67] Bentham maintained that pleasures (broadly defined) are the ultimate good and that such pleasures are roughly equal in the calculation; Mill, however, held that some pleasures and the happiness they foster are intrinsically better than others. These seem minor differences. Mill states, "The creed which accepts as the foundation of morals, Utility, or the Greatest Happiness Principle, holds that actions are right in proportion as they tend to promote happiness, wrong as they tend to produce the reverse of happiness. By happiness is intended pleasure, and the absence of pain; by unhappiness, pain, and the privation of pleasure" (1863, Chapter 2). While useful in theory, a weakness cited by Mill is that both Bentham's and his approaches are not able to adequately define the origins of the moral good, the ethical, without employing a utilitarian calculus. And with Mill, the calculus is literal; a mathematical process of evaluation provides moral guidance.

A significant objection to utilitarianism is that the "greatest good for the greatest number" is a path to hedonism paved by the tyranny of the masses. A few unfortunates may be further disadvantaged, but the overall "good" would be increased.[68] Here, Mill responds by differentiating human pleasures from those of animals, and, by extension, those human pleasures that are base animal pleasures. The "higher" human pleasures (among which I am sure Mill included philosophical musing) are weighted to trump the lower in the calculus. In addition, since the higher human pleasures are more refined, it takes more to produce such pleasure, justifying, in part the subjugation of that which is not human, such as other life and natural resources. He states, "Few human creatures would consent to be changed into any of the lower animals for a promise of the fullest allowance of a beast's pleasures. ... It is better to be a human being dissatisfied than a pig satisfied; better to be Socrates dissatisfied than a fool satisfied. And if the fool, or the pig, are of a different opinion, it is because they know only their side of the question" (Mill 2010, originally published 1859). Better, perhaps, if you are a human. Here again though is the presumption of human domination, of presuming to know "their side of the question," what is in the best interest of all that is not human. I do not know what gives the most pleasure to a pig except through the repertoire of human experiences, and neither did Mill.

Mill's calculus of utility and pleasure favors the interests of the group over that of the individual, but with caveats. True, people knowingly tend to give their own interests full consideration and priority over others', but Mill recognized that altruism is real and that people routinely act to aid the group regardless of self-serving motives. But his analysis overtly maintains its focus on people and limits the group to humans only; humans' altruistic acts serve the human community, thus they are at least in part self-serving.

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[67] Arguably, David Hume (1711-1776) predates Bentham in the development of British utilitarianism by holding that we invent laws because a system of such laws is the best for all of society, on average. This approach begins centuries of strategizing as to definitions of "best" in terms of other factors, such as pleasure.

[68] "It's good to be king!" (spoken by the character of Louis XIV as he shoots peasants for sport in Mel Brooks' comedy *History of the World, Part I*).

More recent philosophers working on this issue, such as John Rawls (1921-2002), disagreed with Bentham's and Mill's models of utilitarianism as applied to ethical concerns. Neither smoothly allows for justice, fairness, or concepts of inalienable rights. Rawls posited that if all tested religions (essentially, the dozen or so prominent global players) had very similar if not identical concepts of the ethical and the good, then the specific religious beliefs not shared among those twelve likely were not pertinent to the question. Being universal among all, the answer must, therefore, lie outside of dogmatic religious theory or revelation. Rawls sought to answer the basic ethical question of determining "the good" and, very importantly, to answer it in such a way that it could be applied to public and political philosophy independent of the more rigid religious foundations. "Though justice can be, as Hume remarked, the cautious, jealous virtue, we can still ask what a perfectly just society would be like" (Rawls 1971, 8). We can also ask what a perfectly ethical society would be like – a task made difficult by the complexity of human histories and cultures on Earth, but simplified in an extraterrestrial context.

3.2.2.6 Derrida

Contributing to the problem of constructing a workable bioethic, one that will provide justice even if foreseeably unobtainable, is that deeply classical philosophical approaches such as those previously described are wed to a human perspective. Ethics is locked into a one-way provisioning of consideration and favor flowing from human to human or from human to other species. As such, the relationships they create cannot help but become Othering tools benefitting the provider. Jacques Derrida (1930-2004) made some progress in the analysis of such relationships in the late 20th century and, especially, drew on the function of the animal as an actor in that process. In his 1997 lecture *And Say the Animal Responded* (2003) and the later *The Animal That Therefore I Am* (2008) he confronts the question of animals *responding* as opposed to reacting, language as limiting analysis of the relationship, and the function of Othering that both of those foster (Derrida 2003; Derrida 2008). In a 2003 filmed interview, he states: "When one says 'animals,' one has already started to not understand anything. One has started to enclose the 'animal' in a cage. To put the monkey and the ant in the same category is a very violent gesture. To put all life that is not human into one category is, first of all, a stupid gesture – theoretically ridiculous – and partakes in the very real violence that humans exercise toward animals" (Derrida 2003b).[69] Peter Singer adds the obvious, but well worth quoting, "We commonly use the word 'animal' to mean 'animals other than human beings.' This usage sets humans apart from other animals, implying that we are not ourselves animals – an implication that everyone who has had elementary lessons in biology knows to be false" (1975, 26). Labeling is certainly a critical (and time-honored) tool for decreasing the perceived need for ethical consideration. Classical ethical philosophy has tended to focus on the definition that being human is *not* being animal; it is definition through exclusion. Derrida, Singer and others provide an

[69] However, in a different and lengthier interview he states, regarding dogs' barking, "Barking is the most stupid cry ever" (Boutang 1988). He praises howling at the moon, but not the bark. Such a remark diminishes his more worthwhile arguments and causes one to consider his other conclusions with a degree of skepticism.

alternative by recognizing that such definitions have the motive of exclusion. The implications of defining human as not being animal, therefore, do not define human. They serve primarily to lower the status of animals.

Derrida effectively directs criticism at language as a significant root cause of this ethical problem we historically have had with establishing relationships with other species as well as communicating among our own.[70] Tools provided by most modern languages influence the way we think about these relationships and tend to diminish our ability to express bioethical associations in other than structured and frequently pre-packaged, self-serving ways (e.g., gendered nouns and the greater implications of gendering, homocentric definitions of words such as "animal," taxonomic classification schemes, broader scientifically acceptable epistemologies) (Boroditsky 2009). Derrida asks us to shed homocentric divisions and think in new and liberating ways.

As expressed by Deleuze and Guattari, the process of "becoming animal" may be a necessary step in this liberation (1987, 233-237). Here, this psychological leap is in the form of transformation responding to the overwhelming desire for some experience to break our self-erected human/animal boundary. Yet Derrida maintains an uncomfortable, arms-length distance from those other species that he is trying to embrace, those same non-human species that are the subject of his study. Of Derrida's recounting of his interaction with his cat, Haraway observes, "He came right to the edge of respect ... but he was sidetracked by his textual canon of Western philosophy and literature and by his own linked worries about being naked in front of his cat" (2008, 20)[71] The standard catalog of past centuries of Western philosophical approaches has not provided much support in crafting objective and just bioethical standards for life on Earth. Much of it appears to exist only to wrestle with justifying why we exist (and justifying our requirement for justification). It has met with significant impediments when confronted by theological explanations that it refuses to confront head-on, resulting in circular arguments that accomplish little for species other than humans. As such, it would certainly be insufficient when applied to extraterrestrial entities.

3.2.2.7 Non-Western traditions

In response to Derrida's and others' philosophical and psychological failed attempts to transcend animal/human boundaries, it is helpful to appreciate that this is predominantly a Western problem. Other traditions hold that there is no boundary or that the boundary is permeable and subject to tearing. Various forms (and various degrees) of shamanism, totemism and animism, for example, have been practiced by many indigenous peoples of all inhabited continents with histories dating to, perhaps, the Neolithic (James 1957; Narr and Auer 1964). Humans with animal attributes appeared commonly in early art, especially in art depicting or relating to hunting. "What is represented is, first of all, that

[70] Drawing on the work of Temple Grandin (2002), an autistic writer and animal scientist, language can be an obstacle in studying animal behavior and animal relationships with humans. Converting observations and reactions to words and then translating back to interpretations can be very limiting; it imparts a range of opportunities for error.

[71] Naked both literally and, I assume, psychologically?

which is essential to the animal, partly in its relation to the hunt, but also in relation to anthropomorphic figures showing the intermixing of human and animal forms. This indicates a special and intimate relationship between humans and animals that transcends and overcomes the boundaries between different realms of being that modern concepts and understanding require" (Narr 2012, pages unnumbered).

Origin myths from many cultures are founded on a theme of humans and animals existing on more equal terms than held in the West, conversing and physically blending (Campbell and Moyers 1988). Accounts blurring the boundary between human and non-human species exist in most cultures, often in the form of myth and fables but also in religions and other broader belief systems.[72] In the West it is certainly a theme in common contemporary fiction. Whether apocryphal or not, stories of morphing from one species to another such as those of Carlos Castaneda (1969) serve the function of expanding our imaginations and heightening our acceptance of the idea that we may not be as distinct as we are taught.

3.3 Changing perceptions of the origins (and evolution) of ethics

Little challenged the general conclusion in the West that reason is *the* foundation of ethical behavior (whether through divine plan or not) until the mid-19th century. Then, another explanation began to emerge that diminished the role of a premeditated, human process of reason in ethical decision-making: that possession of the capacity to reason is not the singular foundation of ethical behavior.

3.3.1 New foundations for ethics

In *Descent of Man*, Charles Darwin stated, "It must not be forgotten that although a high standard of morality gives but a slight or no advantage to each individual man and his children over the other men of the same tribe … an increase in the number of well-endowed men and an advancement in the standard of morality will certainly give an immense advantage to one tribe over another" (1874, 166) This was not a new concept and would have likely met with general agreement had it been presented to Aquinas 700 years before; it was in concert with the Church's teachings. In *Summa contra Gentiles III*, Aquinas asserts that we should not be cruel to animals *only* because it may lead us to be cruel to humans (Newmyer 2006). It follows that by not being cruel to each other, we are of greater mutual benefit. But Darwin's insights extended consideration of ethical (moral) behaviors from predominantly a human invention and concern to include, by inference, non-human species. This expanded the scope of ethics, opening a line of inquiry that it may have roots not in reason, *per se*, but in the evolutionary precepts of descent with modification. Inherited behaviors may have survival value, and the inherited set may include ethical behaviors.

[72] The divide diminishes in belief systems such as Buddhism where humans are viewed as distinct but souls can be reincarnated into other species.

Human practices and behaviors that tend to support the population and aid it in adapting to the environment are preserved in the culture (as memes, perhaps).[73] Those that do not are discouraged or contribute to the population's decline. Such behaviors may be aided by capacities for sapience, self-reflection and a theory of mind (the ability to imagine what another of the same or different species is thinking), empathy and emotions, or abilities to visualize a range of possible futures which have (until recently) generally been reserved as what defines us as human, what differentiates us from other species, from "animals."[74]

Publications in ethology by Nikolaas Tinbergen, Konrad Lorenz and others in the 1940s through the 1960s helped to develop the concept that certain behaviors and social customs largely believed to be exhibited only in humans (e.g., altruism) are also observable in a few of the "higher" vertebrate taxa (predominantly mammals and birds). Similarly, they suggested that certain human behaviors may share ancestral origins with other species as do anatomical structures. Such behaviors may provide evolutionary advantage not only to non-humans but to humans as well (Lorenz 1954; Lorenz 1958; Tinbergen 1968).[75] During the following decade E.O. Wilson, Robert Trivers, William Hamilton and others continued to research the links between behaviors and evolutionary advantage and demonstrated that a population's survival (whether human or non-) may be facilitated, in part, through group or multi-level selection (including kin selection and interdemic selection[76]) of altruistic and similar classes of behaviors (Hamilton 1964; Trivers 1971; Wilson 1975). During this period many of their publications were largely targeted (and thus confined) to those in the biological community.

Observing social behavior in non-human primates, especially apes (and, to a lesser degree, capuchin monkeys), has been very useful for studying mechanisms of the

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[73]Meme was first defined by Dawkins in 1976 (1989) as the theoretical "unit of cultural transmission." They can be perpetuated, amplified or eliminated from cultural or behavioral transmission from generation to generation. Its phenotype is the product of its physical expression, e.g., a cultural artifact such as a clay pot is the phenotype of the cultural knowledge of how to throw and fire a pot.

[74] This would account for the range of ethical practices found in disparate populations. The practices evolved with the cultures in response, in part, to differing environments, broadly defined.

[75] "Whereas human pro-social behavior is often driven by empathic concern for another, it is unclear whether nonprimate mammals experience a similar motivational state. To test for empathically motivated pro-social behavior in rodents, we placed a free rat in an arena with a cagemate trapped in a restrainer. After several sessions, the free rat learned to intentionally and quickly open the restrainer and free the cagemate. Rats did not open empty or object-containing restrainers. They freed cagemates even when social contact was prevented. When liberating a cagemate was pitted against chocolate contained within a second restrainer, rats opened both restrainers and typically shared the chocolate. Thus, rats behave pro-socially in response to a conspecific's distress, providing strong evidence for biological roots of empathically motivated helping behavior" (Bartal et al. 2011).

[76] Kin selection is defined as an individual's actions that serve to promote the survival of that individual's genes by aiding the survival and reproduction of relatives who carry similar genes (generally the definition does not include aid to offspring). Accordingly, aid would be provided to a cousin with greater frequency than to an individual outside the family. Interdemic selection requires the selection of demes, or entire breeding populations, as the unit of inheritance as opposed to survival of individuals and their specific genes -- for example, genetic selection within a colonial species such as termites or ants. Here, the individual's contribution to the gene pool is of less importance than contributions to the growth and survival of the colony (Holldobler and Wilson 1990).

evolution of ethical behaviors without reference to the supernatural (Katz 2000). The following is a very brief list of related observations:

- Kin selection and reciprocal altruism are not restricted to humans, but have been observed in a variety of species (Hamilton 1964; Trivers 1971).
- Social primates in general exhibit a high degree of cooperation and varying degrees of intra-group conflict resolution (Rudolf von Rohr, Burkart et al. 2011; Rudolph von Rohr, Koski et al. 2012).
- As cited by deWaal, the "biggest step in the evolution of human morality was the move from interpersonal relations to a focus on the greater good. In apes, we can see the beginnings of this when they smooth relations between others" to promote peace within the group (2006, 54). The survival of the group over survival of the individual gains in importance, for without the group, the individual will likely decline or possibly not survive on its own (Goodall 1968; Goodall 2000).
- In some primate species (including humans) social pressures are exerted to maintain group cohesiveness. As such, "ethical" behavior contributes to group survival and, therefore, would be selected for its evolutionary value. Actions promoting group cohesiveness are rewarded and those deleterious to cohesiveness are punished by the larger group (Boehm 2001).[77]
- Group cohesiveness is strengthened when the group is faced with an external challenge, such as from an unrelated group (Wrangham and Peterson 1997; De Waal 2007, 54).[78]
- While in-group violence is not uncommon, chimpanzees exhibit behaviors of both forgiveness and revenge that contribute to group stability and survival (McCullough 2008). In humans, children as young as one year comfort others in distress (Zahn-Waxler, Radke-Yarrow et al. 1992).

Accepting the above points supports a conclusion that hostility toward out-groups promotes in-group cohesiveness. In humans, ethical codes assist in strengthening this in-group cohesiveness (Alexander 1987).[79]

3.3.2 Biologicizing ethics

It was arguably Wilson's 1975 publication of *Sociobiology -- The New Synthesis* that exposed the greater public to the concepts that animals and humans may share behaviors advantageous to them and that non-humans as well as humans are capable of altruism even among the "lower" taxa, such as the social insects. As such, there were common themes in the evolution and expression of behavior that seemed to diminish both the status of humans as completely independent and autonomous agents of behavioral action,

[77] Boehm concludes from his studies that the development of weapons in humans is contemporaneous with the formation of more egalitarian societies. Physical prowess was no longer the only determiner of alpha status in the group.

[78] One is reminded of the following: "The people can always be brought to the bidding of the leaders – That is easy. All you have to do is tell them they are being attacked, and denounce the peacemakers for lack of patriotism, and exposing the country to greater danger. It works the same in any country." Nazi Reich Marshall Hermann Goering during the Nuremberg War Trials (Jhally and Earp 2004).

[79] It is critical to my argument that including ETBE as an "out group" is part of this process and that it is critical that such exclusion from "we" be challenged. This is addressed later in this dissertation.

including ethical action. More important was that human behavior was dependent to a significant degree on evolution's more hidden pressures in addition to actions resulting from the exercise of free will (Wilson and Sober 1994). Again, while such thought is not new within the scientific community, it represented a novel departure from the widespread Western public's belief that ethical human actions are entirely the product of conscious rational thought.[80]

Wilson defines sociobiology as the "systematic study of the biological basis of all social behavior" (1975, 4). However, while he includes all animal societies, he limits (wisely, in a political sense) the application of sociobiology in humans to "early man and the adaptive features of organization in the more primitive contemporary human societies."

Perhaps the final chapter of *Sociobiology* (*Man: From Sociobiology to Sociology*) was the most useful for synthesis (or damning, depending on your point of view). Here, Wilson drew from observations and other data from non-human species to speculate on the origins of human social and cultural practices and norms. He described that humans were, after all, social animals that behaviorally responded in ways that provided evolutionary advantage. In addition, he held that there was (in part) a biological basis for culture that followed Darwinian principles. While he was clear that humans have an amazing capacity for reasoning and independent thought, *Sociobiology* helped to popularize the notion that humans were not as behaviorally unique among species as we have largely credited ourselves in the past. Such a bold statement triggered a wave of negative reaction that Wilson should confine his speculations to the social insects, the ants and termites he most studied, and leave the human social sciences to professionals in those fields. He had rudely stepped outside his primary area and had uncomfortably injected a more blatant form of evolutionary biology not only into sociology and cultural anthropology but into political science, speculating on its possible social effects (Lieberman 1989).[81] That an entomologist was commenting on human interactions at a political level seemed anathema to many.[82] His harshest critics opined that he was attempting to justify a range of human behaviors and cultural conditions including war and infanticide, the ills of social Darwinism, empire-building, sexual contracts, slavery and forced marriages, eugenics, genocide, the evolutionary purposes of homosexuality, and the ever-popular catch-all references to Nazi atrocities (Sahlins 1976; Weinrich 1987; Lyne and Howe 1990). To that, Wilson rebuts, "The general biological imagery of the origin of human nature has repelled some writers, including a few of the most discerning

[80] However, rational thought can also lead to unethical actions, and irrational thought can lead to both ethical and unethical outcomes.

[81] As DiGregorio and Stratt (1997, 79) state regarding NASA engineers who venture outside their specific areas of expertise, "…you may not violate the territorial imperative. …A geologist stays with his field of geology, an inorganic chemist stays with inorganic chemistry, and so forth." To do otherwise challenges those disciplines to rethink their various (sometimes provincial) paradigms, which is often frowned upon in the various professions.

[82] But while transitioning among disciplines is difficult, it is refreshing in that it invites discourse; cross-pollination promotes hybrid vigor (to cite an aphorism rooted in biology). It is unfortunate that we have suffered a lengthy period where many universities and their specialized colleges have discouraged such communication, but promising that many are now recognizing the benefits of synergistic inter-departmental collaboration.

scholars in the social sciences and humanities. They are, I am sure, mistaken. They misunderstand gene-culture coevolution, confusing it with rigid genetic determinism, the discredited idea that genes dictate particular forms of culture" (1998, 181). He continues, "Scientists and humanists should consider together the possibility that the time has come for ethics to be removed temporarily from the hands of the philosophers and biologicized." "Even if the problem (here, issues of the origins and purposes of ethical thought and practice) were solved tomorrow, however, an important piece would still be missing. This is the *genetic evolution of ethics*. …Ethical philosophers intuit the deontological canons of morality by consulting the emotive centers of their own hypothalamic-limbic system. …Only by interpreting the activity of the emotive centers as a biological adaptation can the meaning of the canons be deciphered." (emphasis as in the original) (1975, 562-563). He faults Locke, Rousseau and Kant's social contract theories that describe the origins of human ethics as "intuitionist" ("that the mind has a direct awareness of true right and wrong that it can formalize by logic and translate into rules of social action" (562). He continues that others overly rely on implausible scenarios, such as John Rawls' concepts of justice that would arise from an "original position" behind a "veil of ignorance" (described in Section 7.2.2.1).

But given that Wilson asks us to "temporarily biologicize," let us proceed with the acknowledgement that biological, not theological or purely philosophical arguments merit consideration. The basis for Wilson's criticisms is that many philosophers fail to address the fact that the *process* of their musings is a biological one shaped by evolution. There is little wonder why *Sociobiology* and its approaches to social theorizing are still debated with critiques and apologies appearing with regularity, and there has been considerable fine tuning since its publication. But the basic tenets remain a valid argument: thought is the product of a brain that has evolved in response to evolutionary pressures, both biological and cultural (Wilson and Wilson 2007).

Few who accept the theory of biological evolution would disagree that the physiological structures of the human brain are as much a product of evolutionary processes as our toes. Comparative anatomy and demonstrations of structural homologies, the fossil record, genome mapping and other evidence supporting the ancestry of the organ are abundant. And the brain's anatomical and chemo-electric abilities to create images of the environment by analysis of sensory input and thought "mapping" through the formation of biochemical structures have been known since the arrival of the technological ability to detect and measure them (Brill 2006).[83] Again, few would argue that neural pathways and metabolic reactions, although not supported as thoroughly by fossil evidence, are not also the product of evolution.[84] Yet the combined ability of the physical structure of the brain and its metabolic processes to produce abstract and sapient thought is traditionally

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[83] Computed axial tomography (CAT) scanning, radioactive tracers and the three-dimensional mapping of neurons and other networks have made this possible. Also, the Human Connectome Project, an international consortium of universities and other research facilities, is seeking to map the physical structure of the brain to better track sites of activity.

[84] Soft tissue anatomical structures do not lend themselves to fossilization as well as bones and harder tissues, and the fossil record of extinct species is not as well established as with the hard structures. There is no direct fossil record of the evolution of various metabolic pathways. These can only be inferred from the possible function of fossilized structures when compared with extant species.

held as existing in the realm of the supernatural, as something akin to the possession of a soul that is reserved for humans alone. In this way of thinking, humans' more ethereal thoughts are certainly not a product of an evolutionary process.[85] That an ape or dog can clearly express a sense of loss, joy, or curiosity to not only other apes or dogs but to humans and other species as well is considered an organic product of the ape or dog brain; when a human does the same (albeit with a much higher degree of sophistication, as far as we know) it is considered a miraculous product not of the brain, but of the mind. This disjunction forms the basis for much of Western thought, especially in areas of theological and ethical philosophy. Here, the conceptual mind is often held separate from the brain and the rest of the body as a functioning set of organs; dualism all over again. A possible motive is to guarantee homocentrism and a rationale for human superiority. While the study of ethics in a pure sense (as opposed to the ethics of animal "rights" and bioethics directed at human relationships with other organisms) is a philosophical and cultural discipline reserved for humans, evidence of many aspects of ethical behavior have been documented in an increasing number of non-human organisms. This is not surprising in that, for example, altruistic behaviors serve to aid multi-level selection as described previously in full accord with the theory of Darwinian evolution.[86]

If ethical behavior did not evolve through biological and cultural evolution, the only remaining explanations are theological. While possibly serving philosophical agendas, there is no scientific evidence that would support theological origins; they exist within the realm of philosophy. Arguing strongly for a biological basis, University of San Diego neurophilosopher Patricia Churchland holds that our values come from a "combination of our in-born social instincts, habits, and reason. The hub of these instincts is the molecules oxytocin and vasopressin that encourage attachment and trust. Mammalian attachment and trust are the platform from which moral values derive" (Bailey 2012, pages unnumbered). But this either/or argument regarding the biological or cultural origins of ethical behavior is misleading. It seems clearly a combination of the two. To the individual, both factors contribute through biological and cultural inheritance and experience, and our sapience allows us to further modify what is inherited, to mold it to our changing environments to pass on to future generations.

In *Consilience*, Wilson seeks to find common ground among biology and philosophy (Wilson 1998; Wilson 2002).[87] But rather than seeking peace between the camps, others, like Sam Harris, are a bit blunter: "The separation between science and human values is an illusion." He continues, "Facts and values seem to belong to different spheres [but] this is quite clearly untrue. Values are a certain kind of facts. They are facts about the

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[85] I have a gut feeling that "thought" (broadly defined) may also involve other organs, regions or functions in the body in addition to the brain, as in Barry Goldwater's 1964 Presidential campaign slogan, "In your heart you know he's right." Such a notion would be supported by previous observations on the decentralized nature of the body, as a corporation of quasi-independent entities functioning synergistically as a singular unit (Mazmanian et al. 2008).

[86] Neuroscientists from the Max Planck Institute of Psychiatry in Munich, Human Cognitive and Brain Sciences in Leipzig, and Charité in Berlin reported in August 2012 that they have identified a specific cortical network associated with self-awareness. This provides another step in the understanding of the evolved physiological nature of sapience.

[87] This seems to contradict Wilson's call for us to "biologicize."

well beings of conscious creatures" (Harris 2010b). Here, as pointed out by Massimo Pigliucci (professor of philosophy at the City University of New York), Harris is in direct opposition to the idea developed in David Hume's *A Treatise of Human Nature* that facts and values are not necessarily compatible, that a fact of what *is* may have little relationship to what *ought to be* (Pigliucci 2010). And a dominant issue in ethics is precisely that: facts of what is (e.g., our "inhumanity") conflict with what "ought to be."[88]

3.4 Problems in relationships

> *Our failure to study our relationships with other animals has occurred for many reasons…. Much of it can be boiled down to two rather unattractive human qualities: arrogance and ignorance.*
>
> Clifton Flynn (in Herzog 2010, 15)

It is humbling to recall that in the mid-19th century, "the highest court in California explained that Chinese had not the right to testify against white men in criminal matters because they were a race of people whom nature has marked as inferior, and who are incapable of progress or intellectual development beyond a certain point . . . between whom and ourselves nature has placed an impassable difference" (Stone 1996, 4).[89] Similarly, in 1875, the first woman to apply to practice law in the State of Wisconsin was barred from doing so by the State court. They wrote, "The law of nature destines and qualifies the female sex for the bearing and nurture of the children of our race and for the custody of the homes of the world…. The particular qualities of womanhood, its gentle graces, its quick sensibility, its tender susceptibility, its purity, its delicacy, its emotional impulses, its subordination of hard reason to sympathetic feeling, are surely not qualifications for forensic strife. Nature has tempered woman as little for the juridical conflicts of the court room, as for the physical conflicts of the battlefield…" (*supra* citing Goddell, 39 Wisconsin 232, 245 [1875]). As with legal standing, ethical considerability is influenced, if not dominated, by perceptions of hierarchies and political, theological, social and scientific power structures.

3.4.1 Drawing more lines – ethical dichotomies

Much of bioethical thought continues to focus on problems of how to distribute consideration, where to station organisms or objects along a line depicting a sliding scale that typically places humans at the high end and dust motes at the other. The organism or object is positioned along this continuum based on whether it possesses or lacks specific philosophically or empirically derived characteristics (e.g., what is its relative physical complexity; does the subject experience pain; is it sapient; can it respond as well as react; can it use language; is it self-aware; does it have a theory of mind; is it aesthetically appealing; is it of special use to humans?) (Cotezee 1999; Herzog 2010). The reshuffling of criteria used in the past and present to justify or deny ethical consideration seems

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[88] To that, perhaps the present condition of society is not an expression of what is "in our genes" as much as it is the product of cultures responding to a world our genes were not evolved to handle. Arguably, we began this descent with the invention of agriculture and a shift from a hunter-gatherer mode of existence.
[89] People of the State of California v George W. Hall, 1854.

infinite. Assigning place is an inexact process that is increasingly mediated by the technologies that allow us, for example, to discern such conditions as the capacity of the subject to experience pain or, perhaps, its abilities to be reflective. As such, why we apply ethical consideration to a select group of non-human entities is, in part, a product of technology.[90]

Assuming, then, that our technology will continue to be more discerning, we might expect the number of entities provided ethical consideration to grow. This is certainly what we have been observing regarding our ethical relations with non-human organisms over the past two centuries. It is now known that chimpanzees have a theory of mind, and in the summer of 2012 the ability for a humanoid robot to demonstrate the rudiments of this capacity was announced (Gallup Jr 1970; Hart and Scassellati 2012).

3.4.1.1 Emotional affiliations

A tension develops at the intersection of humans and non-humans when matters of bioethical value are at issue. It colors our ethical regard for other species and, ultimately, may influence future relationships with ETBE (perhaps even more vividly than with terrestrial life). The most easily palpable components of this tension are the deep fascination and attraction most have from near infancy for, especially, the "higher" forms of life (e.g., dogs) and, at the other extreme, a general revulsion for some other forms of life (e.g., roaches) (Kellert 1980; Kellert 2005).[91]

Our interest in animals and our choosing those to hold dear and those to fear has adaptive value that is, perhaps, millions of years old; it is part of our neural physiology (Mormann, Dubois et al. 2011). But there seems to be little reason for our selections if based solely on behavioral adaptation for self-preservation. True, we correctly avoid bright red snakes, insects and spiders, but many of us also find other equally as lethal species (e.g., bears) appealing. Among the more regarded species are "charismatic megafauna," those mostly larger species that we (industrialized, urban, largely Western countries) generally don't eat, or at least those species where emotional attraction tends to be encouraged and where the experience of killing and eating are often separated (e.g., chicks and ducklings, shoats, foals and other such animals) (Kellert 1985). They generally include various vertebrate carnivores and larger herbivores, primates, whales, and other poster species that are often cartoonishly portrayed as stuffed toys. They talk to us until we choose not to listen. Laws often bar their abuse with fervor and hunting them for purposes other than survival or sustenance is frequently portrayed as a cultural or personal flaw (for example, bludgeoning baby harbor seals for their skins, sport and trophy hunting, and whaling). But as succinctly put by Randy Cohen, an ethicist for the New York Times Magazine in referencing animals, "In ethics, cuteness doesn't count"

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[90] Similarly, more refined approaches to experimentation have allowed insights not previously available. For example, while not immediately a product of technology, *per se*, studies of the ability of some species such as chimpanzees and gorillas to learn to communicate with humans through rudimentary languages are making progress.

[91] Kellert was contracted by the US Fish and Wildlife Service to poll various demographic groups to assess the degree of attraction to or abhorrence of a range of animals (e.g., bears, eagles, horses….snakes, spiders, roaches). Roaches didn't fare as well as bear cubs. Data were used to guide public relations strategies.

(2009). There is no ethical justification for outlawing the slaughter of baby seals yet permitting their harvesting a few weeks later when they have lost their more photogenic attributes (in harbor seals, when their white fur turns dark, reducing the contrast of their black eyes, thus making them appear less small, helpless and baby-like).

Likewise, size should not be a factor, especially in the context of ETBE. As Charles Cockell has observed on the issue, "Environmental policy has a size bias. Small organisms, such as microorganisms, command less attention from environmentalists than larger organisms, such as birds and larger mammals"(Cockell 2008, 23). While it could be argued that smaller organisms have less neurological wiring and are, therefore, below a threshold of considerability on that basis, our ethical favoritism for larger organisms is also seen when smaller mammals, such as rodents, are ethically compared with larger ones, such as dogs. It appears that size does matter. Cockell continues, "size is important in environmental ethics because conative capacities have played an enormously important role in different ethical frameworks and thus, depending on the viewpoint of the ethicist (or member of the public), size is important as an indirect result of where the line of moral considerability is drawn and how moral significance is determined" (29).

Applying such an analysis to the Viking lander or the Mars Science Laboratory's search for the signs of life, scoops of soil are placed in a chamber and eventually incinerated on completion of the tests regardless of the results of that test. If life was found to be present, it would be killed. Yet if the experiment had a much larger chamber that was able to collect an organism the size of a cat, would there be a differing ethical decision on how that experiment might end? Likely, yes, regardless of the cognitive abilities of the subject.

The human capacity to identify with and engage the organisms themselves, not just trivial representations of them, is the core of this issue. As Donna Haraway asks of dogs in particular and other familiar species in the opening paragraph of *When Species Meet* (2003, 8), "(1) Whom and what do I touch when I touch my dog? and (2) How is 'becoming with' a practice of becoming worldly?" This deeper relationship she references certainly seems a capacity in decline as techno-Western cultures continue to distance themselves from a personal agrarian life intimately enmeshed with both husbandry and home butchering.[92] Work and food animals are brought literally as well as figuratively indoors to become non-working pets; the term pets is re-labeled companion animals; and companion animals are "humanized" as family members (Grandin 2002).[93] In many ways we (and here I again refer to predominant contemporary Western/Northern European cultures) have lost the ability that Haraway references, that practice of becoming worldly.

[92] Here, butchering is not to be interpreted in a negative sense as torture or harming with malicious intent, but the more agrarian rituals of animal husbandry and nutrition.
[93] Even the term "pet" has been denigrated to a degree due to its association with dominance, as a term of hierarchy. It has increasingly been replaced with terms such as companion or friend. In Boulder, Colorado dog owners are termed "guardians" in City business (City of Boulder Revised Statutes 6:1-Animals).

3.4.1.2 Ethical consideration as mediated by technology

> *Getting back to Descartes, I would only want to say that the discontinuity he saw between animals and human beings was the result of incomplete information. The science of Descartes's day had no acquaintance with the great apes or with higher marine mammals, and thus little cause to question the assumption that animals cannot think.*[94]
>
> J.M. Cotezee (1999 61)

> *Aristotle maintained that women have fewer teeth than men; although he was twice married, it never occurred to him to verify this statement by examining his wives' mouths*.[95]
>
> Bertrand Russell (as quoted in Eysenck 1995, 4)

While I believe Cotezee's quotation is far too lenient on the flaws in Descartes' intellectual rigor and powers of observation, it does highlight the importance of information as it applies to ethical relativism. Predominant pronouncements regarding the extent of ethical consideration have habitually been hindered by assumptions that what we know "now" (or, for Descartes, in the 17th century) represents an endpoint in knowledge, that the expertise of the particular age is somehow a conclusion, not part of a process of change. This contributes heavily to ethical relativism, and relativism will not serve us well in the futures.

For example, recent development of acoustical detection technologies, computers and software to analyze complex data sets to discern meaningful patterns, and satellite imagery allowing accurate observation and mapping of humpback whales allows a greater appreciation of their complex communication, social structure and other factors than was possible in the past (Mann, Connor et al. 2000). They are far more intelligent than previously believed, and many people have elevated their ethical consideration of that species as a result. An article in the Economist (2012, 92)), "Whales are people, too," argues that "the proposition that whales have rights is founded on the idea that they have a high degree of intelligence, and also have self-awareness of the sort that humans do." It cited that whales' brains contain "a particular type of nerve cell, known as a spindle cell, that in humans is associated with higher cognitive functions such as abstract reasoning." The article continues, "Whales and dolphins have complex cultures, too." All are observations made possible through technological advances. If the current commercial slaughter of whales is deemed unethical, was the operation of the whaling fleet in the 19th century any less ethical?

Another example is provided by technologies that now allow us to consider the creativity of social insects at solving structural and logistical problems (Lihoreau, Chittka et al. 2010). Research on the possible function of "swarm intelligence" (as opposed to an

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[94] As spoken by the fictional character O'Hearne in Cotezee's book.
[95] Aristotle supported the predominant Greek patriarchal belief system which was supportive of his pronouncements regarding differences between men and women.

individual’s solitary capacities) in some invertebrate species is ongoing, challenging our common definitions of intelligence (Eberhart, Shi et al. 2001).

Even plants have been found to communicate with pheromones or other forms of chemical signaling when attacked by herbivorous insects, and hints of altruism among plants are being studied (Campos, Faria et al. 2008; Murphy and Dudley 2009). Yet thoughts that plants communicate, much less that they may exhibit altruistic behaviors, would have been ridiculed less than a century ago (and likely would be ridiculed by many today). Can we assume they do not sense and respond to pain in ways we cannot yet detect, much less measure? Will the circle of ethical consideration be broadened to include them, should our technology evolve to detect their pain or the other factors we use to mete where ethical consideration is warranted and where it is not?

Closer to possible ETBE forms, terrestrial bacteria are not beyond consideration as possibly possessing more sophistication than they have traditionally been awarded (none). That they communicate via chemical releases is known and activities enabled by bacterial social intelligence (akin to swarm intelligence) are being investigated (Ben-Jacob 1998; Bartal, Decety et al. 2011).

> *Bacteria are not the simple, solitary creatures of limited capabilities they were once believed to be. These most fundamental of all organisms are smart, cooperative beasts that use advanced communication to lead complex social lives in colonies of enormous populations. They know how to glean information from the environment, talk with each other, distribute tasks, generate collective memory, and turn their colony into a massive ‘brain’ that can process information, learn from past experience and might even create new genes to better cope with new challenges.* (Krone 2006, 92)

Both intra- and inter-organism cell-to-cell communications among bacteria via autoinducers (signaling molecules) are also being studied (Taga and Bassler 2003). While such claims were likely seen as ludicrous only a few decades ago, one should be hesitant to claim them false. We have all been surprised by revelations that organisms once believed to lack any intelligence were subsequently discovered to have amazing talents (consider again the previous quote from the California court regarding the Chinese).

- “Birds rival primates in number task.” “Pigeons have matched primates in a test of learning an abstract concept similar to counting” (Millus 2012).
- “Octopus capable of observational learning”(Fiorito and Scotto 1992).
- “Bees outside the nest exhibit social learning in flower choices”(Worden and Papaj 2005).

With the broad acknowledgement that our assessment of animal intelligence has been fraught with errors for the past millennia to the condition today where new insights into animal capabilities are announced with regularity, it is far premature to assume we are able to assign ethical status based on our limited knowledge. We should not be too quick to ethically categorize non-human organisms when the criteria for such determinations are limited by our technology. This becomes especially critical when we are assessing ETBE.

I pose that it is justifiable to extend ethical consideration to ETBE, even those that may be of microbial size and unknown bio-complexity, in part because of our present ignorance. By extending ethical consideration from its ancient core of just a select subset of humans, to all humans (including all genders, races, religions, etc.), to other sapient species, to sentient species, to all life and eventually to ecosystems and landscapes both on Earth and elsewhere, we will end the cycle of exclusion followed by apology that has been a common consequence of our ethical thinking for millennia(McNally and Inayatullah 1988; Nobles 2008). Rather than rule where we will provide ethical consideration and where we will not based on our Earthly experience, we can start fresh with a new purpose and understanding. While there is certainly a cadre that holds that sentience is the minimum criterion of moral status, degrees of sentience and sapience may become irrelevant on extraterrestrial venues and, following, may become less relevant back here on Earth as well (Jeffko 1999).

3.4.1.2.1 Pain-based metering

Part of the rationale of providing higher bioethical standards for humans than for other organisms has been the assumption that humans and only humans have the ability to *respond* to stimuli, while animals can only *react* (Derrida 2003).[96] To react is pre-wired, as a machine is wired to a specific set of reactions only and cannot (as yet) make deeper decisions (responses) when provided a stimulus. The standard begs to be skewered. Whether non-humans are their own agents and are capable of responding or not is irrelevant in that we humans are the only arbiters in decoding that response through language.

A first problem is that most often we are either not looking for a response or we dismiss any perceived response as an aberration. A bird writhing on a barb is considered a response to pain; a worm on a hook is considered a reaction. Peter Harrison, writing in the journal Philosophy (Harrison 1991, 26), challenges assumptions that organisms other than humans can feel pain at all, but specific to the issue of not looking, he states, "Even the simplest representatives of the animal kingdom exhibit rudimentary 'pain behaviours'. Single-celled organisms, for example, will withdraw from harmful stimuli. Insects struggle feebly after they have been inadvertently crushed underfoot. Yet few would want to argue that these behaviours resulted from the experience of pain. Certainly we show little sympathy for those unfortunate ants which are innocent casualties of an afternoon stroll, or the countless billions of micro-organisms destroyed by the chlorination of our water supplies. For all *practical* purposes we discount the possibility that such simple forms of life feel pain, despite their behaviours" (emphasis added). Here, the argument

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[96] Included with *And Say the Animal Responded* was a lecture given by Derrida in 1997, translated from French in a 2003 volume (pages 121-146). Derrida challenges the Cartesian notion of animals as only having the capacity to react, while humans can respond.

becomes one of semantics and interpretations of non-human sensations. Granted, in humans and species with similarly constructed systems of nerves and ganglia we recognize that pain is a product of the brain, bolstering arguments that species without brains or similar neurological complexities are physiologically incapable of feeling. Can we make that assumption? When viewing injured insects as Harrison describes, might there be other sensations equally as upsetting to the organism? Would not the purpose of this ersatz pain evidenced by the feeble struggling serve the same purpose as the pain we feel? Both teach avoidance of the causative agent. Insects avoid swimming in boiling water when presented a choice, as do we. Both behaviors are adaptive.

Consider a person who has suffered some accident that blocks all sensation of pain but is otherwise intact. Assume that person then becomes infected with a degenerative disease that causes massive abscesses but without any physical pain in the traditional sense. How would one characterize the victim's reaction? How might it be manifested if not by some other form of deep anguish or other trauma that may well be visceral, although pain-free in a standard sense? There would predictably be a high degree of stress and anguish that would be expressed in numerous other ways. Might these other ways be equally as "painful?"

Returning to the modifier "practical" in Harrison's thought, it becomes clear that for him denying ethical consideration can be very much a practical issue. For him, it is not *practical* that he considers the possibility that he may be acting unethically toward ants during his stroll. Does practicality justify the ethical nature of our actions? If ethics is founded on practicality, a lot of philosophical effort spent over the past thousand years would have been misdirected. It may be that Harrison's stepping on ants is practical only because there is no easy alternative.

The problematic issue of the sensation of pain as something wholly human is compounded in consideration of the effects of placebos, instances of referred, phantom, and psychosomatic pain, and twin studies that have demonstrated shared psycho-physical pain. Physical pain is relative. As such, it is hardly a marker for metering ethical consideration.

A related second problem is that a non-human species may be responding in ways that we may not understand or that we are mentally or physically incapable of understanding (this may be especially applicable regarding ETBE). We do not expect a response, and those who do detect more than just reactions from other organisms may be labeled delusional or quaint and their observations dismissed. The many cultures that adhere to a degree of animism, however, would more likely accept such responses. Those more adept at listening and observing have practiced perception skills and might be better enabled to not only detect but accept what may be unavailable to the skeptical or untrained. It is helpful to remember that we all talk to animals as if they fully understand and occasionally extend the conversation to plants or even mountains or oceans. It is a conversation and not a monologue, for although the other participants do not speak in our languages, they respond, not react, all the same.[97]

3.4.1.2.2 Intelligence-based metering

As with the capacity to experience physical pain, degrees of intelligence are also argued to be related to an obligation to provide ethical consideration – generally, the more intelligent the organism, the higher the degree of ethical consideration accorded. Yet measuring intelligence even among humans is difficult and among non-humans it is extremely problematic. What is to be measured? How might data be interpreted? Consider that the pseudoscience of craniometry (determining the volumetric capacity of the skull), inferring brain size, and, by extension, intelligence was considered by many to be an exacting science in the late decades of the 19th century (Gould 1996). Data were used to justify ethical metering, here, racial, ethnic and gender discrimination.[98] More recently, genomics was thought promising as a tool for insight regarding race, criminal tendencies, and other factors. It has since lost some of its luster. Like craniometry, it could be used as a metric for political or social ends and as justification for ethical metering (Duster 2003; 2006; Kidd 2006).

Consider: A recent case study provided an account of a college student with normal social skills, a well-above-average intelligence quotient and high proficiency in mathematics. Yet a brain scan revealed that the subject had less than one percent of what would be considered a normal volume of cortex brain tissue (Lewin 1980).[99] "It need hardly be said that when we cross the species boundary and attempt to make projections about animals' putative mental lives based on the structures of their nervous systems we are in murky waters indeed" (Harrison 1991, 29). The evidence supports that it is far premature to claim that comparative brain physiology, anatomy or size provide definitive measures on which to base bioethical consideration.

3.4.1.2.3 Value incrementalism

In *Sentience and Sensibility*, Matthew Silliman makes the claim that moral considerability can be metered to three broad classes, each separated by a threshold of "emergent ability" (2006, xvii-xviii). The first (lowest) threshold includes those entities that are judged to have no ethical or moral considerability, such as inanimate objects (rocks), plants, ecosystems and physical systems. Silliman terms this category "moral instruments." The second threshold comprises "moral patients," organisms that are barely sentient and those who are "conscious subjects of their own lives." Included here would be the great bulk of species we know, from clams to owls to mice. The third

[97] Then again, we've all spoken less than kind words to automobiles that won't start and hammers that find our thumbs, and they certainly are a lot more stubborn in responding, at least in ways we would notice and appreciate.
[98] Data were prone to both intentional and unintentional (but perhaps psychologically premeditated) tampering to bolster social claims (i.e., supporting racism).
[99] "When we did a brain scan on him," Lorber recalls, "we saw that instead of the normal 4.5-centimeter thickness of brain tissue between the ventricles and the cortical surface, there was just a thin layer of mantle measuring a millimeter or so. His cranium is filled mainly with cerebrospinal fluid" (from Lewin 1980).

(moral agents) are capable of reflective self-awareness and able to maintain "autonomous selves." To each group we have specific obligations that are "appropriate to their nature." Silliman terms this approach "value incrementalism."

While debatable in practice, his approach is based on human perception of the world which, as described previously, is largely the product of our own abilities of observation.

3.4.2 Futures of ethical metering

> *When god-like Odysseus returned from the wars in Troy, he hanged all on one rope a dozen slave-girls of his house-hold whom he suspected of misbehavior during his absence. This hanging involved no question of propriety. The girls were property. The disposal of property was then, as now, a matter of expediency, not of right and wrong. Concepts of right and wrong were not lacking from Odysseus' Greece: witness the fidelity of his wife through the long years before at last his black-prowed galleys clove the wine-dark seas for home. The ethical structure of that day covered wives, but had not yet been extended to human chattels. During the three thousand years which have since elapsed, ethical criteria have been extended to many fields of conduct, with corresponding shrinkages in those judged by expediency only.*
>
> Aldo Leopold Regarding Homer's *Odyssey*
> from *Sand County Almanac* (1949, 237)

3.4.2.1 Problems of ethical relativism

A significant stumbling block in the progression of ethical thought has been a general preconception that a perfect ethical standard is both definable and attainable while simultaneously limiting membership to those entities deemed worthy of ethical treatment.[100] While such an impediment is most often argued against human inequities, it more recently has been applied to primates that most-closely "look" and "act" like humans. Such relativism produces standards later found contradictory and ethically unacceptable, triggering the need for another round of redrafting culturally-appropriate ethical guidelines. The circle of consideration is broadened; homocentrism is relaxed to sapiocentrism, then to sentiocentrism, segregating the "Wesorts" from "Yousorts."[101] This process has been repeated through our histories, but the rate of change was slow and frequently accompanied by violence. For example, as stated in the above quote regarding Odysseus, centuries ago a man might have been considered an ethical and virtuous person

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[100] One is reminded of sentiments that one cannot be free until all people are free. It follows that one cannot provide ethical consideration to a select few species based on such criteria as intelligence or physiological complexity without extending consideration to all life.

[101] In Southern Maryland, "Wesorts" was a self-classifying term applied to a small Piscataway and African mixed-race community. Those outside the community, especially other Blacks without Piscataway ancestry, were labeled the derogatory "Yousorts." In brief, "Wesorts don't associate with Yousorts." Other folklore regarding the terms holds that Wesorts were Blacks living in Southern Maryland whose ancestors had never been slaves; they did not want to be considered with those Blacks whose ancestry included slaves. Terms of segregation are similar to the more well-known High Yaller, Yaller, Light Brown, etc. to segregate skin color.

within his culture and community yet own slaves, abuse or even murder his children as directed by family custom and own and barter wives as chattel. Centuries later, in 1274, Aquinas states in *Summa Theologica* (1274, 1355): "The possession of all things in common and universal freedom are said to be of the natural law, because, to wit, the distinction of possessions and slavery were not brought in by nature, but devised by human reason *for the benefit of human life*" (emphasis added), and that slavery among men is "natural" (p 652). Aquinas argued (but did he reason?) that it was natural in that archangels were superior to angels, and since such a precedent of hierarchy was set in Heaven some men could clearly rule over others. Then again, Homer and Aquinas (and countless other apologists) had pre-existing, more mundane agenda to rationalize.

In some cultures, ethical standards regarding more subtle forms of slavery are still entrenched.[102] In the U.S., the practice was regionally considered socially and culturally ethical long after emancipation made it illegal (Litwack 1999). And although Black slaves were legally emancipated by the 13 Amendment, other forms of slavery persist (such as the practice of leasing prisoners, internment, conscription and holding prisoners without trial). We reflect on the practice of slavery from today's cultural vantage and wonder at its hypocritical defenselessness, its ignorance of an ethical foundation. Yet killing, torture and other acts generally considered unethical are still not only endorsed as ethical but are especially honored and celebrated when sanctioned by governments (Paige 2000).[103] To relegate today's authorized forms of slavery and homicide to history as was slavery, as Glenn Paige states (regarding homicide, p 1), is "for most political scientists 'completely unthinkable' for at least three reasons: lethal human nature; scarce resources that lead to conflict and killing; and the biological or moral imperative to kill to defend self and others against predatory aggression. Some will argue that there has never been a non-killing society in history, and thus there can never be one." Certainly, though, while humans are abundantly capable of killing other humans, few do; we arguably do not have a significant lethal human nature. While scarce resources may lead to killing, again, that is not the rule and, arguably, when people do commit lethal action over resources it almost always is predicated by a government blessing, if not instigation or requirement for political purposes.[104] As for self-defense against predatory aggression, the need for lethal force is extremely rare (Pinker 2011).

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[102] E.g., the Hindu practice of *sati* in which a wife is immolated on the death and cremation of her husband was practiced more commonly into the early 19th century, but was not officially outlawed in India until the Commission of Sati (Prevention) Act, in 1987. It still occurs, although rarely. While most incidents appear to have been acts of suicide, involuntary sati has also been recorded. However, it is difficult to discern whether "voluntary" sati is done willingly given the strong cultural and community pressures to uphold the tradition (Hardgrave 1998). More modern examples of the chattel nature of women and children in some cultures are represented by "honor" killings and various forms of disfigurement. Fathers still "give away" the bride in many weddings, transferring implied ownership.

[103] Paige quotes from Max Weber's "pervasively influential 1918 lecture at the University of Munich, Politics as a Vocation. He defined the modern state as 'a human community that (successfully) claims the monopoly of physical force within a given territory'" (Weber 1958, 78).

[104] Few individuals would kill for oil, yet governments seem to have no significant problem in initiating lethal actions resulting in mass killings of combatants and civilians alike to secure it.

As the conditions of all manners of such subjugation (e.g., slavery) were socially challenged and determined to be unethical (i.e., could not be ethically justified by newly-evolving social standards) the circle of ethical consideration was widened to include the formerly excluded. It is seldom constricted except, for example, during times of war, catastrophe or periods of "social readjustments."

Similarly, mistreatment of select animals (e.g., cruelty to horses, bear baiting, cock and dog fights) has been (is being) challenged as unethical and again many species have been subsequently protected from those forms of harm (e.g., a range of vertebrate farm and research animals and even fish and invertebrates) (Hickman 2010).[105] Bullfighting, long engrained in Spanish culture, was banned in Catalonia in 2011.

Readily available indicators of this trend in ethical provisioning can be found in guidelines regulating use of research animals. Public sentiment is also reflected in restrictions placed on school Science Fair submissions such as the following recent modifications to the guidelines:

- "Bacteria, fungi, protozoa, insects, plants and invertebrate animals (except cephalopods) can be used to study basic biological processes. All projects must have scientific and educational merit and avoid gratuitous harm."[106] No specific guidance regarding "gratuitous harm" to bacteria or plants is provided.
- International guidelines limit actions involving vertebrates only (cephalopods [squid and octopus] are not protected). Other school districts disallow any Science Fair projects that involve harming *any* animals (e.g., positive reinforcement for behavioral experiments is allowable, but negative reinforcement of any kind is not).
- "Zebrafish embryos are not considered vertebrate animals until 7 days (168 hours) post fertilization" (Savannah, Georgia guidelines). (Zebrafish are especially useful in genetic engineering experiments due to their rapid maturation and relatively large egg size. Gene splicing, for example, would normally occur prior to 7 days post fertilization, so would meet the Savannah criterion. One assumes that less "useful" fish would not have this restriction.)
- "Vertebrate animals" includes reptile and bird eggs to within three days of hatching.[107]

Cephalopods (squid, cuttlefish and octopus) are rather recent additions to the circle of ethical consideration (Moltschaniwskyj, Hall et al. 2007). Being members of the Class Mollusca (akin to shellfish) they have been traditionally considered as without ethical warrant. But more recent studies have demonstrated that they are relatively intelligent, able to solve puzzles and are capable of long-term memory (Hamilton 1997; Mather,

[105] In the documentary 1997 film "Lost Man's River," Peter Matthiessen, a naturalist and writer, is fishing. He catches a tarpon, but releases it after reeling it to his boat, explaining to his guide that he is a Zen Buddhist and did not believe in taking life needlessly. His guide responds, "what about the baitfish?" Matthiessen does not reply. Such ethical inconsistencies are abundant in most cultures.
[106]Guidelines for Canadian science fair.: Online at: http://www.sciencefairs.ca/getattachment/Science-Fairs/Mentorship/Quick_ethics_guide_AMP.pdf.aspx
[107] http://www.societyforscience.org/page.aspx?pid=318#RuleAll

Anderson et al. 2010). Pertinent to this dissertation, Godfrey-Smith (Professor of Philosophy, Graduate Center of the City University of New York) stated, "Meeting an octopus is like meeting an intelligent alien" (Newitz 2011).

As with other species formerly discussed, it is only through technology and the general advancement of our knowledge of the biological world that builds a degree of empathy that we have come to appreciate the complexity of these organisms. Where we can ascertain that they experience pain, that they may be self-aware, that they are more intelligent than expected or that they possess a sense of purpose we are more likely to extend ethical consideration. Accordingly, as our tools and technology improve our ability to ascertain the degree of their pain or measure their intelligence we may be unable to avoid being in an ethical bind if we do not also extend consideration where we have not before. Should we find that insects or plants, for example, are far more complex than we have imagined, one would expect that our ethical relationship with them will change accordingly (as did Science Fair regulations in recognizing cephalopods).

From a futures perspective, it is not unreasonable to consider a time when the malicious mutilation of a plant may be ethically questionable. It is no more preposterous than considering the prohibition of the use of squid or insects in school science fair projects would have been a century ago. What was considered to be ridiculous is now taken more seriously.

3.5 Crafting new ethical relationships for ETBE

3.5.1 Costs of ethical consideration

A primary consideration in applying bioethical codes is that they are, obviously, human inventions. They are founded on a widely-variable classification system that certifies where consideration ought to be applied even though a cost (including inconvenience) is borne by the provider. Factors for certification of humans as ethically considerable are still influenced by ethnic or religious affiliation, race, age, mental condition and gender, political or social status, wealth, degrees of enslavement or imprisonment and other factors. These may be codified, but ethical standards are more often embedded in cultural and customary practices.[108]

Philosophies of bioethics have been prejudiced and constrained by direct and indirect “worth” of various species and environments to humans, cultural significance, and taxonomic status (Newmyer 2006).

3.5.1.1 Utility

The degree of ethical consideration afforded non-human life is influenced by how useful such life is to humans, how much an organism is “worth” to humans and its “value” to humans (Rawles 2010). A ready example is the above citation placing less ethical restriction on research regarding zebrafish for school science fair projects than for other

[108] I would cite any current newspaper for abundant evidence.

species of fish with assumed similar physical and mental capacities. Utility extends beyond Bentham's calculations of utiles. Conversely, where non-human life poses an economic obstacle or disincentive, ethical consideration tends to be withheld. For example, in the West we generally apply a higher ethical standard when dealing with horses than we do with rats. There are laws hundreds of years old protecting horses from cruelty, but until very recently little was said of ethical standards directed at the protection of rodents. Current U.S. laws and practices serve primarily to caution that we house, use and kill them with a minimum of pain and trauma, but only when they are in our employ, such as in scientific experimentation. Wild rats are generally not addressed and local stores stock what may be means for the cruelest of deaths, sticky traps that can take several days of extreme stress and dehydration before death.

An example applicable to space is provided by the potential for forward contamination (biological contamination of outer space by Earth's microbes) due to unsterilized vehicles and equipment that may land or crash on bodies such as Mars (National Research Council Committee on Preventing the Forward Contamination of Mars 2006). It has been argued that a high degree of sterilization is essential to ensure that Earth life does not confound the ongoing search for Martian life and that forward contamination does not adversely affect any alien life (McKay 2009). That conservative approach of sterilizing vehicles to a higher standard, however, has been challenged as failing cost-benefit analyses. NASA management holds that such a strategy will impose additional costs on an already strained space exploration program (Walsh 2009). The conclusion discounts both the ethical consideration of possible alien entities in addition to the scientific and economic potentials they may offer.

3.5.1.2 Cultural significance

The Hawai'ian *kapu* and '*aumakua* systems, in part, serve to protect certain species of wild animals, plants, and even inanimate objects such as rocks from human harm for cultural and conservation purposes (Pukui and Elbert 1986). Other cultural practices strain ethical justification, such as maiming and sacrificing animals in religious practices and a variety of blood sports, such as dog, cock, and bullfighting staged for entertainment. In contrast, while some extraterrestrial bodies such as the Moon and Sun have cultural significance in a spiritual, religious, or artistic contexts, no extraterrestrial biological entity plays a significant role in human culture (Cashford 2003). None is eaten, none is used in sacrificial or other ceremonies, none is hunted for sport or entertainment except in Hollywood productions.

3.5.1.3 Taxonomy

Our classification systems are largely based on degrees of evolutionary relatedness, and that provides an array of valuable tools for understanding the diversity of Earth's organisms and their phylogenetic relationships. But as addressed in Chapter 2, taxonomic status is a human construct. Until recently, most taxonomic treatments placed humans at the topmost "branch of the tree" or at the apex of a pyramid of all species, yet over a century ago Darwin cautioned us to avoid the term "hierarchy" in the taxonomic approach to describing relationships among life. In his copy of *Vestiges of the Natural History of Creation*, he penciled "never use the words 'higher' and 'lower'" in reference to taxonomic classification (Light 1998, 111). The "tree of life" analogy is more fitting for Spencer or Lamarck and is decidedly in keeping with traditional Christian models.[109] Relegation of other species to various sub-levels has been influenced by the organisms' complexity and relative relatedness to humans through assumptions of the degree of exhibited sentience (evidence that the organism perceives and reacts to its environment) and sapience (that it has developed sophisticated abilities to reason and be reflective) in addition to phylogeny (Silliman 2006). Higher ethical standards are generally applied to organisms "higher" up this chain of growing complexity. Accordingly, we tend to confer greater ethical consideration to a bird than we do to a clam, there is very little consideration of plants (unless they have cultural significance, such as revered trees), and microbial-scale life is afforded next to no ethical consideration at all (Stone 1987; 1996).

3.5.2 Issues of terraforming

> *Some people consider the idea of terraforming Mars heretical - humanity playing God. Yet others would see in such an accomplishment the most profound vindication of the divine nature of the human spirit, exercised in its highest form to bring a dead world to life. My own sympathies are with the latter group. Indeed, I would go farther. <u>I would say that failure to terraform Mars constitutes failure to live up to our human nature and a betrayal of our responsibility as members of the community of life itself.</u> Today, the living biosphere has the potential to expand its reach to encompass a whole new world. Humans, with their intelligence and technology, are the unique means that the biosphere has evolved to allow it to make that land grab, the first among many. Countless beings have lived and died to transform the Earth into a place that could create and allow human existence. Now it's our turn to do our part."* (Emphasis as in original.) (Zubrin and Wagner 1996, 248-249).

Martyn J. Fogg (2000, 207) rebutted these ideas by delineating four potential rationales on which to evaluate the ethics of terraforming - anthropocentrism, zoocentrism, ecocentrism, and preservationism, roughly forming a spectrum from placing the most value on human utility to placing the most value on preserving nature.

Ethical theory	Central moral principle	Basis of intrinsic value
Anthropocentrism	Categorical imperative	Rational and moral capacity
Zoocentrism	Principle of utility	Individual consciousness
Ecocentrism	Principle of respect for life	All life
Preservationism	Principle of the sanctity of existence	Uniqueness of "formed integrity

These categories he proposes are based on intrinsic value, the value of an object independent of the valuer. Possessors of intrinsic value hold rights based on that value and, as Fogg summarizes, are entitled to justice and respect. An entity with instrumental

[109] It is increasingly replaced with a "web" configuration.

value has no intrinsic value, and its value is determined by the valuer (a hammer, for example, may be described to have no intrinsic value, but does have instrumental value to a carpenter). The hammer, accordingly, has no claim to rights. With those precepts in mind, Fogg addresses the four ethical categories:

-Anthropocentrism poses that only humans have rights -- the individual human's capacity to think rationally and act morally as sapient beings. All else in the Universe is amoral. This has been the predominant approach in many Western traditions. Nature, in that it has no intrinsic value and no rights, is a resource to be used by man to reach (ideally) moral ends. Future generations of humans are certainly to be considered in our actions, justifying an environmentally balanced approach to resources use. We preserve and husband natural resources as a way to provide for future generations of humans. Anthropocentrism would allow the "wise use" of any extraterrestrial resource in a manner similar to any resource found on Earth.

-Zoocentrism broadens consideration to include not only humans but other entities that have the capacity to be sentient, to demonstrate participation in maximizing happiness, achieving a degree of "happiness" that could enter a calculation of "greater good" within a context of utilitarianism. These animals (humans included) would meet the minimum criteria for having intrinsic value; they have "inner lives" (Singer 2001, Silliman 2009). Those entities not able to demonstrate such lives to us would lack intrinsic value, have no rights, and, therefore, would fall out of the equation of considerability. Should we encounter sentient beings on Mars, for example, we would determine they have intrinsic worth and would provide them certain rights. The extent of those rights would have to be determined based on the "degree" of sentience they demonstrate to the human investigators.

-Ecocentrism moves the threshold of consideration to include all life. It finds all life to possess intrinsic value by nature of being alive. All life has rights including the ecosystems of which they are a part. Humans are not afforded the superior position provided by zoocentrism in that humans are not required to make judgments as to the capacities of other species to have inner lives. Fogg references Aldo Leopold (1949) in defining the principle of respect for life as "preserving the integrity, stability and beauty of the biotic community." Here, Fogg begins to show his preferences by concluding that an ecocentrist approach would demand we "dismantle our energy and resource-intensive civilization, reduce our population, and adopt a simpler lifestyle in harmony with nature;" "it subordinates the rights of the individual to those of an holistic abstraction" (208). It is a "cozy illusion" (209).

-Lastly, cosmic preservationism takes the final step in ethical consideration by posing that terrestrial life's intrinsic values cannot be imposed on the extraterrestrial. "The cosmos has its own values, they claim, and its mere existence gives it not only the right to exist, but the right to be preserved from any human intent" (208). As such, not only would terraforming be an ethical violation, but any human action affecting any extraterrestrial body would be suspect. Preservation and passive uses would be the only allowable actions. Citing Holmes Rolston, a proponent of preservationism, “rocks would have rights on Mars” (1986).

In conclusion, Fogg supports terraforming (here, of Mars, and by extension, anywhere else in the Universe that may ether be sterile or have non-sapient life). His rationale is that life may be transmitted through natural processes not involving humans, as supported by life-bearing ejecta of one planet seeding another. There is no proof that this did not originally bring life to Earth from Mars or the reverse. If transfer of life is a “natural” process, then humans *purposefully* taking life from Earth to terraform Mars is a “natural” act and is ethically defensible (assuming no sapient life on Mars). I certainly do not agree. It equates to an ethical defense of importing chimpanzees or boa constrictors to Hawaii by stating that life naturally arrived on the Islands independent of humans, so it is a natural, thus ethical process. There are groups (e.g., The Panspermia Society) that have taken this further by calling for the wide and indiscriminate broadcasting of Earth’s life throughout the Universe (Mautner 2004).[110]

3.5.3 Opportunities

The opportunity we now have is that no extraterrestrial biological entities have yet to be discovered and, as such, they have no utility or utilitarian value or worth. We share no history with them; they are neither heroes nor villains in our cultures, so their place within the context of our cultures has not been established. They have no taxonomic status and have not, therefore, fallen into a possibly prejudicial preconception of "place" or ranking. And we have no measure of if they suffer physically or emotionally or if those terms are even appropriate or applicable. They are free in that they are unknown.

However, the moment that extraterrestrial biological entities are discovered, opportunities to craft protocols and policies that foster enlightened relationships less biased and confined by predominantly utilitarian and exploitive motives and other influences will decrease. Compounding this immediacy, human-extraterrestrial relationships established at our first encounter have the incredible power of legal, political and cultural precedent; after discovery, it will become increasingly difficult to alter the aforementioned relationships as special interests become entrenched and bureaucracies calcify. It is not difficult to imagine the immense commercial pressure to afford less ethical consideration to an entity discovered at a prime mining site on Mars, for example, as opposed to one found in a far less valuable location, or a microbe-like form possessing enzymes that promise the potential of tremendous financial gains through patenting and industrial use contrasted with one of little obvious biochemical potential. We must, therefore, resolve our policies regarding extraterrestrial ethical issues prior to their discovery, before we know whether or not they exist; prior to learning of their possible commercial value and before we attempt to speculate on their capacity for suffering.

[110] www.panspermia-society.com I find this proposal appalling for many reasons. Imagine our reaction if our oceans were purposefully seeded with some alien organism from outside our Solar System by an entity that believed that was their duty, their obligation?

In the context of space exploration we are provided a rare moment to craft policies that reconsider what is ethical and what is not. Once extraterrestrials are discovered, such entities will rapidly be relegated to terrestrial ranking and an opportunity for creative and liberating new approaches to humans' relationship with the greater biological universe will be lost until the next new world is "conquered."

3.6 Personhood perspectives

Some have argued persuasively for extending legal rights (personhood and legal standing) to non-human species.[111] Species to be given such rights are, however, mostly limited by some pre-defined criterion of mental capacity, such as sapience or, to a lesser degree, sentience. In her critique of Stephen Wise's *Rattling the Cage – Toward Legal Rights for Animals*, Katrina Albright cites that Wise advocates legal rights for primates that demonstrate a degree of sapience, chimpanzees and bonobos, because they would, as Wise states, "pass current standard tests for personhood," those "deemed to possess rationality" (Wise 2000; Albright 2002). It withholds similar rights from those species failing tests for rationality. But while many animal rights advocates such as Wise extend consideration to sapient and sentient species, Albright makes the case that such restriction is arbitrary, that it represents a continuation of a history of patriarchal domination of women and the related domination of nature and non-human animals. She urges an embracing of a "feminist caring ethic" and recognition of animals' "inherent right to bodily security and integrity based not on their rationality, but instead on their emotional lives and relationships with humans, as well as on humans' ethical responsibilities to end animal suffering" (*supra*, 915; Gilligan 1982). I agree with her analysis, but while she calls for extending consideration beyond those few mostly primate species that demonstrate rationality to include those animals that suffer, she fails to answer the dominant question, why stop there? Is our assessment of suffering any more foundational to ethics than our assessment of mental capacity?

Aristotle's "Great Chain of Being" assigned positions within a hierarchy based on perceived rationality, with those at lower stations "serving" the higher. Aristotle's influence on subsequent Greek and Roman law was substantial, and traces of the Great Chain remain through the development of Western systems of law (Mason 1993). While the term likely does not appear in modern law except in historical contexts, the ordering of life is generally accepted without challenge (or much thought); it is institutionalized and assimilated as part of most cultures in the West. But while such order facilitates domination of nature, for better or worse, it has been cited in ecofeminist work as also perpetuating the darker side of patriarchy, the domination of women, minorities, nature and animals by men (Albright 2002, 925). Albright cites Mason (1993, 266): "[P]atriarchy…is our dominionist culture's system for the control of hierarchal relations

[111] Animal welfare cases often gain access to the courts through the proof of human plaintiffs being harmed either contemporaneous with harm done to an animal or later in time as a result of harm inflicted on animals. This has been extended to harm done to animals indirectly through adverse modification of the animal's habitat (e.g., Palila vs. Hawaii Department of Land and Natural Resources). In Palila, the bird itself had standing, setting precedent. The first sentence of the decision reads, "The Palila (*Psittirostra bailleui*) seeks the protection of this Court . . ."

between men and women. It maintains order in those relations just as dominionism maintains relations between human beings and the rest of nature." Accordingly, women are of the realm of the Earth ("Mother Earth," etc.) in many cultures, whereas men are of the heavens and, therefore, in the dominant quarter.[112] When women and nature are similarly classed they can be similarly dominated.

Wise, Adams, Mason, Albright and many others point to a need to consider the ethical treatment of at least some animals in the context of ecofeminism, that solutions to inequities can (must) be brought to the fore. Such approaches are based mostly on recognition that the traditional hierarchy is flawed and indefensible in concept, structure and practice, and that a considerable leveling is required -- certainly across the board with women's rights and equality in all its forms.

Animals' status within Western legal systems continues to make progress, and whether or not "personhood" in the legal sense, the ability to have standing, will be achieved is debatable. But courts certainly can surprise both liberals and conservatives, alike.[113] . Calls for not only higher primates but some groups of animals to be afforded moral consideration and legal standing as "non-human persons" are growing in frequency, e.g., dolphins (Edwards 2010). In Bolivia, similar actions have been proposed not for species, but for ecosystems, such as the rainforest (Vidal 2011). While no legal action has been taken, they demonstrate a growing concern.

This brief digression into ecofeminist thought aids in understanding the tension that exists within a Western patriarchal model of human relationships with non-human organisms and with the environment. All of this becomes extremely pertinent to the discussion of yet-undiscovered extraterrestrial biological entities.

Kellert, Wilson and others point to biophilia, our innate sense of connection with not only non-human animals but with the world itself, its features and its environments (Wilson 1984). It is expressed, in part, as something deeply emotional that issues forth in our cultures, dance, music, poetry, and all other artistic forms. Our system of laws, however, has purposefully removed sentimental expressions from the courts as not only counterproductive to the practice of law but to the determination of justice itself. Perhaps a purpose of this exclusion has been to sustain Western patriarchal domination over the "emotional" Other. Regardless, animal rights theory (and just about any other issue of legal context) remains clinically sterile of emotion; it is banned from consideration (Donovan and Adams 1996).[114] But "rights are complex concepts founded on moral, policy, societal and cultural ideas. Thus, we should not focus on finding some single basis for a right, but on discovering the sundry elements of a right. The more bases we

[112] Such characterizations, however, may also serve to reinforce the male/female divide by highlighting presumed differences. All women are not somehow innately more intuitive regarding the natural world than men. There seems abundant evidence that over the past century what were believed organic proclivities in these areas have proven to be cultural and learned behaviors and, as such, can be changed.
[113] Recent decisions by the US Supreme Court regarding the standing of corporations in regard to political contributions and free speech come to mind.
[114] Note the language explicating the removal of emotion from law in the quote from the Wisconsin court regarding the application to the bar of Lavinia Goodell in Section 3.4.

find for a right (here, referring to animal rights) the more firmly convinced we may be that it is a legitimate and well-founded right" (Kelch 1999, 23). Those qualities that are most applicable when considering classes of rights holders, such as emotion and compassion, are dismissed. And as with "emotional women" being barred from legal practice and many other professions for centuries, sentiments regarding non-human organisms and even landscapes remain generally ignored or even ridiculed in Western legal practice. Biophilia and all its permutations must be included as legitimate sentiments when deciding where to provide ethical consideration.

In sum, rather than seeking to name species to the class of organisms deserving our ethical consideration because of their sapience, sentience, or other mental attributes and then administering such consideration through a legal system of defined rights, the ecofeminist approach suggested by Albright would be based on human emotional and moral relationships with nonhuman animals. The "caring ethic" she proposes, as she states, "embraces compassion, kindness, and ethics as the basis of legal rights. … Importantly, it recognizes humanity's moral obligations to respect and protect the bodily integrity and bodily dignity of nonhuman animals" (Albright 2002, 937). This caring approach is much more inclusive, and it diminishes the power of hierarchical structures and related powers.

As such, it threatens the *status quo*.

What limits much of the work done on extending rights to date, however, is that the focus has been almost entirely on animals. Our emotions and moral community arguably extends well beyond them to include all biological entities which have emotional connections to our species. Adding emotions and related sentiments to the criteria for extending some form of legal consideration and standing, the path is open to the inanimate as well, to include landscapes, …or even Marsscapes.

3.7 Leopold on Mars

Our history as a species abounds with examples of how we alter our physical and biological environments, and while there are still some indigenous cultures living in balance with their environment relatively free of significant or lasting alteration, the human drive to initiate landscape-scale change appears essentially universal (Mann 2005). Many of our more recent technologies have increased our efficiency in bringing about those changes. This was especially demonstrated during the period of European colonial expansion in Africa and the New World where the ability to rapidly and systematically initiate dramatic alterations at the ecosystem and landscape levels was dramatically proven (Myers 1979; Crosby 1986; Elkins 2005; Hochschild 2008). Documentation demonstrating political intent to establish new territory for the expressed purpose of subjugation and exploitation through the appointment of Spain as "lords of them with full and free power, authority, and jurisdiction of every kind" was provided by Pope Alexander VI in 1493, just months after Columbus's fateful voyage (Mann 2011). There is a long list of similar pronouncements up through the present.

As technology nears the point where extraterrestrial exploration will permit significant exploitation, reflection is required if we want to avoid past mistakes regarding environmental change. The same technology that permits space exploration also accelerates our ability to significantly alter otherwise pristine worlds.

In his 1949 *Sand County Almanac*, Aldo Leopold cites expanding ethical consideration from a few individual humans to many, to all, and eventually to include other animals, plants, and landscape components as a process of ecological evolution. "All ethics so far evolved rest upon a single premise: that the individual is a member of a community of interdependent parts . . . The land ethic simply enlarges the boundaries of the community to include soils, waters, plants, and animals, or collectively: the land" (238). He argues that both cooperation among people and maintaining harmony with our environment are forms of symbioses. In his usage, it seems unlikely he viewed it as evolution in a genetic sense. Leopold's "ecological evolution" does not conflict with the evolutionary advantages or genetic predispositions to cooperative behavior, such as altruism, discussed previously in this chapter. To generalize, we have not genetically evolved suddenly over the past few centuries to recognize certain ethical obligations to all humans, regardless of gender, race or other classification. Rather, we have become increasingly aware of the justice of those obligations and better appreciate the adaptive advantages of being more inclusive. Perhaps we have become more aware of our better natures, a reassessment of previous appraisals of our possibly "brutish" core. Genetic predisposition to ethical behavior is present; it is a talent we possess, but have chosen to not fully develop through practice. This is promising in that we need not await some random gene mutation and selection or biochemical shift for ethical enlightenment. At a meme level, behavioral change can, and has, happened quickly and pervasively. We can control and continue this promising trend by consciously changing our behaviors. Genes need not be directly involved.

It is not surprising that Leopold's epiphanies in the American Southwest and subsequent reflections while on his farm in Wisconsin during the first half of the 20^{th} century did not include Mars. There are no references in his work to whether he ever considered applying his "land ethic" beyond Earth that I am aware of. But I believe that if he were writing today he would have little difficulty in seeing its application off of this planet as a natural extension. If he did not, the land ethic he cherished and espoused on Earth would be diminished. It would lose its power and meaning. But while Leopold may not have considered his land ethic's extraterrestrial application, other more modern writers commenting on potential human impacts on extraterrestrial worlds have. A significant theme in Kim Stanley Robinson's Mars "Trilogy," for example, is that humans can recognize the value of landscapes and human obligations to maintain them (Robinson 1993; Robinson 1995; Robinson 1996). Such actions serve both human survival and honor the intrinsic value of the landscape itself, the "Marsness" of it. Robinson's endorsement of this theme in the Trilogy was influenced directly by Leopold's writings.[115]

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[115] J. Baird Callicott (Distinguished Research Professor, Department of Philosophy and Religion Studies, University of North Texas and author of *Companion to A Sand County Almanac*) related in an email to me that Robinson told him this in personal conversation.

J. Baird Callicott, author of *Companion to A Sand County Almanac* and a Leopold scholar, however, holds views that disagree with my analysis of Leopold's likely view on extraterrestrial application. Callicott maintains that Leopold's moral considerability was based on Earth's life being biologically related, sharing "evolutionary kinship and ecological community" (Callicott 1979). Terrestrial life is "ecologically integrated and mutually interdependent." He continues that assuming extraterrestrial life would "not be our kin…nor would they be participants in Earth's economy of nature or biotic community, they would lie outside the scope of Leopold's land ethic." "The very failure of (Leopold's) land ethic to provide moral considerability for extraterrestrial life reveals at once its strength for Earth-oriented environmental ethics – which is of course the only variety of environmental ethics with any genuine practical interest or application" (Callicott 1987, 247).

With due respect for Callicott's scholarship regarding Leopold, I cannot agree with his conclusions. True, in *Sand County* (p 251) Leopold states, "We can be ethical only in relation to something we can see, feel, understand, love, or otherwise have faith in," and perhaps Mars is a bit too remote to meet those qualifications. Still, had Leopold addressed applications in an extraterrestrial context and replied as Callicott holds, I may be swayed, but it seems more probable that Leopold did not consider Mars in his ethic because, simply, he was writing in the 1930s and 1940s; Mars was not his immediate concern, much less mining on that planet. Consideration of extraterrestrial life would have been a significant distraction and would not have been expected. Had he mentioned Mars, it seems likely his work would have been ridiculed and discounted.

Callicott admits within the text of his essay on Leopold, however, that he is "skeptical about the technological feasibility of off-Earth colonization and industrialization" and also "skeptical about the possibility that life presently exists on any planet other than Earth in our own solar system." I cannot speak to why he believes so, especially considering that he is addressing the indefinite futures, not the present state of technology. Never say never.[116] Given that NASA is presently looking for signs of life on planets and moons in our Solar System and beyond, his second skepticism also seems premature. If one denies that we will ever colonize Mars and holds that it is necessarily lifeless, there is little wonder why he would consider any human impacts there, physical as well as philosophical, ethical or not.

But more important to the ethics theme of this dissertation, Callicott exhibits not uncommon tendencies to view the Earth as a discrete entity, that we share nothing with the other members of our Solar System, much less the rest of the Universe unless extraterrestrial life is "related," unless we share ancestry. "Human life is evolved from and specifically adapted to, presently embedded in, integrated with, and utterly dependent

[116] Callicott states regarding our solar system, "(extraterrestrial) life would be possible only on a liquid water planet, and the only such planet in the solar system is the Earth" (p 237). This was published in 1986, a decade before proof of a saltwater ocean beneath the ice surface of Europa (true, not a 'planet' but don't fault me that). Callicott appears to assume that our knowledge is fixed at the present state, that new surprises don't await us if we but look, keep an open mind and are patient.

upon the exact and unimaginably complex physical, chemical and biological conditions of the planet Earth. The realization and affirmation of our Earthiness, our inseparability from the Earth, should be, and hopefully soon will be, the biggest payoff of space exploration"[117] (Callicott 1987, 229). If *Earth-like* life is found, he states Leopold's land ethic would apply on Mars or wherever such life is found. By extension, should life be found that is a product of a "Second Genesis" and biochemically distinct and unrelated to terrestrial life, Callicott holds the land ethic would not apply, that we would have no obligation to extend conserving practices to those worlds.

We have returned full circle to previous discussions of Othering. As represented by Callicott, even if Mars has life, unless it is related to us it has no ethical considerability; this seems hardly a conclusion Leopold would have supported. We will have returned to "Wesorts don't associate with Yousorts," perpetuating behaviors that have not served us very well here on Earth. There are those, perhaps Callicott, who are threatened by the prospect of the existence of those Others.

What make Leopold's writings so compelling and pertinent to this dissertation is their recognition that the inanimate components of the Earth are not only critical to the animate's survival but that the two are inseparable. "A land ethic changes the role of *Homo sapiens* from conqueror of the land community to plain member and citizen of it." Frequently in *Sand County Almanac* and elsewhere he personifies the inanimate. He urges us to "think like a mountain" (1949, 137). Not that he is inferring the literal, but that we need to change our perspective and widen our sense of community. The root question is: Is Mars part of 'our' community; are we part of its? While arguably not in 1949, it certainly is now and grows more-so with each vehicle we send there.

3.8 Bringing bioethics home

The exercise of re-evaluating the current state of bioethical thought in the extraterrestrial context, determining if and/or how to extend ethical consideration to ETBE, may be of as much use as the actual practice of such an ethic on another world. As stated previously, prior to such a discovery we are relatively free of utilitarian motives, commercial pressures and the other biasing concerns that have plagued coherent bioethical standards. While John Rawls' "veil of ignorance" methodology may be applicable in a theoretical context, ETBE may provide a more practical and workable medium. Not all would agree. Callicott states, "Shouldn't we get our intellectual priorities straight and worry first about the treatment of terrestrial life, which is presently under such extreme and actual duress? Once we've got a persuasive ethic worked out to help address the more pressing real-world problem of wholesale terrestrial biocide, then maybe we can think about how we ought to treat extraterrestrial life – if there is any" (1986, 242). I would

[117] Callicott appears to be looking back at human's historical biological and cultural histories rather than forward to what futures may offer. True, we cannot long survive on Mars without substantial technological assistance, but that may not always be such a limiting factor for both biological as well as technological advances. After these negatives and faulting him for not being a futurist, I admire and respect the bulk of Callicott's philosophical work. He is one of the foremost contemporary environmental philosophers and has provided me much insight to the subject; I very much value his exchanges with me.

reply that first, there is no either/or matter about it. We can certainly improve our ethical consideration of terrestrial species while we simultaneously "think about" how we ought to treat the extraterrestrial. Second, and something very much at the core of my approach, is that it has taken several millennia of tinkering with philosophical treatments of bioethical consideration here on Earth just to recognize that all humans have some basic rights, and even that is more a goal than a conclusion. Animals (and people as well) are still tortured for entertainment alone. The primary reason a more coherent bioethic has been unachievable on Earth is that there are just too many personal interests at stake, too many deeply ingrained cultural traditions and theological, political, and philosophical perspectives that are concerned with maintaining the *status quo*. Callicott and others are emphatic that we should wait until the discovery of extraterrestrial biological entities to address our ethical relationship with them. He asks, "Can there be, really, any serious justification for this exercise? If animal-welfare ethics are controversial, if terrestrial biocentric and ecocentric environmental ethics are contemptuously ignored or ridiculed, isn't the construction of an ethic for the treatment of something we know not what or whether it may be more than just a little fatuous?" (242). I believe this dissertation adequately addresses those questions.

Once we are on Mars (or any other extraterrestrial venue) as residents, not tourists, we *are* Martian life. The Martian landscape becomes as much a part of that life as the plains of Africa are to those who live there. Biophilia and Leopold's land ethic are limited to terrestrial application only because it is the only world we have experienced, and Mars would soon become as much of our native environment as any place on Earth, especially to succeeding generations. As Robinson states in the opening paragraph of *Red Mars*:

> "And so we came here. But what they didn't realize was that by the time we got to Mars, we would be so changed by the voyage out that nothing we had been told to do mattered anymore. …We were on our own; and so we became *fundamentally different beings*" (emphasis as in original).

CHAPTER 4
MYTHOLOGY OF SPACE EXPLORATION

> *Mars is to the new age of exploration as North America was to the last. …The true value of America was as the future home of a new branch of human civilization, one that as a combined result of its humanistic antecedents and its frontier conditions was able to develop into the most powerful engine for human progress and economic growth the world had ever seen. The wealth of America was in fact that she could support people, and that the right kind of people chose to go to her.*
>
> Robert Zubrin - *The Case for Mars* (1996, 38)

> *Offering an account of the past, in disciplinary histories as in ethnic and national ones, is in part a way of justifying a contemporary practice. And once we have a stake in a practice, we shall be tempted to invent a past that supports it.*
>
> Kwame Anthony Appiah - *Experiments in Ethics* (2008, 6)

4.1 Premise

The preceding chapter addresses bioethics in its conventional sense as human cultural invention, a consideration of a set of relationships established by culture and influenced by utilitarian motives. This is the predominant view in most Western philosophies and theologies. The chapter also describes the theory that ethical behaviors evolved biologically with us as a species as evidenced in the ethologies of a spectrum of ancestral species. The approaches are not incompatible; both likely contribute.

But predominant approaches to space travel draw heavily on the cultural approach and rely significantly on Western frontier mythologies that grew, in part, from the relegation of non-human species and landscapes to a status unworthy of ethical consideration. When applied to ETBE there is little evidence that our ethical approach will be significantly different. Landscapes and the life they may support, while initially held in awe, will predictably be devalued in an ethical context when potential commercial as well as scientific values are recognized and exploited. The potential of our first encounter with ETBE, however, provides a perfect opportunity to restructure bioethics to redress its weaknesses if we replace the current mythology of space conquest and domination with more cooperative and humble models.

4.2 *Veni, vidi, vici*[118]

The November 2010 issue of the Journal of Cosmology comprises a series of articles addressing the development and execution of hypothetical human missions to Mars, from conceptualization to eventual colonization (Cosmology 2010). Included are

[118] I came, I saw, I conquered. Attributed to Julius Caesar summarizing a brief war.

considerations of human factors in training and adaptation, searching for life and mineral resources, economic modeling for capital development and arguments for ecopoesis, terraforming, or other premeditated and purposeful modification of the Martian environment on a grand scale.[119] As demonstrated by that publication, both our activities and imaginations generally focus on modifying and exploiting Mars and, by extension, other extraterrestrial venues for human benefit in much the same conceptual way that we have colonized and exploited Earth (Crosby 1986; Zubrin 1996a; Mann 2011). However, there is relatively little discussion in that journal or elsewhere (at least in non-fiction) of how human culture and habit might be modified to aid the emergence of a genuinely novel relationship with the extraterrestrial environments we are experiencing for the first time and are, in many ways, creating.

4.2.1 The mythology of the extraterrestrial landscape

Rather than embrace new extraterrestrial environments as opportunities for learning and philosophical advancement, dominant guiding paradigms grow directly from patterns of human exploration and exploitation that have occurred on our own planet throughout our shared histories. This perpetuates (and, in many instances, glorifies) the past ills of those pursuits. For example, the referenced issue of the Journal of Cosmology included positive references to "conquer" and "conquering" in the context of our exploitation of Mars (Joseph 2010). The significance of selecting these terms to describe our future actions is subtle but telling in that it demonstrates a continuing conception of winners and losers and baits the question of what, then, is conquered; what loses in this context? Can conquest and conquering ever be peaceful? Does their use presuppose or even require that we foster a strongly anthropocentric relationship?

Many spaceflight advocates maintain it has become a "durable American cultural narrative – a national mythology of frontier pioneering, continual progress, manifest destiny, free enterprise, rugged individualism, and a right to life without limits" (Billings 2007, 483). NASA and others have worked to maintain that image (Williamson 1987; Billings 1996; Billings 1997). However, relying on the lexicon of settler colonialism and referencing largely American frontier analogies not only color the exploration of celestial bodies, their landscapes and resources, but affect our possible relationships with any extraterrestrial life we may encounter (Paine 1986; Beebe 2008). Where metaphors of the frontier are employed, the status of extraterrestrial places, their physical features and their possible life are diminished, abetting their being viewed as inferior and falsely justifying, in part, their domination through colonialism. Once assigned a subservient status we may even be more prone to perceive an obligation to dominate them "for their own good," akin to Kipling's *White Man's Burden* (Zubrin and Crossman 1971; McKay and Marinova 2001; Zyga 2009).[120] This fosters a climate of careless and short-sighted

[119] Ecopoesis refers to the artificial creation of a sustainable ecosystem on a sterile (lifeless) planet or other body (Haynes and McKay1992). It differs from terraforming in that the latter refers to ecopoesis for the specific purpose of creating an Earth-like environment suitable for terran organisms, possibly including humans. Ecopoesis, therefore, may include engineering an environment suitable for extraterrestrial organisms.

[120] Space Man's Burden, perhaps?

exploitation that relegates ETBE to the status of the excluded Other, as targets, both figuratively and possibly literally, existing solely for the benefit of the human explorer.[121] "Wild" extraterrestrial landscapes must be "tamed" in the same manner as the New World. Once that condescending and negative view is established, opportunities for cultural and philosophical advancement presented by those extraterrestrial venues are diminished (Kramer 2011).

Space exploration must guard against the temptation to perpetuate the use of exploitive colonization and frontier mythologies, language, analogies and metaphors. To do otherwise would jeopardize its nobler purposes by stifling creativity and blocking implementation of novel, perhaps even eutopian experiments.[122]

We create a shared reality through culture and sustain it by communicating a common mythology constructed of symbols, images, histories, and visions(Campbell and Moyers 1988). In the creation and maintenance of national, cultural, or even corporate identity these are frequently essential. They require a shared sense of purpose (e.g., destiny, divine plan or direction, long-term goals, nationalistic right, or the expression of governmental or social ideals) and a degree of commonly-perceived inevitability. It is not uncommon to hear comparisons of the US's space program to the European colonization of North America. Outer space is frequently described as our new frontier, the modern free range once represented by the American West (Hartmann 1984; Limerick 1992). Space presents us with an unknown place and geography inaccessible to but a few and, in keeping with Earthly frontiers, an area void of the familiar. It represents a realm where the "laws of civilization" and custom do not apply and, therefore, all that is civilized must be reinvented. Frontiers allow the pioneers who first venture there an opportunity to redefine who they are, but initial and possibly noble ethical intentions may be quickly drowned by exuberance.

4.2.2 Language matters

In a review of Brendon Larson's 2011 *Metaphors for Environmental Sustainability*, Nancy Golubiewski remarks, "Language matters…for anyone engaged in understanding and interpreting the world. Language influences how scientists relay their findings and how they conceive scientific phenomena and frame research questions" (2011, 700). Regarding words employed in metaphors, her review continues, "Such multiple, context-dependent meanings (polysemy) ensure that even if defined narrowly, a metaphor retains its lay interpretation. The technical cannot be kept distinct from the ordinary; science and society mix." References to "conquering" Mars in Cosmology and other media obviously are not intended to be taken in a literal bellicose sense, but, as Larson posits, using a term retains its lay interpretation; it permits the spirit of conquering to enter the conversation along with a tacit approval. It nurtures disregard and the right, even the

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[121]Here the term "Other" identifies the excluded, as posed by Hegel, Foucault, Said and others. To gain or maintain social and political power, the Other is the entity described in negative terms then employed as a societal or political foil, scapegoat or outsider.
[122] Eutopian refers to preferred futures, not necessarily perfect futures. It is distinguished from the vernacular "utopian" which, literally, means no future, or an impossible future.

expectation, to take spoils as in its original meaning (Larson 2011).[123] The stage is set for an adversarial relationship.[124]

Other words drawn from the myth of the American frontier may be just as powerful as "conquer" in establishing a hierarchy justifying exploitation: unknown, vast, lonely, godless, godforsaken, virgin, barren, unbroken, untamed, heathen, wild, desolate, savage, unforgiving, cold, hostile, foreboding, limitless, dangerous, uncivilized and even angry. These, then, justify the suite of terms that describe pioneers' responses: fear, war (as in battle and war against), challenge, attack, push, assault, conquer, subdue, civilize, and tame. This same lexicon is found especially in fiction about outer space but also appears in contemporary non-fiction works directly related to the American space industry, space politics and policy and elsewhere in the discussion of extraterrestrial issues.

4.2.3 Employing mythology as justification for ethical ignorance

In the 1950s the US space program was easily assimilated into this foundational pioneering mythology of growth and destiny, and the words that described it were accepted with little challenge. Although public support for the Apollo Program during the period from 1965-1975 was far from robust, whether supported or not, Americans in space was, and remains, an integral part of the Nation's widely-shared vision among our possible futures (Krugman 1977).[125,126] In their 1990 report to President George HW Bush, the National Space Council declared that the US space program's objective was to "open the space frontier. America's space program is what civilization needs…Our success will be guaranteed by the American spirit – that same spirit that tamed the North American continent and built enduring democracy" (National Research Council Space Studies Board 2009). Astronaut Edgar Mitchell wrote, "Throughout our history, we have never been able to predict the perils nor the benefits of exploration, but *in every case humanity has always prevailed* over all obstacles and the rewards it has reaped have *always* far exceeded our expectations" (emphases added) (Mitchell and Staretz 2010, 3500).[127] Such statements make sense only from the biased perspective of the colonizer but not likely to those who were the victims of colonization.[128]

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[123] This theme is addressed in the context of intellectual property rights in Chapter 5.
[124] Use of "conquer" in the mythology of space is not limited to the US. Engraved on Konstantin Tsiolkovsky's (Russian rocket and space engineering pioneer) 1935 grave marker, "Man will not always stay on Earth (but will) conquer the whole of outer space" (Introduction to Tsiolkovsky's *Beyond The Planet Earth* [1920, 13], edition published in 1960).
[125] Twenty percent of Americans surveyed favored continuation of government spending on space launches while those opposed to launches rose from 30 percent to 50 percent during the period.
[126] Recent mention by Republican presidential candidate Newt Gingrich of his support for an initiative to establish a mining operation on the Moon demonstrates it is still very much alive.
[127] Mitchell, the author of that statement, was an American astronaut and the sixth man to walk on the Moon. He threw a make-shift javelin there, becoming the first individual to symbolically launch a weapon on an extraterrestrial body; a truly symbolic gesture.
[128]The Mau Mau in British East Africa, the peoples of the Congo under Leopold, the Sioux or hundreds of other subjugated indigenous peoples would likely not agree that they needed "taming" by Europeans or that "humanity" has always prevailed (Brown 1970; Elkins 2005; Hochschild 2008; Mann 2011).

In NASA's report on the 40 Years of Human Spaceflight Symposium, Laurie Zoloth cites President Jefferson's letters to the early 19th century explorer Meriwether Lewis as applicable to the space program:

> *He (President Jefferson) writes of something more -- of the intrinsic nature of the quest itself and of the obligations to the frontier borne by societies that encounter it. And while there was much to say then and much criticism was given by contemporaries like Adams and others, there is still much to say now about the ethics of such an encounter. The arguments, the promises, and the vision that animated that journey (*the Lewis and Clark Expedition*) are familiar because they are the substance of the vision that has animated much of NASA's efforts*.
>
> (2002, 168)

President Reagan, in speaking of the space shuttle Columbia, continued that theme in stating, "The quest of new frontiers for the betterment of our homes and families is a crucial part of our national character" (Limerick 1992, 251).

In addition to the words associated with the myth, present day space exploration embodies many of the attributes of myth. First, as with American westward expansion and its links to destiny, space affords milestones documenting progress. These are easily measured in space venturing by increments of improved engineering, architecture of space vehicles and the required hardware and software to launch them; catalogs of new technologies; employment and the economics of the space industry itself; and the most easily measured forms of progress: tons lifted, linear distances travelled and duration of travel. NASA maintains websites listing planets, asteroids, comets, and moons that have been orbited, photographed, or landed on, plus tabulations of new extra-solar planets identified by the Kepler Space Telescope.[129] A catalog of spinoff technologies, patents, and similar documentation of accomplishments is also maintained on-line.[130] All provide measures of progress that can be plotted and, more importantly, extrapolated into the years ahead, a critical tool for controlling a singular vision of one specific future by dominating a sense of goal and direction to the exclusion of competing visions of alternatives, a call to destiny.

Second, like European exploitation of the Americas, there are potentials for extraordinary economic gains from the effort in the forms of mining, transportation, tourism, communications and other sectors in addition to more political and military benefits (Ehricke 1981).

Third, space allows for exploration, adventuring, and the call for the "rugged individualism" that perpetuates a national self-image of pioneering at the edge of a vast frontier. It offers the opportunity for the expression of the "right stuff" referenced in Tom Wolfe's 1979 book of that title, Zubrin's *How to Live on Mars* (2008), and countless other books and films, both fiction and non (Wolfe 2005). As a result, we have a space program that reflects the perceived national character of an optimistic and adventurous people facing a promising unknown in keeping with the Nation's mythology.

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[129] http://kepler.nasa.gov/

[130] NASA maintains a "spinoff" homepage and website at http://www.sti.nasa.gov/tto/

Loss of life in its pursuit promotes an otherwise industrial accident to an act of heroism.[131]

"Frontiers have the reputation for generating a 'Frontier Mentality'. This is generally thought of in terms of the American frontier mythos. The sturdy pioneer is seen as independent, self-sufficient, and highly motivated to provide a better life for his family. He is also portrayed as having little regard for any environmental devastation or for any indigenous society he might encounter" (Gray 1999, 161). In *Parables of the Space Age*, Jane Young states,

> *These qualities were embodied in turn by personages such as the woodsman, the pioneer, the cowboy, the oilman, the businessman, and, finally, the spaceman…,"* but, she continues*, "…all characterized as much by their exploitation of the natural environment as by their drive towards exploration. …as various areas of the Earth have been labeled nostalgically as the 'last frontier,' the need for adventure and for new sources of energy has given rise to the concept of outer space as the 'new frontier.'* (1987, 228)

Robert Zubrin, founder and president of The Mars Society, stated in support of a more aggressive space program, "Every feature of Frontier American life that acted to create a practical can-do culture of innovating people will apply to Mars a hundred-fold; …it is our destiny to do so. …Mars is the New World" (Zubrin and Wagner 1996, 239). Similarly, Doris Hamill, a NASA technology manager, wrote, "America's efforts to open then settle its western frontier were a source of pride, growth, power, and wealth. Today, the space frontier offers the prospects of similar benefits for the nation and humanity" (Hamill 2009). This application of the frontier mythos coupled with the concept of destiny is clearly misleading and inappropriate. No, "every aspect of Frontier American life" will not apply to Zubrin's or anyone's Mars or anywhere else. The frontier American life he and many others reference is a narrow and largely fictional one written *by* the colonizers and those with a financial, political or social stake in their success; it both contributes to and draws from an inaccurate vision of noble settlers, unbroken and unoccupied forests and virgin prairies where challenges required only ingenuity and perseverance to overcome. It entirely discounts, however, the considerable realities that four centuries or more of frontier American life perpetrated on those who were the victims of that colonization and the landscapes colonized, and these are no minor trivialities. It ignores the Indian wars, slavery, introduction of diseases, indenture, institutionalized racism, union-busting, exploitation of immigrant labor and other strong negatives that have been bowdlerized for their distraction from the desired vision. Again, the American frontier provides a poor analogy to guide ethical behavior in space.[132] As aptly stated in *Environmental Culture -- The Ecological Crisis of Reason*: "Remoteness negates responsibility, for consumers, workers and shareholders. In rationalist

[131] E.g., the national angst regarding the explosion of the shuttle Challenger.

[132] It has been argued that a flaw in linking the space program with pioneer, frontier, and other histories is that "our perception of the past is distorted by the ethics of our society and the historic, social and entertainment mediums by which the picture of the past is presented" (Gray 1999, 161). True; there are certainly disparities separating historical fact and the historical myth we find in works like the 19th century novels of Karl May or Bret Harte. But whether accurate or not, it is the mythos of the frontier that is referenced as a motivating and guiding narrative, not historical fact.

commodity culture, we are actively prevented from exercising care and living in ecologically-embedded and responsible ways" (Plumwood 2002).[133] Without caution and serious ethical consideration, we may foreclose unimagined scientific and social opportunities both on those other worlds and on our own.

Lastly, beliefs in Western exceptionalism and destiny that are so closely allied with the frontier mythology both nurture and are nurtured by a subtext of conquest often accompanied by violence (Bacevich 2002, 2009; Elkins 2005; Hochschild 2008; Zinn 2010). Conquest is a charged term, one of the more blatant employed to describe our motivations and actions in space. Its use has become routine to the point where its meaning has been largely forgotten. In 1960, the US Space Policy on Outer Space promised, "Manned space flight and exploration will represent the true conquest of space. No unmanned experiment can substitute for manned exploration in its psychological effect on the peoples of the world" (Logsdon, Day et al. 1996).

To use the metaphor of conquest in reference to space exploration one must ask "who or what is being conquered?" A familiar poetic response in the context of space is that we are conquering the "unknown." It seems "understand" would be far more accurate and productive; one rarely learns much through conquest. A possible answer to why conquest remains in the lexicon of space is because it grows from and supports Western expansionism and, importantly, American exceptionalism. Michael Griffin, Director of NASA in 2005, remarked to a meeting of Women in Aerospace: "When human civilization reaches the point where more people are living off Earth than on it, we want their culture to be Western." He continued that Western civilization is "the best we've seen so far in human history" and that the "values they take with them should be Western values" (Billings 2007, 294). Such statements make it clear that exceptionalism is a concept at home in the American space program.

But, perhaps, more at the root of the use of the word "conquer" in this context is that it expresses the coupling of fear with feelings of superiority and hubris. This fosters a belligerent attitude toward the unknown, which becomes the Other. In its usual sense, this term is applied to a person or group who are different, neither "us" nor of us. The Other's culture, history, and ways of thinking cannot be understood and are, therefore, unpredictable, thus dangerous. In frontier North America, indigenous peoples encountered by Europeans were characterized as "savage" and thus cast as Others for non-consideration. The tension produced was expressed through metaphors of conquest and the belligerence of colonialism, a battle pitting "civilized" man against the native peoples and their environment.

As applied to space, fear of the dangers of space travel or of the unknown it poses may conjure the Other in the form of landscape, something required to be dominated because of its mystery and difference. In this extraterrestrial context, defining planets, etc. as Other ensures that the distinction of the alien "them" or "it" from "us" remains clear. We

[133] The Apollo 14 mission to the Moon included hitting a golf ball and throwing a javelin. Those actions don't speak well of the presence of a deeper nature and significance of the expedition. Then again, perhaps hitting a golf ball and throwing a javelin are presciently appropriate!

remain apart from it, making assimilation difficult. Thus, we have heard reference to outer space as threatening, hostile, foreboding, bleak, inhospitable, extreme, barren, harsh, menacing, and cruel. An MSNBC article entitled “Assault on Mars Nears Its Climax” described the planet as a “dusty, frigid world, shrouded by an atmosphere too thin to breathe, bombarded with radiation and largely dry beyond the ice that caps its poles. It seemed altogether hostile to life as we know it” (Bridges 2003). Hostile infers ill intent, giving Mars, for example, a malevolent personality that justifies whatever we may do to it or take from it. These bolster the justification of conquest and decrease the need for consideration of its environment.

It may be argued that “explore” may be a more appropriate term than conquest. Certainly, it is far less belligerent, even passive in that it does not infer any impact on any other entity -- human, other organism or landscape. Its impact may be little more than leaving a footprint. But it represents a form of trespass and is a requisite precursor of conquest. European colonization and exploitation of the New World and other continents began with exploration, often seemingly for the most benign purposes, such as the botanical and zoological collecting and cataloging missions popular from the 18th century forward to the present (most currently represented by bioprospecting for pharmaceuticals and minerals, especially oil). But while many had *bona fide* scientific rationales and, perhaps, were financed entirely by private scientific organizations or businesses, geographic, demographic, geologic and other data essential to subsequent colonization were implicit (Brockway 1979; Williamson 1987; Lester and Robinson 2009). Space programs, both public and private, are crowded with the use of the term explore, and while exploration is what we do in space, like conquest, it nourishes expectations and should be used carefully. When billions or more dollars are invested in exploration there is an expectation, perhaps even a demand, for exploitation. Bioethical considerations are diminished in the face of those competing demands.

Ben Finney has described a different mythology, one that is based on concepts of *voyaging* in space rather than mission-oriented expeditioning – he describes voyages of discovery (Finney and Jones 1986; Finney and Lytkin 1999). It describes the approach of Polynesian and others who set out in open boats guided by stars, waves, currents, and other indicators to find new shores, but largely without fixed destinations. Voyaging is an exceptional concept in that it has strong historical as well as emotional power, an openness and reverence for the unknown without the need to challenge, master or dominate -- to accept without a need to conquer.

4.3 Ecological violence

Over the past half-century, patterns of ecological violence spread through colonialism have become more widely recognized. The inter-relatedness of colonized landscapes, ecosystems, and the cultures of both indigenous peoples and colonizers is profound (Crosby 1986). These relationships become so interwoven they cannot easily be teased apart; what affects landscapes affects ecosystems, including humans, and the reverse. It is tempting to dismiss the adverse cultural impacts of past colonialism when applied to space and its related bioethical issues. True, although millions of indigenous people died and vast unwritten libraries of knowledge were lost as a direct result of Western expansion in the Americas and other targets, such losses have no predictable extraterrestrial parallel, at least in our Solar System. It may be argued that the metaphor of settlement of a frontier through pioneering and colonization merely provides a colorful and poetic vehicle for describing our space ventures --and little more. But colonizing also resulted in significant environmental degradation that would be applicable to space exploration. The more forgotten products of settlement are depleted soils and denuded landscapes, dust storms, mine leachates that polluted the environment and the squandering of resources later learned to be invaluable (Crosby1986; Diamond 2005; Mann 2005; Zinn 2010). American settlers could not imagine that the forests could be depleted by the ax, aquifers pumped dry or the broken soils washed and blown away in less than a century. Off of Earth, we have no evidence that the situation would be different. What may first appear limitless would prove finite.[134]

While unlikely that we will encounter sapient aliens in our Solar System, ETBE of other sorts might be discovered if we cast our exploratory net far enough and are open to detecting what may be very novel forms. What might be its concerns? How might its interests be considered within the framework of an ethic patterned after a Western pioneering and frontier paradigm that discounted the concerns of other humans only a few generations before?

Identifying the concerns of affected entities and providing ethical consideration is not a new concept, and it has been extended to include landscapes (Cockell 2004; 2005). But what evidence is there that it would be applied to ETBE? Robert Zubrin, aerospace engineer, entrepreneur, president of the Mars Society and published proponent for the application of the frontier metaphor to space maintains that the welfare of extraterrestrial microbes would be inconsequential if one were to terraform Mars into an Earth-like planet. Not only did he find terraforming to be ethical even if detrimental to indigenous life, he determined it unethical to *not* terraform given that result. Zubrin states, "What if you could take a world like Mars, a desert world that may have a few microorganisms in its groundwater, and transform it into a fully living magnificent planet like the Earth with forests and meadows and coral reefs and cities and universities and used bookstores? In doing this, you would have performed the greatest positive act of environmental change anyone has ever proposed" (Lamb 2010b, 39). But this proposal would be implemented before even knowing what those Martian microbes might offer, what they might be able to teach us, and prior to any consideration of the complexity of their ecosystems or their roles in maintaining it, much less any ethical consideration for their existence. Such an attitude mirrors aspects of the frontier spirit that are likely best left to history.

Regarding the forward contamination of Mars with Earth bacteria, a NASA astrobiologist wrote that such contamination is ongoing, and while sterilization of life-seeking missions is justifiable, other missions may not be worth the added expense of sterilizing spacecraft

[134]For example, the growing enormity of the problem of space "trash" in geosynchronous and lower orbits was likely not imagined in the Sputnik era of the first satellite launches.

(McKay 2009).[135] McKay argues that such contamination should not cause undue concern because we can clean it up later at relatively low expense and only moderate effort. This attitude is reminiscent of 19th century Europeans who likely did not believe their introduction of an assortment of plant and animal species to North America, Australia, the Hawaiian Islands and many other places would cause the collapse of ecosystems and the extinction of hundreds of species (Crosby 1986; Weisler 2002; Carlquist 1994; Kramer 2009).

Referencing mythology that describes space as a new frontier to be conquered requires some careful rethinking. Its negative aspects, including the damages done on Earth as a result, should be acknowledged and considered a foreboding portent. That may cause the myth to lose some of its luster as a guiding model of our preferred futures in outer space. Most importantly, however, continuing the mythology erodes ethical consideration in the same manner that environments and peoples were excluded from concern.

4.4 Colonizing the future through mythology

Since the late 1940s few national initiatives have been as futures oriented as the United States' space program in linking projected technology with future patterns of society and culture. To many, the program encompasses the best shared vision of possible national and global futures, and it is most often portrayed in a very positive light as Gallup Polls' tracking of American opinion of NASA has reported (Jones 2004; Jones 2009). More importantly, the program has been nurtured and managed over the past half century as one of the best examples of what is "good" about America.

However, alternative visions of possible futures in space are suppressed by the concept of "destiny," an almost supernatural predetermination of how a singular future or narrow range of possible futures *must* unfold. For example, while many argue for an immediate and aggressive space program, it can be difficult for them to describe why it should be awarded priority over pressing issues here on Earth, such as mitigating global climate change, improving public health, universal education, or decreasing the potential for food chain collapse. Many will answer by invoking destiny (Zubrin 1996; 2011). It stops discussions about priorities; they may argue that space exploration *is* our destiny, universal education is not.

Similarly, reference to some innate human drive to venture into the unknown is employed as part of the pioneering mythology to justify space ventures. It has been portrayed as an instinct that is part of our DNA and, as such, remains unchallengeable as a drive over which we have little control (Anderson 1970). Following the Soviet Union's successful launch of Sputnik in 1957, President Eisenhower charged his Science Advisory Committee to prepare an "Introduction to Outer Space" as a way to communicate the US's founding rationale for space activities to both the US and, assuredly, the rest of the world. The Committee's first-listed reason for a national interest in space was a

[135] Forward contamination refers to biological contamination that originates on Earth and is unintentionally transported to an extraterrestrial location (e.g., microbes on the Mars Rover). Back contamination refers unintentional biological contamination arriving on Earth from an extraterrestrial location.

“compelling urge of man to explore and to discover, the thrust of curiosity that leads men to try to go where no one has gone” (President's Science Advisory Committee 1958). President Bill Clinton said exploration was “in our genes,” and President George W. Bush stated in his 2003 speech on the Vision of Space Exploration, “This cause of exploration and discovery is not an option we choose; it is a desire written in the human heart”(Bush 2003). This drive we can’t control is cast as integral to American manifest destiny. [136] Yet to act solely because of innate behavior can be irresponsible and without defense. The unethical results of following instincts without more rational justification have been demonstrated many times in our histories (Robinson 2010).

But the premise that our genetic coding impels us to explore does not withstand anthropological or cultural scrutiny. Many human societies and cultures (e.g., the East Asian cultures of Japan, China, and Korea) have no history of such a will nor do they express an overwhelming psychological urge to venture beyond their traditional geographic ranges.[137] Metaphors of conquest are largely limited to the American space program.

In Japan, for example, the website for their corporate space agency states,

> *On October 1, 2003, the Institute of Space and Astronautical Science (ISAS), the National Aerospace Laboratory of Japan (NAL) and the National Space Development Agency of Japan (NASDA) were merged into one independent administrative institution to be able to perform all their activities in the aerospace field as one organization, from basic research and development to utilization. The independent administrative institution is the Japan Aerospace Exploration Agency (JAXA.) As space development and utilization, and aviation research and development are steps to achieve the nation's policy objectives, our contribution to problem solving is an important mission for us. JAXA proposed its long-term vision, ‘JAXA2025,’ to realize our own mission. Under our corporate message ‘Reaching for the skies, exploring space,’ JAXA is pursuing great possibilities in various aerospace fields and is striving to succeed with various research and development missions in order to contribute to the peace and happiness of humankind.*[138]

While the English language translation mentions exploring space and although “Exploration” is the “X” in their Anglicized acronym, neither the quote nor their vision statement draws on metaphors of conquest, calls for destiny or claims that we must go because our genes tell us to, and inclusion of “exploration” is suspect. There is no equivalent to the English word “explore” in the agency’s title in Japanese, prior to

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[136] US expeditions to the Arctic and Antarctic in the late 19th and early 20th centuries were also advertised as a natural extension of manifest destiny (Dudley-Rowley 1998).

[137] In *1421- The Year China Discovered America*, Gavin Menzies describes the immense Chinese flotilla that sailed to several continents. While certainly having the resources to establish colonies, the voyages were predominantly launched for trade, not exploration for the sake of some inner genetic or cultural urge to see what is over the horizon. Similarly, there is no culture of exploration for the sake of exploration in the Arabic/Islamic world or among African cultures. Whether or how Western religions’ tendencies to proselytize are related to the expressed “human need” to explore would be an interesting thread to follow.

[138] http://www.jaxa.jp/about/2025/index_e.html

translation. Perhaps "explore" was added to the translation to more closely match the predominant American language and mythology of space. As a corporation, they appear to have a much more practical agenda that does not require myth to justify.

We may appreciate colonization's flaws in a historical context and continue to witness their impact in the present day throughout much of the world, yet many in the US and elsewhere in the West find it extremely difficult to visualize futures in space exploration that are *not* also based on the premise of colonization and the model it provides. The image has been effectively sold for decades. But to continue the "Westward Ho" paradigm and to perpetuate the support of its mythology does the space program a disservice. It is indicative of a purposeful colonizing and exploitative motive that links a rallying cry from a checkered past to a singular vision of *a* future in space, not the rich array of potential futures that are possible. Perhaps those who find the metaphor so powerful may not be able to fully justify or articulate that vision on its own merit. Myth serves that purpose. Quoting Mody Boatright, folklorist and past Professor of English at the University of Texas, "The more these values (the space program) are threatened, the more vigorously will the myth (here, the pioneer and frontier in American history) be defended" (Stoeltje 1987, 236). It is not difficult to insert concepts of the space program to change the quote to "The more the values required for continued economic growth of the space program are threatened, the more vigorously will the myth of the Bowdlerized history of the American pioneer be defended." Sadly, past patterns of exploitation in advance of critical evaluation (often followed decades or centuries later by deep regret at opportunities lost and injustices perpetrated) still provide the predominant paradigm guiding space exploration.

4.5 The 100-Year Starship Study

The 100 Year Starship Study (100YSS) is a joint NASA-DARPA (Defense Advanced Research Projects Agency) initiative organized to assess what engineering, political, economic, social, human physiological and psychological, and other actions would be required to achieve a goal of launching a crewed flight to another star system within our galaxy 100 years from now. The project provides an excellent opportunity for reassessing the frontier mythology so often employed to describe our futures in space.

4.5.1 Opportunities for changing the mythology

I offered the following 7 suggestions to 100YSS planners in 2011. In the context of bioethical consideration of relationships with ETBE, they may be essential:

1. Language matters. Consciously abandon the language of conquest, dominance, patriarchy and violence in discussions of space travel and policy. Recast adversarial approaches such as "taming hostile environments" to more neutral descriptions that do not confront the unknown as an adversary. "Learning through encounters with the diversity of our universe" is just as powerful a description of purpose as "conquering the unknown" and is a more accurate accounting of our purpose. Describe the purpose of space travel as voyages of discovery, not as missions.

2. Ensure that the effort is a global human effort whenever possible by facilitating the participation of all cultures who wish to participate. The US and USSR were the only spacefaring nations for the first few decades, but now many European countries, China, India, Japan, and others have joined the effort. The International Space Station provides billets to a much broader demographic. However, while this trend certainly helps in diversifying gender, race, and culture among participants, there is little evidence demonstrating it has led to significant changes in our visions of potential uses of space or our philosophical approach to it. Rather, the existing Western model of human's relationship with the cosmos is being taught to the non-Westerner with very little of the reverse.

Projects should consider instituting a program whereby spacefaring nations enable the participation of non-spacefaring countries in a far more comprehensive and meaningful way. Sponsor the participation of non-industrialized, non-Western indigenous groups in a broad spectrum of Starship program development and implementation, including mission creation and visioning (Logsdon 2008). For example, Jane Young suggests, "Because Native Americans have a different perspective of the world, they can offer us alternative ways of seeing ourselves in relationship to the natural world and help us answer the question of what constitutes appropriate behavior – in outer space, as well as on Earth" (Young 1987; 1987b, 270). If a motive of a launch is to perpetuate a Western, capitalist, colonizing model, it would likely be best to not invite indigenous cultures' perspectives and participation. If, however, it is seeking new approaches to designing space-faring civilizations, inviting their participation is essential.

3. Our various histories of human expansion and colonialism are rarely complimentary of our species' regard for bioethical justice. NASA has made the search for life within and outside our solar system a priority, yet there is little in the way of policy guiding the ethical ramifications of first encounters unless our immediate assessment of that alien life is that it is clearly sentient. Voyages must challenge our common definitions of life and avoid attempts to classify alien life within Earth's familiar taxonomies. We must strive to explore with an abundant regard for the potential life, ecosystems and landscapes that may be harmed by our actions, regardless of size, sentience or seeming complexity.

4. Starting early in any project, undertake actions to instill and institutionalize a culture of non-violence. While there may be a need for internal, intra-crew policing on the voyage itself, there is no need for any militaristic force or defense capability.

5. Terraforming (strictly defined as a re-creation of Earth's environment on an extraterrestrial body) should not be a prime or singular objective. Rather, humans' potential to adapt to new worlds through artificial speciation, bio-technical augmentation and incorporation of artilect and robotic capabilities may be far preferable. Assimilate with natural environments; adapt. The purpose of the voyaging should not be to create new, identical, Earths; that was the approach of the colonizers who attempted to build a New England or a New Amsterdam in a New World. They failed to recognize that the destination of a voyager, as opposed to that of a colonizer, frequently changes the

individual and his society into something unintended but often improved, and that is where the power of voyaging lies. As Kim Stanley Robinson states in the first paragraph of his Mars fiction trilogy, "We were on our own; and so we became *fundamentally different beings*" (Robinson 1993). There are reasons why some will choose to leave this planet. We are, in many ways, escaping a world that we have, both by ignorance and by choice, mismanaged to the point of near self-destruction. We must guard against packing our shortcomings, those very factors we are hoping to escape, along with other baggage. Adapting to a refreshingly novel universe, not recreating a sentimental past, must be a guiding principle.

6. There are no true eutopian forms of government on this planet, so attempts to perpetuate any singular form of existing government would be an opportunity lost. Similarly, all existing economic and social systems have their flaws and strengths. Make use of the strengths in designing on-board governance and culture. Question the use of a capitalist model, both while in transit and after arrival at a destination and seek alternatives that do not foster social or economic hierarchies.

7. The project must represent a global effort incorporating the best of what all cultures have to offer for realizing utopian ideals. Even if the Starship never sails, lessons learned from the experience of planning such culture may prove invaluable in creating a more harmonious and just Earth and in more modest expansions to planets and other bodies within our own solar system. In the end, that may be the project's greatest achievement.

4.5.2 The opportunity of re-creation

100YSS represents a bold experiment in visioning our possible futures in the context of a voyage beyond our own Solar System. But in addition to the myriad of prerequisite engineering and architectural challenges of the vessel itself, the undertaking not only allows for reconsideration of a range of social and cultural issues, it demands it. As such, it provides a unique opportunity to re-invent humanity based on our highest principles and ideals. It allows for the premeditated creation of new cultures, the design of new governments or perhaps even the decision to forego governments in any traditional sense altogether in favor of some novel form or structure. In short, the Starship allows us to design a eutopian society.

Whereas previous attempts at eutopian living have been hindered by the reality of sharing a planet dominated by millennia of violently conflicting beliefs, the Starship is not bound by such restrictions unless we fail to purge it of those destructive traditions, unless we fail to understand that we *can* abandon them. This is the key rationale for avoiding the language of frontier colonization, conquest, exploitation, and violence along with their associated social and environmental injustices. To continue to talk in those terms is useful only if one's motives are regressive, are motives to perpetuate a sub-optimum *status quo* by exporting it beyond Earth. We are better than that. We have an opportunity to leave that behind us.

Such forward thinking need not be limited to the Starship, but adds depth to any extraterrestrial travel. It is critical in founding a new mythology of space based more on bioethical concern than existing models.

CHAPTER 5
INTELLECTUAL PROPERTY RIGHTS AND THE IMPLICATIONS OF BIOPROSPECTING IN GLOBAL COMMONS AND IN SPACE

> There is nothing which so generally strikes the imagination, and engages the affections of mankind, as the right of property.
>
> Judge William Blackstone -- Mid-18th century[139]

5.1 Premise

Preceding chapters have called into question common Western concepts of life. Definitions have grown more complex with continued research on life's parameters and limits, blurring distinctions among species and challenging philosophical arguments that humans are uniquely distinct from the world we share with the animate and inanimate alike -- one flows with the other. Similarly, bioethical relationships among humans and non-human life are equally as problematic. Organically, we are not *apart*, but are *a part* of a greater universe, not only in an ecological sense but *as* the system itself. This shift in perception has led to our incremental reconsideration of ethical relationships with other humans, other animals, all life and landscapes. The process is aided by advances in technology that allow us to better perceive the capacity of non-human life to experience and respond to their environment.

This chapter explores how perceptions in both biology and bioethics are reflected in the history of pertinent Western concepts on the ownership of life as promulgated through the American patenting process. It reviews current standards and practices for bioprospecting and "life patents," provides applicable notes on intellectual property patenting law and practice and reviews current regulatory controls and international agreements where bioprospecting is conducted within global commons. Most useful among these are the Antarctic Treaty, the Convention on Biological Diversity and the United Nations Convention on the Law of the Sea and its establishment of the International Seabed Authority (Korn, Friedrich et al. 2003; Herber 2006). While they have often proven to be inconsistent and, at times, contradictory, they have all been legally tested and have evolved to be more efficient. As such, their administrative frameworks regarding resource management and the patenting of life provide guidance for designing similar protocols for possible relationships with extraterrestrial biological entities

5.2 Introduction

The Outer Space Treaty does not address intellectual property rights derived from any living system that may be encountered.[140] There is no commonly accepted protocol for

[139]In, Commentaries on the Laws of England, 8th Ed. (Oxford: Clarendon Press, 1778, 2:2) (in Banner 2011, 2).

[140] Formally known as the Treaty on the Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies.

how to assign "ownership" to any biological resources found in the ultimate commons, extraterrestrial space. With a suite of nations having stated that space exploration and exploitation are within their visions of possible futures and, more problematic, that private ventures that are rapidly approaching the point where they may be launching for the expressed purpose of creating profits for their investors, it is critical that the issues of ownership be resolved before the moment of discovery.

When new biological resources are discovered in uninhabited, unexploited regions of global commons (such as Antarctica), questions of traditional knowledge (TK) and novelty are generally unchallengeable and rights for patenting may be nearly guaranteed.[141] In such circumstances, a portion of the profits generated by the patent may be required to be distributed for use in conserving that environment based on benefit-sharing or royalty formulas. Although such arrangements have not generally been successful due to conflicting bureaucracies, such financial arrangements may be appropriate for extraterrestrial finds. Existing protocols governing bioprospecting in the global commons may provide insights for extraterrestrial application.

It has been argued (in fact assumed by many) that should ETBE be discovered, legal treatments available for their exploitation will mirror the restrictions and liberties found on Earth; derivative products and processes will be patentable if other requirements are met.[142]

5.3 Concepts of ownership and patenting life

Both the concept and practice of a human individual's or group's control of a biological entity, whether plant, animal (including another human) or other taxon likely evolved as a meme along with human cultures. But it is not unique to humans. The behavioral roots of ownership, although certainly not in any legal sense, are also documented in non-human species (Wilson, 1975; Kummer and Cords 1991).[143] However, while many customs of possession among humans are ancient, the construct of both real property (ownership rights applied generally to land and permanent structures, such as buildings) and personal property (generally, transportable possessions) is a more recent invention. It is closely allied to the provision of social and political rights and, in some circumstances, theological doctrine and practice. While the anthropological emergence of an individual human's right to own biological property is evidenced in control of the fate of the family pig or yam patch, the legal concept of exclusive or near-sole use and ownership of living organisms is a more recent concept that is now well established in law, especially

[141] Global commons is defined here as areas that are outside any nation's legal jurisdiction and sovereignty.
[142] NASA's attorney for such issues (Jeffrey Nosanov) indicated in an interview in 2011 that extraterrestrial life forms themselves would likely be patentable in the same manner as terrestrial life. Any processes or the products of such life identified as "inventions" would likely be able to be patented, assuming all other patenting requirements are met. He continued that as there are no precedents, legal outcomes of possible treatments by patenting bureaucracies is difficult to predict.
[143] For example, the claiming of a toy or blanket by a chimpanzee or dog, denoting a degree of ownership even when the object is physically possessed by another. This concept of ownership may also be applicable to territories, which would apply to a full range of species at least to the invertebrate level.

Western law (Stone 1996; Banner 2011).[144] Property rights vary widely, however, among various non-Western cultures.

Rights of ownership (and the possible liabilities that are carried with such rights) are products either of a system of laws and regulations or are nested within cultural norms and conventions that prescribe *de facto*- or quasi-legal status through custom. Both culture and law define the parameters of ownership and ownership rights and responsibilities, but which has precedence in instances of their considerable overlap is often unclear. Adding to this confusion is that laws and regulations are mostly created and circumscribed by often arbitrary and ephemeral political boundaries. Custom and convention and the cultures that generate them generally predate these political boundaries and are likely more permanent. They may span multiple political/legal regions. Many of the intellectual property rights issues related to bioprospecting (defined below, but in simplest terms the purposeful seeking of biological resources or knowledge for commercial uses) are products of this conflict between legal and cultural approaches to traditions of ownership.

Compounding this tension is the philosophical concept of human ownership of living entities. Jeremy Bentham (1781) argued that there is no property where there is no legal system (Bergström 2000). Of course, it must be modified with the caveat that there is no *legal* property where there is no legal system, and real and personal, not intellectual, property was the issue of discussion. But natural or moral rights and related duties remain regardless of the nature of the property.[145] This secondary conflict (between law generated through political process or its equivalent and ethical concepts of ownership) is also heightened by bioprospecting. It cuts to the core issue: Where does the basis of indigenous ownership of a biological resource reside if it is so deeply imbedded in culture that legal, political prescriptions for ownership don't apply? Is the boundary between the individual or group and this cultural resource so fine that the two cannot be individually defined? Can an outside party appropriate that resource as they might some other commodity without also taking (perhaps stealing) away part of that culture?[146]

Issues of ownership and sale (although not issues of patentability) of human corpses were debated in Europe and the US in the latter half of the 19th century as anatomical and other medical studies supported a demand (Sappol 2001; Roach 2003; Bovenberg 2006). If a corpse was not property, would its theft be considered a crime since the thief had not

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[144] In the US, the legal right to own other humans as property was only disallowed by the 13th Amendment to the Constitution in 1865, but *de facto* slavery with tacit consent of governments continues to varying degrees in the form of conscription for military service or for commercial exploitation to a degree in this country and more blatantly in many foreign areas. Notable 19th century examples include Belgian King Leopold's domination of the Congo, Britain's colonization of Kenya and the military's establishment of forced labor camps, French colonizations, Germany's and Japan's military expansion, and more modern examples in 21st century Africa, e.g., Somalia (Elkins, 2005).

[145] Bentham was one of the first to discuss the linkage of the moral and the legal regarding non-humans in his analysis of human infliction of pain upon animals. The law, he argued, should consider the prevention of happiness among sentient animals as a legal as well as moral issue.

[146] For example, as has been argued regarding the collection of other indigenous artifacts (ceremonial masks, religious objects, human remains, etc.) for museum collections or research.

taken anyone's "property?" Who within a family could determine where to bury someone if the family could not agree? Who could sue an undertaker if he fails to perform his duties properly or if someone were to mutilate a corpse? These questions lead to the concept of "quasi property" regarding human bodies, allowing law suits to be settled without classing the human as ethically-distasteful property (Banner 2011). Sale of human hair for the wig trade, milk, and even live human skin all raised issues of ownership and the tangle of legal as well as ethical problems that emerged.[147] Trade in a range of human products escalated to include (chronologically) blood, sperm, eggs, fertilized eggs, and finally organs themselves.[148]

But issues and inconsistencies continue. Corneas, for example, can legally be sold after removal from a cadaver but the family of the donor cannot claim the value; the doctor or facility that removes the cornea can (O'Neill 1998). Similarly, cell lines, once extracted from a human become the "property" of the new owner, not the patient (Skloot 2010). This begins to take on aspects similar to criteria for patentability. The "work" of extraction (whether of corneas or DNA) is added to fundamentally change the nature of the product, and although a natural cornea cannot be patented, portions of human (or any other species') DNA that have been removed from the cell and genetically engineered for a specific purpose generally can.

5.3.1 Patenting life as intellectual property

As required by the U.S. Patent and Trademark Office (USPTO or PTO) three elements must be proven by the applicant for a patent to be awarded for an invention: novelty, lack of obviousness, and utility. First, with novelty, that no one has invented it before -- that it is original in design, function, use, or other attribute. Second, that its structure, use, etc. is not obvious. Examples of "obvious" would include using a stick to pry up a rock or using a rock to throw at a target. These are considered obvious, so one could not patent a stick or rock for those purposes. What would not be obvious would be shaping or bending of the stick in an unusual way to make it a better lever or chiseling the rock in a specific way to give it a more accurate trajectory. The subtleties of such determinations in the patenting process are obvious. Lastly, the invention must demonstrate that it has credible, specific and substantial utility, that it accomplishes a specified task. If, for example, the rock is shaped in a novel way, yet accomplishes no specified task, it may fall under the category of "art" as contrasted to "invention." As such, it may be claimed as intellectual property (IP) as is, for example, music, sculpture or other iconic art or choreography(Connelly 2004).[149] The term "intellectual property" was coined in the 19th

[147] Banner (2011) cites that skin was sold by the square inch in the first decade of the 20th century for skin grafts and breast milk by the quart. As with hair, such sales were mostly from the poor. Sale of blood continues. (As reported by Banner, "professional" blood sellers organized under the American Federation of Labor in the 1930s.)

[148] Congress outlawed the sale of organs with the National Organ Transplant Act of 1984 and the 1987 Uniform Anatomical Gift Act made sale both a federal and state felony.

[149] For example, a US District Judge determined that the Martha Graham School owned the intellectual property constituted by Martha Graham's iconic choreographic techniques, not her estate's heir (Carmen 2001). Movement, when so stylized that it is identifiable to a specific choreographer, can be considered for copyright.

century, although various forms of patent protection were available prior to that(Lemley 2005). IP now includes broad classes of patents, copyrights, trademarks, industrial designs and trade secrets.

The Patents Act of 1970 states (at Section 3(d)) that patents will not be issued for "the mere discovery of a new form of a known substance which does not result in the enhancement of the known efficacy of that substance or the mere discovery of any new property or new use for a known substance or of the mere use of a known process, machine or apparatus unless such known process results in a new product or employs at least one new reactant." Specific to life patents, Section 3(j) stipulates that "plants and animals in whole or in part thereof *other than microorganisms* but including seeds, varieties and species and essentially biological processes for production or propagation of plants and animals" are not patentable (emphasis added). This is in agreement with the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) 27(3) (b) which sets a minimum standard by stating that members *may* exclude from patentability all species of plants and animals except microorganisms. This is a continuing source of confusion, for the Patent Act and its subsequent iterations do not clearly define "microorganism." In the vernacular it simply means something small enough that it is not easily seen without the aid of magnification. Under favorable conditions one can easily see unicellular organisms such as larger protozoans without technological assistance. One cannot, however see bacteria. It is clear, however, that any genetically modified microorganism (e.g., a modified bacterium) is patentable.

Significant confusion results from differing patenting regulations among states. The Indian position, for example, agrees with the USPTO position regarding microorganisms, that plants and non-human animals are patentable if removed from their wild condition and genetically modified. However, in opposition to the USPTO, India maintains that any process for the medicinal, surgical, curative, prophylactic, diagnostic, therapeutic or other treatment of human beings or similar such process for treatment in animals are not patentable. For example, a technique for *in vitro* growing of a replacement human organ would be patentable in the US but not in India (Gabriel 2012). The European Patent Office adds additional caveats to patenting living organisms. Applications for patenting genetically-engineered animals there are denied where the animal would suffer as a result of such engineering in excess of the potential benefit of its use for humans. This aspect of the law arose from the 1985 application to patent the "Harvard Mouse," genetically engineered to develop cancers to assist cancer researchers. While the application was originally rejected as "immoral" in Europe, it was granted 18 years later after further consideration of suffering vs. benefit. The mouse was also granted a patent in the US in 1988, representing the first "higher form" of life to be patented (Gabriel 2012).

In the US, genetically modified organisms are generally patentable because they do not exist in nature (so are novel creations), are certainly not obvious and, where the patent is goal oriented, have credible utility. They require work ("the hand of man") to extract from their wild environment. More remote legally are other genetic products, such as a DNA sequence that has existed in nature for millennia. In such a case, courts have ruled that they are patentable because the DNA has been removed from the organism, purified, sequestered from its "natural" environment and applied to a new process (which is any process external to the original "owner") (Dutfield 2003). A purified segment of DNA does not exist in nature; once purified, it becomes generally patentable.[150] Controversy continues, however, in the ability of that purified DNA segment to meet the test of novelty.

5.3.2 Patenting as counterproductive

When President Thomas Jefferson (abundantly familiar with the political implications of invention, its relationship to national wealth-building and European models of property management, both positive and negative) contributed to the drafting of the U.S. Constitution he wrote that a subsequent Federal office would "promote the progress of science" and offer protection for the works of inventors, including intellectual property in addition to the more familiar machinery and process.[151] He avoided mention of "patents" as this harkened to both Columbus's claim of a "patent" on the New World, including all resources, land and people and the British system of patenting followed by monopolization of commodities, such as sugar and salt -- this was certainly not the decade to perpetuate or otherwise honor British practices (citing Albright, in Krimsky and Shorett 2005, 29). But the ultimate impact of the workings of the US Patent Office (USPO), especially in the last century, has arguably done that in addition to providing protection for the inventor. Patents can serve to create monopolies that stifle creativity. As provided by Albright, Jefferson was well aware of this potential. From Jefferson's personal papers regarding one of his own inventions: "(A)s soon as I can speak of [the hemp-break's] effect with certainty, I shall describe it anonymously in the public papers, in order to forestall the prevention of its use by some interloping patentee" (as quoted in Curtis 1901, 381). This potential for patents to be willfully employed as impediments to progress was clearly recognized over 200 years ago. In addition, patent-created monopolies can also function to decrease competition and therefore, it can be argued, conflict with capitalistic ideals (Albright 2004, 187).

An excellent example is provided by the aircraft industry. When the US entered the First World War there were fewer than 100 aircraft in this country; France had over 2,000 and Germany had 1,000. Although Orville and Wilbur Wright had invented and patented a mechanism for controlling pitch, roll and yaw in 1906, the following decade was fraught with legal wrangling and law suits brought by the brothers on any who attempted to construct an aircraft approaching their design. They considered their patent an umbrella protecting their profits from infringement, and while their patent was for specific components of their craft, they maintained their patent was for the theory of wing design and resulting differential pressures that allowed flight. They fought to block other attempts to patent craft based on that theory and design (Albright 2004, 145). Clearly, their patent served to impede, not stimulate, the advancement of both the technology and industry, and similar law suits are still having anti-innovation effects (Porter 2012). The

[150] This was established in *Amgen Inc. v. Chugai Pharmaceutical Company* in 1991.

[151] U.S. Constitution, Article I, Section 8, in part: "To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries."

US government broke the logjam with the creation of the Manufacturers Aircraft Association (MAA), creating a patent "pool"(Dykman 1964). Aircraft manufacturers paid royalties into the pool and shared patents. This was critical to developing American air power early in the First World War. However, this resulted in the creation of a quasi-monopoly among the members of the MAA and blocked non-members from experimenting with and manufacturing aircraft of their own design that employed patented technology (e.g., cable assemblies, wing struts, and other design features that were at that point rather standard in the industry). The problem was remedied, in part, through the placement of the MAA under the Department of Commerce. Although now regulated, information was more easily shared among a wider user group. Federalizing the coordinating effort also facilitated substantial federal funding for the industry, and the federal government was by far the industry's primary customer. Lastly, as aircraft tend to fail in dramatic ways, liabilities were shared, in part, by the federal government. The MAA provided a model for similar developments in space exploration in the 1950s with the creation of NASA. (The model of shared patents and liabilities provides some guidance for approaching the problem of patenting ETBE.)

Government involvement was a positive step for aircraft development. With life patenting, however, the federal government has taken a decidedly benign position, especially through the PTO which has processed patent applications but hasn't significantly developed a regulating policy on the range of products produced. The relatively recent emergence of the biotechnology industry coincided with more than a decade of administrative hesitance among all branches of Federal government to insert regulations into new technological fields, such as biotechnology, relying more on the Judicial rather than the Executive or Legislative branches to address the issue.[152] It is arguable that there would have been similar reticence with the MAA but for the threat of the First World War and the absolute necessity of rapidly developing a military air capability.

In a modern context, as cited by Matthew Albright (2004), Todd Dickinson, a former director of the USPTO stated in remarks to Congress that life patents involving human diseases with genetic bases were justified in that they stimulate research. "Without the funding and incentives that are provided by life patents, research into the basis of genetic diseases and the development of tools for the diagnosis and treatment of such diseases would be significantly curtailed."[153] However, such patents can have the opposite effect. They may (1) instigate competition not so much to produce cures but to produce patents, thereby dominating profits; (2) secure knowledge and "ownership" of the disease only to develop, patent and market processes *for testing* for the proclivity to contract the disease (e.g., genetic screening), which does little to cure should the malady be expressed; and (3) monopolize research on the genes themselves, preventing competition that may lead

[152] It could be argued that allowing a broad range of issues to be settled by the Judicial Branch, by deferring to the Court, relieves both the Legislative and Executive branches from having to make unpopular decisions.

[153] Provided to the Subcommittee on Courts and Intellectual Property, Committee of the Judiciary, House of Representatives, July 13, 2000 (access via www.house.gov/judiciary-/scot0713.htm)

to cures as opposed to marketing detection procedures.[154] Abetted by the patenting process, a cycle of identifying the genetic or metabolic causes of a disease and patenting a process for either diagnosing the malady or methods for determining the likelihood of it developing in an individual (i.e., genetic propensity), informing the public of the condition and generating a degree of fear, and then marketing the diagnosis can be far more profitable than curing the disease, which would subtract patients from the market.[155] This is the reason India does not allow such patents.

This rather negative scenario is exemplified in the 1990 identification of the breast cancer gene (BRCA1), the result of 20 years of work by Mary-Claire King. She published the location of the gene in a public database (Breast Cancer Linkage Consortium) to freely share the information with other researchers in hopes of aiding the search for effective treatment or prevention. The Consortium site, however, was accessed by Myriad Genetics, who patented the BRCA1 gene without consulting King or other researchers outside Myriad. Once in their possession, Myriad proceeded to use the information to develop tests that screen for the gene, not on cures or treatments. Others were not allowed to conduct research for a cure without Myriad's permission and without payments or royalties to Myriad (Smith 2001, in Albright 2004, 15).

The patenting process promotes secrecy among competing researchers rather than facilitating the free exchange of information . This retards productivity and inhibits the creative benefit of group thinking. As provided in Albright (2004, 25), the Journal of the American Medical Association reported in 1997 that one third of life science researchers surveyed had been denied access to research results from organizations and facilities other than their own; in 2002 the fraction had risen to 47%. This lack of sunshine inhibits the ability to confirm the validity of published research. In addition, publications can be held up for months awaiting patent filing, slowing the overall flow of information.

There is an abundance of arguments regarding the adverse impacts of patenting on creativity. In testifying in support of the Plant Variety Protection Bill, Floyd Intersoll, the president of the American Seed Trade Association, stated, "The absence of any form of legal protection for the originators of new plants which reproduce sexually has forced many companies to forgo comprehensive research programs. Experience indicates that when some form of protection is available, research finds are made available by private industry" (as quoted in Bugos and Kevles 1992)[156]. As with most such issues, a balance between the two extremes should be sought.

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[154] Occasionally royalty payments demanded of potentially competing research facilities are inflated over what would normally be charged to discourage rivals from conducting research (Warshofsky 1999).
[155] Where life style and personal habits play a significantly important role in health, these are down-played, if not supported by other industrial factors, such as the fast food industry. Perhaps unduly cynical, but helping people to become unhealthy, diagnosing the condition and then selling them palliatives but not cures makes for good business model.
[156] From Patent Law Revision: Hearings Before the Subcommittee on Patents, Trademarks, and copyrights of the Committee on the Judiciary, United States Senate, 90th Congress, 2nd Session, 1998, p643.

5.3.3 What life is patentable?

The first US patent for a biological product was issued to Louis Pasteur in 1873 for his culture of yeast that was “disease free." The yeast was not modified biologically in any way. Rather, Pasteur’s invested work was purification, separating the desired yeast organism from its natural environment of contaminating bacteria and non-target yeast strains. A later case that reinforced judicial opinion regarding the classes of living and life-produced products as patentable was adrenaline. Although a US patent was issued for the compound the decision was challenged in court in 1911 on the grounds that adrenaline was discovered, not invented. The court upheld the patent and explained, “Takamine (the patent holder) was the first to make (adrenaline) available for any use by removing it from the other gland-tissue in which it was found, and, while it is of course possible logically to call this a purification of the principle, it became for every practical purpose a new thing commercially and therapeutically" (Dutfield 2003, 115). Firm precedent was again set that an extracted, naturally occurring compound could be patentable if it was purified and had the requisite utility and novelty.

The scope of life patents expanded greatly in 1980 with the landmark *Diamond v. Chakrabarty* decision.[157] Here, the US Supreme Court upheld a patent on a genetically modified bacterium designed to break down hydrocarbons found in petroleum oils through its altered metabolic processes (for the purpose of pollution remediation -- the modified bacteria “ate” petroleum).[158] Ananda Chakrabarty, working for General Electric, took plasmids from several bacteria and inserted them into another.[159] The court ruled that the resulting bacterium was not a “product of nature” and was, therefore, an invention. As such, it was patentable. In writing the majority decision for the Supreme Court, Chief Justice Warren E. Berger further stated, “We have cautioned that courts should not read into the patent laws limitations and conditions which the legislature has not expressed,” and that “in choosing such expansive terms as ‘manufacture’ and ‘composition of matter,’ modified by the comprehensive ‘any,’ Congress plainly contemplated that the patent laws would be given wide scope” (Justia 1980). Dissenting Justices, however, opined that Congressional intent was clear to *not* permit the patenting of bacteria, citing the 1930 Plant Patent Act (the first American protection for new varieties of plants, essentially through cuttings and grafts) and the 1970 Plant Variety Protection Act (7 U.S.C. §§ 2321-2582, which provides patent protection for the seeds of hybridized plants) (Lumelsky 2004). Congress, whatever their intent, did not expressly forbid patents for living organisms of any kind. The Jeffersonian sentiment that US law permits patents on "anything under the sun that is made by man" appears to hold true (as reported in Justia US Supreme Court Center, undated).

Chakrabarty has withstood challenge and the concept of patenting organisms has been expanded. For example, the Plant Variety Protection Act codifies that a plant breeder may patent a cultivar or variety of an existing organism that is not found in nature. The

[157] Sidney Diamond was the US Commissioner of Patents and Trademarks.
[158] Chakrabarty’s original purpose was to design a bacterium that would convert petroleum into edible proteins but the dramatic increase in the price of oil during the 1970s made that uneconomical.
[159] A plasmid is a self-replicating DNA molecule found primarily in bacterial cells.

degree to which plants (and other organisms) are modified from those that are naturally occurring is small, but the precedent is firmly set.

The USPTO maintains that "a patent on a gene covers the isolated and purified gene but does not cover the gene as it occurs in nature" (Mathur and Dua 2005). As such, for example, naturally occurring genes in the human cannot be patented *in vivo*, inside the human. However, if extracted and purified or biochemically altered in such a way as to make that gene useful to some other purpose, say, research or for study or treatment of a disease, it can be patented. It follows that the altered gene could be re-inserted back into the original donor who would then contain a mix of both patented and unpatented genes that originated in his or her body. As summed by Mathur and Dua (no page number provided), "By examining these legal precedents, it becomes clear that the difference between a discovery and an invention is a difference in degree rather than in kind, and when the human and material resources inserted in research reach a certain level, the product of such research is protected under patent law."

In stating its defense in the Diamond case, the US government cautioned the court that by allowing Diamond to patent a bacterium it would open the door to patenting genetically engineered human life, a "prospect sounding dangerously close to slavery" (Banner 2011, 253). The Court was clear that humans were excluded from any patenting; parts of humans, genome segments, for example, are patentable. However, any organism other than humans may generally be patentable if it does not occur in nature and if it meets other patenting criteria (novelty, etc.). In this context, "organism" includes bacteria, plants, animals and other forms of life. However, hybrid humans are not addressed. For example, insertion of a human gene into a fish would be allowable. The question avoided, however, was at what point does the percentage of human genes employed in such a creation violate prohibitions on patenting "humans?" While a mouse might be engineered through the addition of less than one tenth of one percent of a human genome (as was done with the human Foxp2 gene for speech), would the same rules allowing patenting be permitted if ten percent of a human genome was engineered and inserted to form a transgenetic chimpanzee egg? (Enard, Gehre et al. 2009). Eighty percent? Perhaps ninety-nine percent? These kinds of questions will have to be left to future courts or a legislature bold enough to tackle them.[160]

5.4 Bioprospecting

The practice of purposefully collecting natural materials in "foreign" areas and then transporting them back to one's home has been documented as far back as 3500 years when Egyptian military excursions sought exploitable plants during conquests (Juma 1989). "Bioprospecting is as old a concept as medicine itself" (Shankar 2008, 1). In the modern context, however, and in its most favorable light, bioprospecting is the process of

[160] At TRIPs' Third Ministerial Conference (1999), the African Group (a collaboration of mostly lesser-developed countries) and India requested that amendments exclude all life from patentability. They also motioned that in issues regarding species, the WTO should be subordinate to the Center for Biological Diversity (CBD). They held that such a move would reintegrate an ecological perspective. The proposals were rejected.

(1) searching for, collecting, and subsequently analyzing naturally occurring biological organisms and/or their products to determine their agricultural or biochemical properties for either direct use by humans or by synthesizing and mass-producing target compounds; and/or (2) gathering indigenous knowledge or practices regarding the processes that enable the target organism, its processes or products to be used or enhanced (Pan 2006, iv).[161, 162] Most often, products are subsequently used as pharmaceuticals or cosmetics, as crops and crop-related agricultural materials and in industrial and manufacturing processes. Typically, bioprospecting is initiated by industrialized or otherwise technologically advanced nations in countries that have no, or only the rudimentary basics of, technology required to capitalize on this process.

Here, the term bioprospecting is generally limited to the two actions listed above where the goal is securing a patent and/or where there is some expectation of commercial gain. Generally excluded are expeditions and similar activities that sample the biological environment and organisms for educational or purely scientific purposes, for vouchering, determining environmental components, tracking environmental trends and similar actions.

When successful, the process of bioprospecting may culminate in patenting a compound and/or process in the home nation of the patentee (e.g., an American pharmaceutical company sends a botanist to Bolivia who returns with plant material. Targeted compounds are extracted, purified, and patented under US patent law).

In general, IP rights are applicable to "creations of the mind: inventions, literary and artistic works, and symbols, names, images, and designs used in commerce," and such rights may be secured through the patenting process (WIPO 2009). For the class of products resulting from biotechnological processes, the specific creation to which the patent may be applied may be a product resulting from the manipulation of natural biological processes to create something useful and novel. While there is no country that permits patents for a naturally occurring "higher" organism (whether it has been previously described or not), in the US, patents on specific chemicals isolated or purified from organisms can be awarded where such uses or processes are novel. In most cases, even though the effects of a biological organism may be known (e.g., chewing willow bark to relieve a toothache), the metabolic paths, enzymatic activities, or biochemical properties of such compounds are not part of indigenous knowledge. Further, any significant modification to the organism subsequent to its being removed from the wild may facilitate its patenting. As a result, for example, even if indigenous medical knowledge is taken as prior art, that knowledge does not by itself make the active chemical compound sought by the pharmaceutical company "obvious," the standard applied under patent law.[163]

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[161] There is a general distinction made between scientific research for non-commercial purposes ("pure" scientific research) and commercially-oriented research ("applied" research).
[162] The definition of bioprospecting varies depending on use, and it appears that there is no uniform definition among nations or international laws, treaties, regulations or policies.
[163] Regarding aspirin, Hippocrates described how to dry and powder willow bark and leaves for the treatment of headaches. Charles Frederic Gerhardt was the first to identify the active agent as

Over the past century, the rate of discovery of patentable products and processes has increased dramatically in tandem with developments in the fields of biological analysis and synthesis, assessment, mass production, biotechnology, and increased access to remote areas. Accordingly, the value of the products produced through these processes has also increased. Annual sales (2003 data) of products derived from TK using genetic resources were $3-billion for the cosmetic and personal care industry, $20-billion for botanical medicine, and $70-billion for the pharmaceutical industry (Lohan and Johnston 2003). But this dollar value "snapshot" is misleading and, in a way, additional evidence of the co-opting of traditional knowledge through the largely Western metric of monetary valuation (Gregory and Trousdale 2009). Loss of TK cannot be measured in dollars alone.

5.4.1 IP piracy

5.4.1.1 Theft of knowledge

The concept of *terra nullius* (unclaimed land – land belonging to no one) is a fixture in Western law dating from Roman times. Until the mid-20th century, however, it was liberally applied not only to clearly uninhabited and unclaimed lands (e.g., Antarctica) but to lands inhabited by those determined by Western colonizers as not having sovereign status. For example, Australia was determined by Britain to be *terra nullius* in the 19th century even though it was clearly populated by indigenous peoples. The 1835 proclamation by Governor Bourke legally established that the land belonged to no one prior to the arrival of the British (Fry 1946). Aboriginal populations were entirely discounted. A fuller definition of the term *terra nullius*, therefore, would continue that the land is not owned or claimed by any sovereign as territory and that the definition of the legitimacy of such a sovereign is to be determined by the potential settler or colonizer. It provides a legal form of not only theft, but Othering, the denigration of the target population by creating a class of non-people. The Bourke Proclamation was not overturned in Australia until 1992.

The concept is also applied to knowledge that is held by non-Westerners; it is not recognized as *real* or legitimate knowledge until blessed with a Western patent or other form of cultural possession. This, then, provides justification (and a legal remedy) for market control, presenting a *fait accompli* in favor of Western profiteering. Language demonstrating this is provided in the US Patent Act of 1952, Section 102, regarding the definition of "prior art" in the US and in foreign publications:

"A Person shall be entitled to a patent unless:

A. The invention was known or used by others *in this country* or patented or described in a publication in this or a foreign country before the invention thereof by the applicant for patent, or

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acetylsalicylic acid in the mid-19th century. Bayer Pharmaceuticals further refined the drug and patented it in 1900 (Sneader 1997).

B. The invention was patented or described in a trade publication in this or a foreign country or in public use or on sale in this country more than one year prior to the date of the application of or patent in the United States" (emphasis added).

Therefore, if "prior art" knowledge is held in another country but not published, it is generally patentable (i.e., able to be claimed as property by the patent applicant). Indigenous knowledge that is not published and not known in the US is analogous to the indigenous peoples of Australia under the British; it/they do not exist for consideration in a legal framework that would compete with colonization. Patent law provides a tool for colonization of information similar to the way that subjugation of indigenous populations is a tool for territorial colonization.

In 2011 the US Patent Office's Copyright and Intellectual Property Services' Copyright and IP Officer, Kathy Moore, argued for patenting traditional knowledge (TK) by reversing the charge that IP was a form of theft. "Just because products and technologies based on TK have been collectively held for a long time, does not mean they cannot be treated as an IP. The publication of illustrated, traditional folk stories is a simple example which is always popular with children. If indigenous people don't find some way of protecting their cultural heritage, it could disappear altogether" (Fiji Times 2011).

5.4.1.2 Biopiracy

Bioprospectors and the companies that employ them cannot patent plants or animals simply collected from their natural habitat, or just identified or analyzed; the term "patent" is frequently misapplied in that context. Traditionally cultivated plants cannot be patented unless genetically altered, but statements such as, "What gives the University of Hawaii the right to patent taro?" demonstrate the frustration and anger such misunderstandings may generate (Ritte and Freese 2006).[164] Fear of biotechnology (not necessarily unwarranted) coupled with unethical bioprospecting have fostered the concept of biopiracy, "(i) the theft, misappropriation of, or unfair free-riding on, genetic resources and/or traditional knowledge through the patent system; and (ii) the unauthorized and uncompensated collection for commercial ends of genetic resources and/or traditional knowledge" (Dutfield 2004, 2).[165,166] "Biopiracy rejects the legitimacy of bioprospecting in its entirety. (In) its extreme it holds that all knowledge is public and free" (Pan 2006, 3). Also included in the derogatory context of the term is patenting

[164] Many extant varieties of the taro plant that have been bred by Hawaiians and other Pacific Islanders for centuries to develop production in varied habitats (e.g., wetland and upland), and patents on these would not be allowable. Patents, however, are sought for newly-created taro strains bioengineered for disease resistance. The negative reaction was largely a result of the combined fear of bioengineered taro cross breeding with traditional varieties and the high significance of the plant to Hawaiian culture.

[165] As defined by the Convention on Biological Diversity (CBD), traditional knowledge is "that body of knowledge built up through generations by a group of people living in close proximity to nature and manifested by practices in which tradition filters human innovation."

[166] During the mid-20th century, for example, Richard Schultes (1915-2001), known as the "father of modern ethnobotany," reportedly collected over 30,000 plant specimens with medicinal and cultural significance in Central and South America by befriending local shaman. Hundreds of the plants had never been described. He returned with these to his collection at the Harvard University Botanical Museum without compensating his indigenous benefactors in any way (Davis 1996).

without respect to novelty demonstrated by previous use and traditional (indigenous) knowledge (Smith 2004). Combining bioprospecting and biopiracy as one and the same, some claim that both are representative of "an initiative of the North to globalize the control, management, and biological diversity of resources which lie primarily in the Third World" and represents, therefore, an extension of the inertia of colonialism (Shiva, 1997 –as quoted in Pan 2006, 3). Further, Shiva states, "The IPR (intellectual property rights) regimes in a digital age carry the mask of earlier times, when patents were licensed to plunder and piracy. The primary difference between patents in a digital age and patents in the gunboat age is that the new technologies can colonize life itself, while the older technologies could only colonize land. But patents and IPRs in the digital age share the earlier history of patents as instruments of conquest, which deny prior rights and erase prior histories of cultures" (Shiva 2000a, 201).

Whether legitimate and ethical research agents or acting as biopirates, bioprospectors frequently target technologically underdeveloped areas of the world. These regions are especially sought because (1) they often contain biota that are relatively unknown outside the locality or are taxonomically undescribed; (2) the areas still contain a varied mix of native species existing within intact ecosystems; and (3), indigenous peoples inhabiting the areas rely more heavily on gathered natural organisms and their byproducts than on commercially manufactured medicines and cosmetics. Cultures have survived (perhaps evolved) in the areas for hundreds or thousands of years, allowing the time required for trial and error experimentation with biologicals, their properties, habitats, cultivation, and processing. Frequently, indigenous knowledge of organisms and their uses may be passed only orally, so the bioprospector must go to the geographic source of the knowledge to learn from it. Much of this knowledge may be rapidly lost with "modernization," perhaps within a generation or two, requiring a degree of immediacy that contributes to the "piracy" image.

This combination of factors coupled with the lucrative nature of the discovery of new compounds has produced a range of questions regarding property rights issues:
Who "owns" the original biological material, if anyone? Any country, culture, or region? Does collection of biological material fall outside the normal agricultural exchange practices of production and sale? How does it differ from a food crop, if at all, for example? Has the history of Western exploitation of archeological and anthropological artifacts from less advantaged cultures without reciprocity contributed to bioprospecting issues by creating a history of suspicion? If a natural biological product is collected and exported but is subsequently engineered (e.g., genetically modified), how are intellectual property rights and patenting affected, if at all? Singular answers are impossible; cultures differ, there are overlapping and conflicting applicable laws and regulations, and enforcement and tracking are difficult.

What, then, can help to shape a set of regulations and policies that will adequately address bioprospecting and the ensuing patents that many may expect from exploration of extraterrestrial habitats, such as Mars? Analysis of the relationship among bioprospecting and patenting within the global commons on Earth provides a starting point. The Convention on Biological Diversity, the International Law of the Sea and its associated protocols for deep seabed mining and the Antarctic Treaty System (ATS) all attempt to manage the resources of their respective geographic areas efficiently. However, they all fall short of that goal to varying degrees.

5.5 Agreements on biological and mineral resource management related to IP

Garrett Hardin's remarkable paper "Tragedy of the Commons" commented on the futility of attempts to avoid the problems associated with human overpopulation (Hardin 1968). He argued that we must relinquish the freedom to have as many children as we wish as the only reasonable solution to avoid the disasters associated with a population that the world's resources cannot support. If we do not significantly reduce the global average birth rate by way of self-imposed behaviors we will, according to Hardin, be faced with outcomes that are beyond our direct control, such as regional or global famines, associated diseases and the wars such needs would precipitate. Hardin noted 27 years later that the debate had generally shifted from population to economics and the environment but still held the core of his original conclusion -- any consumptive use of the resources of the commons must be regulated if they are to be maintained (Hardin 1995). However, the answer to question he posed in 1968, "How do you legislate temperance?" remains as elusive as ever (1968, 1246).

Humans have been able to significantly affect ecosystems and the life they support for millennia. Anthropological and other data support that the extinction of a suite of large mammals, birds, plants and other species in North America, Europe and many island groups is directly linked to human hunting and landscape alteration (e.g., the use of fire) (Myers 1979; Hume, Martill et al. 2004; Lyons, Smith et al. 2004). It has only been with the advent of more modern technologies, however, that dramatic impacts on global commons areas such as the oceans have been realized. The decline in the number of whales world-wide and the collapse of the cod fishery in the North Atlantic provide two early examples (Kurlansky 1997). However, the availability and efficiency of modern ship-supported fishing and mining over the past century now allow massive exploitation of the ocean commons. As a result, international agreements and similar protocols regulating the conservation and exploitation of biological and mineral resources in these areas have been implemented.

5.5.1 The Convention on Biological Diversity (CBD)

CBD was a product of the world conference convened in Rio de Janeiro in 1992 (the "Earth Summit") to address, in part, the widely recognized need for international cooperation to foster the conservation of biological diversity (Convention on Biological Diversity 2009). The Convention entered into force the following year. As part of the United Nations Environment Programme (UNEP), it pledges that maintaining such diversity is a common human concern and an integral part of the development process that is of interest to the UNEP and other UN programs. To accomplish that objective, it strives to implement policy to conserve biological diversity, sustain the function of ecosystem components (through principles of "multiple and sustained use") and foster the fair and equitable sharing of benefits arising from genetic resources. This final goal is most pertinent to the regulation of bioprospecting.

Still, the basic tenets of the Convention were not new. The concept had been proposed by the International Union for the Conservation of Nature (IUCN) a decade earlier in 1981 and other aspects of the CBD had their origins in other UN agreements and protocols. The Convention was unique among previous conservation-goaled documents in that it was legally binding on signatories; parties were obliged to implement its provisions. In the US, however, this provision was interpreted to constitute "taking" (essentially, encumbering the use of private land without compensation).[167] As a result, political pressure for the US to withhold signature of the CBD was effective (Sovereignty International 1998).

As of 2012 the CBD has been ratified by all countries in the world except for the United States (which has signed, but has not ratified), Andorra, and the Holy See (CBD 2012). It appears that the US has withheld support due to concerns within its own borders regarding perceived overextension of Federal control of private lands rather than a reaction against maintenance of biodiversity. The US participates in various groups within the hierarchy of CBD projects, such as the global taxonomy initiative and the invasive alien species effort. It also supports the CBD's emphasis on programmatic ecosystem approaches to integrated management, conservation, and sustainable use (Blaustein 2006a).

As reported by the International Chamber of Commerce (ICC), prior to 1993 access to and use of biological resources and traditional knowledge of the use of those resources in a particular country primarily fell to the national government of that country; it was prone to abuse (2008). There was no unified enforcement and laws and practices were not globally or even regionally consistent. However, to quell any apprehension among those attending in Rio de Janeiro that national control over their internal affairs would be decreased, the CBD (Article 3, Preamble, unnumbered page) provided that "states have the sovereign right to exploit their own resources pursuant to their own environmental policies."

Recognizing the economic potential of bioprospecting to unfairly exploit, Article 1 of the Convention urged the promotion of "fair and equitable sharing of benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources."[168] While statements incorporated in the various documents imposed obligations on signatories regarding access to biological materials and directed that countries address the benefits of profit sharing through royalties and other instruments, few states have implemented the protocols (ICC 2008). However, as described by Laird

[167] Congressional tensions regarding takings issues were especially pronounced in the decade after the 1978 amendments to the Endangered Species Act. These required consideration of the designation of "critical habitat" for listed species. Such designations were applicable to private as well as federal lands and were viewed by many land owners as a devaluation of their property without compensation, termed "taking."
[168] To assist with generating benefit sharing initiatives, CBD parties adopted the Bonn Guidelines on Access to Genetic Resources and Fair and Equitable Sharing of the Benefits Arising out of their Utilization (Bonn Guidelines) in 2002 (see Section 5.5.1.2).

et al. (2006, 12), where CBD-negotiated benefits packages are designed they typically include monetary benefits based on a per sample basis, periodic milestone payments, and royalties on net sales and licensing agreements in addition to non-monetary benefits such as training, capacity-building, research exchanges, equipment, technology transfer, and joint publications. "Groups with the most experience in benefit-sharing generally emphasize the importance of non-monetary benefits and 'front-loading' benefit-sharing packages. Front-loading benefit-sharing packages ensures that provider countries receive a stream of benefits through the discovery and development phases, given the small odds of any one partnership yielding a commercial product and the fact that all products will not necessarily be billion-dollar 'blockbusters' generating large royalties, or that in most industries products rarely, if ever, achieve this status" (Laird, Wynberg et al. 2008, 118).

International discussions on the protection of TK, access and benefit sharing in relation to genetic resources continue, with work being conducted by the World Intellectual Property Organization (WIPO) and the World Trade Organization (WTO) in the context of the 1994 TRIPs and Article 10 of the 2001 International Treaty on Plant Genetic Resources for Food and Agriculture.[169] As their mission statement provides, WIPO was created by the UN to "promote innovation and creativity for the economic, social and cultural development of all countries, through a balanced and effective international intellectual property system" among their 185 member states (WIPO 2012). WIPO generally supports both defensive and positive protection approaches to aid in directing derived benefits to TK holders, thus avoiding having them diverted elsewhere within government. They also serve to protect and promote TK (WIPO 2009a). Such approaches are supported through instruments such as the International Patent Classification System and other Patent Cooperation Treaty Minimum Documentation requirements. Some member countries (e.g., the Republic of the Philippines) have developed legislation specifically addressing the implementation of such defenses and protections and the Philippines has implemented one of the stronger national requirements for benefit sharing when indigenous peoples hold TK.

Although the US has not ratified the agreement, it is affected by CBD's benefit-sharing protocols and policies regarding genetic resources. "The UN General Assembly and the 2002 World Summit on Sustainable Development have endorsed the CBD as the authority that will set the standards for the cross-boundary access of genetic resources" (Blaustein 2006b, 560). The competitive nature of bioprospecting, now that international standards have been/are being established with or without US ratification, forces American compliance, at least in spirit. While setting a global standard, it adds bureaucratic hurdles that may impede bioprospectors' access to many areas of the world by slowing or blocking the permitting process. This is especially true when issues of

[169] Article 10 of the International Seed Treaty states: "10.1 In their relationships with other States, the Contracting Parties recognize the sovereign rights of States over their own plant genetic resources for food and agriculture, including that the authority to determine access to those resources rests with national governments and is subject to national legislation. 10.2 In the exercise of their sovereign rights, the Contracting Parties agree to establish a multilateral system, which is efficient, effective, and transparent, both to facilitate access to plant genetic resources for food and agriculture, and to share, in a fair and equitable way, the benefits arising from the utilization of these resources, on a complementary and mutually reinforcing basis." At: http://www.ukabc.org/ITPGRe.pdf

sovereignty (e.g., border delineation disputes) and cross-border disagreements among countries are coupled with the potential for profit. As with most policy issues, it becomes a matter of balancing benefits and costs.

CBD protocols also have the potential to hinder scientific research and resulting publications. For example, should a researcher enter an area to study a plant and subsequently publish notes regarding the location, ecology, biochemical details, ethnobotanical uses or other data regarding that species there may be no immediate or traceable financial profit from that publication. However, where subsequent development of patentable products are enabled in whole or part by the publication of that research, no mechanism exists for garnering royalties. "But as indigenous peoples' groups, governments, and others seek greater control over their knowledge and resources, there is increasing pressure to limit or restrict publication of certain types of data, or at the very least [require] informed consent before doing so" (Blaustein 2006b, 563 [quoting Sarah Laird of "People and Plants International"]).

Most pertinent to bioprospecting and property rights, however, is that CBD aids in securing rights to control access to genetic resources for the countries in which those resources are located. This allows lesser-developed countries to better benefit from their resources and traditional knowledge. CBD stipulates that bioprospectors must obtain informed consent from the destination's government prior to gaining access and must share the products of their work with that country. However, CBD is weak regarding the issue of biopiracy in that it has no legal enforcement capacity. That is left to the legislatures of national and local governments.

Even with its administrative weaknesses CBD has been successful in its consideration of species and genetic resources in an ecosystem context. This marks an improvement over most other narrower conservation programs that address only selected segments of that universe (e.g., where only migratory birds, elephants, corals, cetaceans and other marine mammals are addressed or, where only specific habitat types, such as wetlands or rainforests, are considered). CBD's comprehensive approach provides a biologically sound advantage in that it tacitly acknowledges that effective conservation programs must be ecosystem based. By being inclusive, future problems that may arise in sectors other than more narrowly targeted biota or habitat can be better avoided.

Further, it recognizes the often counterproductive relationship between predominant Western approaches to conservation (e.g., systems of national and regional parks or species-specific actions) and the local cultures and economic systems that depend on them.[170]

The optimism of the CBD and the premise that bioprospecting is in need of regulatory control are not universally shared. A study funded (but not necessarily endorsed) by the

[170] Conservation efforts that have failed to gain local support have generally not been as successful in reaching goals as those that do gain local support. For example, national parks that disallow passive uses (e.g., collecting moderate amounts of wood for fuel and sustainable, small-scale agriculture) in an attempt to preserve rather than manage resources tend to be less successful and short lived.

Pharmaceuticals Research and Manufacturers of America (PhRMA, a significant pharmaceutical industry trade organization) concluded that “a lot of the focus is misplaced.[171] There have been no major, new drugs developed from bioprospecting by pharmaceutical companies in the genetic material of developing countries. There is no ‘green gold’ bonanza. Bioprospecting is falling off. There is no evidence that biopiracy is a major problem” (Bowen 2005, 12). Bowen calls for a capitalist and competitive market approach to encourage and manage bioprospecting that deemphasizes regulation by an international body, suggesting nation-by-nation regulation instead. These conclusions are in accordance with PhRMA’s stated “belief in the power of markets to best determine the value of our medicines and support for strong intellectual property protection as a necessary prerequisite for innovation” (PhRMA 2009). However, Bowen’s conclusions have been challenged: “There are about 18,000 known species of plants in India alone, medicinal implications of a large number them is still mystery. We are sitting on a mine of green gold" (Shankar 2008).[172]

Some industries engaged in bioprospecting doubt the efficacy of CBD’s protocols, stating that CBD has a largely negative effect on their use of bioresources. Cited are complex and unclear regulations, bureaucratic delays in processing applications and issuing permits, CBD’s lack of understanding business, unrealistic expectations and costs, and restriction of scientific protocols (Ten Kate and Laird 1999). More recently, however, industries are tending to view CBD more favorably, perhaps because CBD personnel have more experience and industrial representatives have a greater understanding of the requirements of the bureaucracy and its processes (Laird, Wynberg et al. 2006).

5.5.1.1 Cartagena Protocol on Biosafety

CBD was supplemented by the Cartagena Protocol on Biosafety (CPB) a year after adoption in 1992. With advances in biotechnology, the CPB recognized concern for the safety of humans and their environments when biological materials are genetically or similarly modified and moved to habitats outside their natural ranges (U S Department of Agriculture 2003). Specifically, it:

- Establishes an internet-based "Biosafety Clearing-House" to facilitate the exchange of scientific, technical, environmental, and legal information about living modified organisms;[173]
- Requires exporters to seek consent from an importing country before the first shipment of a live modified organism that is to be introduced into the environment (e.g., seeds, fish, or microbes);

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[171] PhRMA’s mission statement: “PhRMA’s mission is to conduct effective advocacy for public policies that encourage discovery of important new medicines for patients by pharmaceutical/biotechnology research companies” (http://www.phrma.org/about_phrma/)

[172] Based on casual scanning of literature originating from within the pharmaceutical and other industries, from international and regional conservation interests, from CBD and other governmental and quasi-governmental organizations, it appears that Bowen is overstating his case. If the pharmaceutical, agricultural, and industrial industries are significantly concerned about regulation of bioprospecting, it follows that they likely are demonstrating the significance of the practice to their product line and potential profits to be made.

[173] http://bch.cbd.int/

- Requires labeling of modified commodities intended for use as food or feed, or for processing, to be accompanied by documentation, and;
- Includes a statement that the agreement shall not be interpreted as implying a change in the rights and obligations of a Party under any existing international agreement, including, for example, WTO agreements.[174]

Even with the Cartagena Protocol in place, the CBD was still not effective in meeting a significant goal of the 1992 Rio conference: establishing a fair system of benefit sharing among indigenous peoples. To address this shortcoming, party nations met again in 2002 in Bonn, Germany.

5.5.1.2 The Bonn Guidelines

The purpose of CBD is, in part, to facilitate technology transfer and ease access while benefitting the primary source (e.g., indigenous cultures with TK) of a potentially patentable organism or process. By the end of the 1990s, CBD recognized that those people and cultures were not reaping the benefits originally anticipated in Rio de Janeiro1993. Accordingly, CBD created a "panel of experts" that included indigenous and local communities, nongovernmental organizations (NGOs), industry, scientific and academic institutions, and inter-governmental organizations to develop guidelines that would be provided to member governments to aid them in drafting legislative, administrative or policy measures and contractual arrangements under mutually agreed terms for access and benefit sharing. Member Parties adopted the Access to Genetic Resources and Fair and Equitable Sharing of the Benefits Arising out of their Utilization (the Bonn Guidelines) in 2002. The Guidelines resolved to develop and implement effective and innovative mechanisms to counter the destruction of biological diversity by supporting sustainable use and aiding the "custodians of this natural wealth" through the bioprospecting process (Scully 2003). Further, the Guidelines urged member governments to "guarantee" equitable benefit sharing. NGOs and conservation alliances were generally opposed to the measure because they were guidelines, not binding accords; they lacked any power of enforcement.

Simultaneously, private sector industries were benefitted by participating at Bonn, their incentive being, in part, that integration of biodiversity goals into their corporate culture aided in developing a positive brand reputation; it gave them a "green" appearance. Such recognition enhanced their competitiveness, allowed a premium on their products and supported the perception of corporate social responsibility, whether factual or not. In addition, and evidencing possible NGOs' distrust of the industries' motives and actions, businesses have tended to limit benefit sharing to non-monetary benefits, such as participation in community projects, supporting conservation and industry initiatives through provision of materials and services, personnel exchange and education, and sharing biological information (Scully 2003). By not contributing cash to more general funds that are directed by the communities, the kinds of assistance listed above allow

[174] Such a statement of limitation was likely included to assure nations (like the US) that CBD did not seek to trespass in sovereign property issues.

industries to direct and control projects to a greater extent. This may or may not provide the best benefit answering the goal of biodiversity, conservation, and just compensation.

Adding to these schisms that were exposed at Bonn, representatives of indigenous peoples maintained that they should be recognized as "rights-holders and not merely stakeholders" regarding genetic resources.[175] They referenced existing legally-binding but softly worded and unenforceable guarantees for their 'participation' in decisions regarding resource exploitation of their concern with the caveat, "wherever possible." The Bonn Guidelines had failed to provide much more than a determination that access to indigenous resources "should be" subject to their consent.

Aside from its weaknesses, the Bonn Guidelines do provide the following:

- Strengthen efforts to halt biodiversity loss;
- Improve the way foreign companies, collectors, researchers and other users gain access to valuable genetic resources in return for sharing the benefits with the countries of origin and with local and indigenous communities;
- Offer guidance on setting fair and practical conditions for users seeking genetic resources. Users must offer benefits such as profits, royalties, scientific collaboration, or training.

"Although voluntary, these new Guidelines establish generally accepted norms that promise a fairer, more collaborative approach to access and benefit-sharing as regards genetic resources" (Convention on Biodiversity 2002, 1).[176] Case studies of examples from Costa Rica, the Philippines and the US exemplify that the Bonn guidelines are flexible and allow for a range of benefit sharing options. The flexibility provided is especially beneficial in that it allows adaptation to the goals of the specific bioprospector, the local environment and the needs and resources of the people and environments it seeks to aid (Boussard and Smagadi 2006). It remains up to each member country to establish administrative procedures and regulations. Although the US has not ratified CBD it maintains control over bioprospecting activities on Federal land and receives benefits, demonstrating that national policy is generally in accordance with the CBD guidelines.

5.5.1.3 Nagoya Protocol

In 2010 additional attempts to encourage benefit sharing were made during the Conference of the Parties to the CBD. They adopted the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity (Nagoya Protocol). As CBD stated in its press release on the event, the Nagoya Protocol provided an international agreement "which aims at sharing the benefits arising from the utilization of genetic resources in a fair and equitable way, including by appropriate access to genetic resources and by

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[175] From Scully, 2008, quoting from CBD, *Report of the Ad Hoc Open-Ended Working Group on Access and Benefit Sharing* (UN Doc UNEP/CBD/COP/6/6, 2001) 30, pp. 45–46, Annex, recommendation 1

[176] Each step in the evolution of CBD has improved its efficacy and gained broader support among nations. To the best of my knowledge, however, there has not been an independent audit of the overall program.

appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding, thereby contributing to the conservation of biological diversity and the sustainable use of its components" (CBD website, undated).[177]

As of this writing, the Conference of the Parties has met 10 times, yet although "much has transpired and tremendous work done in relation to biodiversity protection, barely are there any effectively and efficiently functioning measures/regimes for access and benefit sharing" (Kamau, Fedder et al. 2010, 248). Much can be summed from the title of an article on Nagoya: "One embodiment of an endless discussion" (Aubertin and Filoche 2011). Despite language that calls for obligatory actions, benefit sharing under CBD remains fragmented, inconsistent and unenforced.

5.5.2 Bioprospecting in the global commons

While the CBD addresses bioprospecting within states' political jurisdictions it does not provide guidance related to actions within global commons. The IUCN defines global commons as "those parts of the Earth's surface beyond national jurisdictions - notably the open ocean and the living resources found there - or held in common - notably the atmosphere. The only landmass that may be regarded as part of the global commons is Antarctica…" (IUCN 1980). In the modern sense, global commons areas generally were not claimed either because they were inaccessible or because they offered no tangible asset worth the effort and cost of settlement or exploitation.[178] International waters and their floors and Antarctica provide two significant examples of how international treaties have attempted to manage biological resources and bioprospecting within these international commons. They provide useful models for crafting policies regarding bioprospecting in outer space, the ultimate commons.

5.5.2.1 International waters and the United Nations Law of the Sea Treaty

5.5.2.1.1 United Nations Law of the Sea Treaty (1982)

Prior to the last century high seas resources were limited to fisheries (include whaling).[179] Technologies required to exploit deeper seabeds did not exist. As such, the sea represented a true global commons; it was not owned beyond statutory national boundaries (generally 3 nautical miles, the horizon viewed from shore or the distance that cannon on shore could reach) and had no resident human population. In addition, it was reasonably accessible to any nation (or person) able to secure a ship. Importantly, no indigenous populations, customs, or culture had claim to TK in the context of property

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[177] http://www.cbd.int/abs/ accessed April 2012.

[178] Although the coast of the Antarctic continent was used for seasonal whaling stations in the 19^{th} and 20^{th} centuries there were no ventures inland due to the inhospitable climate and the perception that there were no resources worth the cost and effort of extraction. More modern technology now makes exploration possible.

[179] The "high seas" are all parts of the marine environment that are not included within the exclusive economic zone, in the territorial sea or in the internal waters of a State, or in the archipelagic waters of an archipelagic State (UNCLOS Article 86).

rights.[180] While customary practices have been established over past centuries through both formal and informal agreements (e.g., regarding mutual assistance during emergencies, use of shipping lanes and associated maritime etiquette, etc.), any invention and intellectual property that would be used on the high seas was not *of* the high seas.

Over the past several decades the fragility of the oceans, the decline of living resources once thought limitless and demonstrations of our ability to drastically and detrimentally alter marine environments has been increasingly recognized.[181] With the advent of greatly improved technology for fishing, recognition of the international nature of pollution and other factors the UN Convention on the Law of the Sea (UNCLOS) was drafted in 1982 and adopted in 1994. Among its purposes are both the conservation and "equitable and efficient utilization" of the oceans' resources, both living and mineral. However, rather than stressing conservation, a significant focus of the document has been maintained on freedom of the high seas and their economic exploitation (Thiel and Koslow 2001).[182] Such freedoms include navigation, laying cable and pipelines, and fishing and are regulated and governed by the laws, policies, treaties, and similar instruments specific to the nation under whose flag the vessel is sailing. Whaling, for example, is generally permissible on the high seas if sailing under a Japanese flag but not on an American ship; US laws prohibit that, not UNCLOS mandates. Fishing is administered under a myriad of individual treaties and agreements, not under the aegis of the UNCLOS.[183] It contains only the general principles listed in Article 240 which do not include restrictions on scientific research or bioprospecting on the high seas; it excludes all living marine resources living within the high seas. These resources are owned in a legal sense only after they are taken into possession. Bioprospecting is not addressed and is not prohibited, for example, at deep ocean thermal vents by any nation outside a nation's Exclusive Economic Zone (EEZ). As defined in UNCLOS Part V, Article 55: "The exclusive economic zone is an area beyond and adjacent to the territorial sea, subject to the specific legal regime established in this Part, under which the rights and jurisdiction of the coastal State and the rights and freedoms of other States are governed by the relevant provisions of this Convention." It normally extends 200 nautical miles from the shore. Within an EEZ, permission of the specific EEZ state may be required for

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[180] Areas of accessible bottom resources (e.g., shellfish, sponges) were generally confined to shallows that fell within territorial and national waters and were, therefore, under the jurisdiction of the nation claiming those waters. Modern technology, however, has enabled exploitation of deep seabeds in commons areas.

[181] Oil spills, depletion of fisheries, "ghost nets," warming, acidification, shoals of "trash" and other alterations provide examples.

[182] Beyond states' Exclusive Economic Zones (EEZ) are the "high seas" and the traditional freedoms of the high seas.

[183]Fisheries are harvested and managed based largely on where they occur, even though individual fish or schools may swim in complex patterns through international pelagic and national near shore waters, various exclusive economic zones, and other legal jurisdictions (e.g., the Western Pacific Regional Fishery Management Council). "There are varying degrees of rights and duties of states with respect to the conservation and management of fisheries resources and the factors that have to be taken into account in different regimes. However, the common basic principle of conservation and management of fisheries resources that applies in many of these regimes is that the allowable catch shall be determined and that conservation measures be adopted to maintain or restore populations of harvested species at levels which can produce maximum sustainable yield, as qualified by relevant environmental and economic factors" (FAO 2012).

bioprospecting if that state chooses to require their permission. UNCLOS has no power to require it.

UNCLOS declares that the ocean's resources are "the common heritage of all mankind, and that their exploration and exploitation shall be carried out for the benefit of humankind as a whole, irrespective of the geographical location of the States" (Preamble, UNCLOS). Yet whether or not the genetic resources sought by deep sea bioprospectors are included as "common heritage" is unclear (Diamond 2012). Herein begin the semantic problems that plague many such documents: what constitutes the "ocean" and a "living resource?" At the time of its drafting, abyssal microbial forms were not considered. Further, "living resources" were limited to mobile species (e.g., fish, cetaceans, reptiles). In theory, mobile species provided the regulatory umbrella under which other resources were to be protected. Excluded were predominantly sessile species such as shellfish. The reason for this dichotomy rests in the fact that UNCLOS applies in large part to the continental shelf and EEZ areas. Nations manage their own shellfish as they wish; if they are depleted or polluted, the loss falls predominantly to that specific nation only. Conversely, mobile species such as tuna are free to migrate through various nations' EEZs, so management of those stocks is in the interest of all fishing nations; they constitute a common resource to be managed cooperatively.[184] Deep ocean (over a kilometer, e.g.), however, offers no harvestable shellfish in this traditional sense so regulation of bottom sessile resources was omitted from the Convention (Arico and Salpin 2005).

While many unique seabed ecosystems lie outside the territorial waters or the EEZ of any state, no state or international organization has enacted measures to specifically regulate bioprospecting in international waters (Bio-Medicine undated). At the UN's 2007 annual Oceans and Law of the Sea Conference participants expressed a range of opinion on the need and advisability of addressing ocean bio-resources within the context of UNCLOS (United Nations University 2007). Although there is no specific regulation pertaining to deep seabed bioprospecting, there are other international agreements that address, in part, the issue with varying degrees of success.

5.5.2.1.2 The International Seabed Authority (ISA)

ISA was established under UNCLOS Section XI to manage seabeds within the high seas, a commons outside nations' territorial waters and EEZ termed "the Area." As of June 2012, it comprised 162 signatory parties. The US has not agreed to that Section but maintains "observer" status. As stated in Section XI, "States cannot claim or exercise sovereignty over the Area nor its resources, nor appropriate any part of the Area." However, exploitable resources regulated by the ISA are limited to those that are "solid,

[184] Similar reasoning has been applied in providing plants and animals differing degrees of protection under the U.S. Endangered Species Act where they occur on private land. A landowner is prohibited from harming an endangered animal (e.g., a spotted owl) on private land because the owl may fly to others' property or to Federal land at will. Endangered plants, however, may be harmed by that private landowner; they would not be expected to move to Federal land. The precedent was established under English common law.

liquid or gaseous mineral resources in situ in the Area at or beneath the seabed, including polymetallic nodules (e.g., manganese/cobalt)." While life forms that may be targeted by bioprospectors are not included within the definition, the ISA does provide for the "equitable sharing of financial and other economic benefits derived from activities within the Area" and offers models for how profits may be distributed to other nations. For example, although specific to mineral and not living resources, those submitting applications and a plan of work for mining authorization must identify two claim areas, two sites proposed for exploration and/or exploitation. Such applications are required to include an assessment and analysis of expected environmental impacts for each of the two sites. The ISA then has the option to select either of the two sites as the area to be explored/exploited by the permit applicant; rights to explore/exploit the other site are maintained by ISA itself if it so chooses. This "parallel system" helps to ensure an equal sharing of benefits and risks. Should the ISA lease the reserved site for exploitation at some time in the future, a percentage of the profits produced are available for benefit sharing distributions.[185]

A portion of the keynote address presented by the Secretary General of ISA at their 2008 meeting is pertinent:

> *Over the past few years the question of the management of so-called marine genetic resources has become one of the most prominent issues in the law of the sea. The issues involved are complex and multi-faceted. Although the initial concerns related to the impact on the marine environment of the recovery of genetic resources from the ocean, many other concerns have emerged as discussions on the issue have continued under the auspices of the General Assembly. Some states, especially the developing states and less technologically advanced states, are concerned about fair access to genetic resources. Others are preoccupied with the problem of sharing of the financial and other benefits derived from genetic resources, whilst some are concerned about the lack of environmental regulation of unrestrained scientific activity. It is interesting to see that some of the same ideological positions that preoccupied the Seabed Committee and the First Committee of UNCLOS III during discussion of the regime for deep seabed mining have come to the fore in recent discussions over marine genetic resources. It is to be hoped that the sort of estimates that are being placed on the potential financial rewards from the exploitation of marine genetic resources do not turn out to be as wildly optimistic as the estimates made in the 1960s and early 70s for polymetallic nodules.* (Nandan 2008, 5).

The tepid nature of this statement speaks to the general lack of enthusiasm in addressing genetic resources in the context of ownership, property rights, and benefit sharing. Whether due to the complexity of the issue or, perhaps, ISA's seeming disinterest (e.g., the Secretary General's choice of modifying his description of marine genetic resources as "so-called," while, in the same sentence, identifying it as "one of the most prominent issues" facing the law of the sea), not much progress has been made. International

[185] Tracking how funds produced by benefit sharing were distributed and used was beyond the scope of this dissertation, but it would be intriguing to see how much profit is generated, the percentage sequestered for benefit sharing programs, who receives such funds, and how it is actually employed.

agreements of this type are both complex and arduous and demonstrate that the massive and rapid inertia of technology, especially in biotechnological areas, can overwhelm the intergovernmental institutions that are designed on 1940s and 1950s models.[186] Although a need had been recognized by the CBD and LOS administrators as early as 2003, no measures specifically addressing bioprospecting undertaken outside the limits of national jurisdiction have been adopted (Arico and Salpin 2005).

Neither UNCLOS nor ISA have adequately addressed prospecting. Neither has met their goals of providing equitable benefit sharing, uniform regulation and, for UNCLOS, effective conservation and management of living resources. Given the multinational claims involved and the depth of their historical controversy it would be unrealistic to expect a higher degree of success. In designing a protocol to guide the exploitation of extraterrestrial biological finds they are most useful as precautionary models, examples of potential problems that can be avoided. A more positive model is provided by the Antarctic Treaty System.

5.5.2.1.3 Patents and intellectual property rights related to CBD and LOS

Patents have been awarded for products resulting from exploitation of deep seabed organisms and concerns have been expressed to and by CBD that unconditional use will decrease biodiversity and, importantly, result in an unequal sharing of benefits (profits) derived from a common resource. "Recent patent claims on DNA sequences found across organisms may have significant negative 'anticommons' effects on the future of agricultural research and innovation: The problem that emerges here is that if the patent application is successful anyone using the sequences, or 'substantially similar' or 'homologous' sequences for trait selection, identifying varieties, and plant breeding may run the risk of patent infringement" (Oldham and South 2004, 39). "It is essential that to ensure that the resources or organisms have been legitimately accessed and that benefits arising out of the utilization of the source genetic resources are shared between owners of the resources and users" (Arico and Salpin 2005, 42). They continue, "This is especially true for deep seabed genetic resources, the status of which as open-access or common heritage of humankind is still disputed, but the potential commercial applications of which are numerous." As stated by Oldham (39), "some resources are too important, in terms of the present and future public benefit, to be subject to strong intellectual property protection."

WIPO formed the Intergovernmental Committee on Intellectual Property and Genetic Resources, Traditional Knowledge and Folklore (IGC) in 2001 as a forum for discussion of, among other things, access to genetic resources and models for benefit sharing. A significant focus of the IGC has been to establish guidelines for the disclosure of the origins and sources of original genetic material and the legal context in which they were

[186] As described in Arico and Salpin (2005), "Outside the context of the ISA itself, it has been proposed to expand ISA's mandate to include activities related to genetic resources of the Area. While this would require amending UNCLOS and entail a time-consuming process, the advantage of such an option would be to build on an existing institutional framework and regulations addressing benefit-sharing, sustainable use as well as conservation needs."

acquired, the purpose being to monitor and better ensure legal compliance. One recommendation that has emerged is that any material collected by a bioprospector be vouchered and placed in a recognized collection, such as a national museum or research institute. The 1977 Budapest Treaty on the International Recognition of the Deposit of Microorganisms for the Purposes of Patent Procedure established a system of International Depositary Authorities (IDAs) for vouchering. This serves the patent applicant in that it provides, in part, proof of the originality of the organism or biological material on which the patent is based.[187] However, as soon as the patent application has been received, the collected item becomes public for other purposes. While this increases research potential, it can be counterproductive by discouraging collectors from making the optional deposit. Collecting the organism may have involved considerable cost and making it freely available would seem a poor business decision.

TRIPS requires member nations to provide uniform protection of intellectual property and protection for "subject matters not covered at the national level" (applies mostly to those nations that are less developed or lack the internal governmental framework to administer such a program). Pertinent to bioprospecting, TRIPS Article 27(3) excludes patentability of high taxonomic levels of plants or animals but doesn't exclude microorganisms and microbiological and non-biological processes; these are not prohibited from being patented. Accordingly, genetic resources from deep seabed organisms (e.g., from geothermal vents) are not excluded. Further, under Article 28, such patents provide the owner with essentially exclusive rights to that organism. This seems contrary to the purposes of patents, which is to encourage new uses by other parties.[188] The 40th Conference on the Law of the Sea included space-related issues on its 1998 agenda. Smith and Mazzoli wrote that the UN's Committee on the Peaceful Uses of Outer Space (COPUOS) "should take the initiative in indicating how the provisions of the Outer Space Treaty (OST) should be implemented with respect to intellectual property (IP) legislation and its use before the courts. …However, in order to be efficiently implemented into national legislations, an agreement similar to the GATT/TRIPS treaty, and its implementation mechanisms could be proposed. The provisions of the OST will only be effectively implemented with respect to IP legislation and practice when the different national legislations are modified to take the OST provisions into account and a competent judicial body is designated for enforcement of the OST" (Smith and Mazzoli 1998, 173) . Those are serious tasks to accomplish, and no such actions have been taken in the 14 years since the 40th Conference.

[187] Between 1980 and 2000, a total of 43,533 microorganisms was deposited with IDAs. The system has been critical in tracking organisms and the patents they may generate which is essential for benefit sharing protocols.

[188] I have not researched the origins of the establishment of this dichotomy of patentable life forms, separating "higher" from "lower," but it highlights that taxonomic hierarchies are human cultural constructs of perception. It creates a fertile area for creation of new problems as additional organisms are discovered. Are we to assume them "lower?" This will test some of our philosophical assumptions regarding human status.

5.5.2.2 Antarctica and the Antarctic Treaty System[189]

5.5.2.2.1 Political basis

The Antarctic continent is unique in that although it has been known to exist as a geographic feature, unlike the Arctic there is no evidence of it ever being inhabited by any indigenous population and it has never been claimed as a sovereign territory or possession in any traditional legal sense by any nation. Although first documented by Captain Cook in 1793, regular exploitation of the Antarctic fishery wasn't significant until the mid-19th century. Various nations launched a series of exploratory mapping expeditions of the interior of the continent starting in the first decades of the 20th Century. Cooperative multi-national expeditions involving over sixty countries in the 1950s, the relative scientific and diplomatic successes of the International Geophysical Year (IGY) (1957-1958), growing tensions related to the US/Soviet Union "Cold War" and fears of militarization of the continent culminated in the signing of the Antarctic Treaty (AT) in 1959 by the twelve leading participating nations; a total of forty-nine nations have now signed. As the first arms control agreement of the Cold War, the Treaty pledges, in part, that the continent "shall continue forever to be used exclusively for peaceful purposes" and guarantees access for scientific research in all territory south of 60° south latitude.

The success of the Antarctic Treaty System (ATS) over the past half century has been due in large part to the initial fear and subsequent caution that surrounded the potential acquisition of the area by any one nation or block of like-minded nations (i.e., the Soviet Union, the US and allied Western nations, or the People's Republic of China). It was drafted with great care to maintain that balance. The USSR had successfully launched Sputnik in October 1957 and the US placed Explorer 1 into orbit three months later. The timing of these two events to coincide with IGY had significant value to both nations. Under the auspices of IGY they were expressly proposed as non-military, as scientific instruments regardless of their psychological impact on Cold War relations or as significant steps toward future military hardware or intercontinental rocketry. They did not constitute an escalation of the Cold War or an action that would have justified reprisal.[190] For any single nation to gain significant control of the Antarctic Continent would have had global geopolitical repercussions during a period where maintaining balance among powers was critical. Second, the area was *terra nullius*, never (significantly) claimed by any sovereignty and never significantly used. Initial surveys had noted exploitable natural resources, but these were not immediately accessible or practical for development. As such, agreement on its future through cooperative use was possible where it was not in other inhabited or more resource-rich parts of the globe. There, centuries of human use and tradition and possible immediate economic gain made such agreements much more problematic. These same factors pertinent to Antarctica are

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[189] The Antarctic Treaty System comprises the original Antarctic Treaty and its subsequent approximately 200 related agreements.

[190] The US could have chosen to preempt Sputnik and place Explorer into orbit a year earlier. It chose not to do so because such a US launch would have been viewed by the Soviets as an aggressive act exacerbating Cold War tensions. By allowing the Soviet Union to be first to orbit a satellite and first to call it a peaceful action, the US was then able to follow and equally claim the peaceful nature of its endeavor without meaningful challenge (Dulles 1957).

applicable to the cooperative use of outer space and can guide policy on intellectual property rights.

5.5.2.2.2 Antarctic natural resources and bioprospecting

The uniqueness of Antarctica extends beyond its remoteness and relatively recent discovery and human use. First, while seasonal occupation of coastal areas by private enterprises (e.g., supporting whaling and sealing stations) has been established for nearly 200 years, there was little reason for private exploration inland. As such, the interior has only recently been a target of expeditions that are not sponsored or otherwise subsidized by nations or academic institutions. Second, the nature of harsh environmental conditions has contributed to a suite of organisms, especially microbial life, which has adapted and evolved to exploit the habitats the Antarctic offers, likely existing nowhere else on Earth. Classified as psychrophiles, many of these organisms thrive under cold conditions fatal to those favoring more temperate climes. Their unique adaptive genetic and biochemical qualities (such as low-temperature effective enzymes) make them especially desirable as potential sources of pharmacological and industrial products. "Biological prospecting for extremophiles is already occurring and is certain to accelerate in Antarctica" (Zakri and Johnston 2004, pages unnumbered).

The continent has also proven to be far more geologically diverse than originally expected. It includes active volcanic areas, oxygen-saturated freshwater lake systems kilometers beneath glacial ice that have not been exposed to the atmosphere for over 10-million years and high altitude dry-valley lakes.[191] Although the high lakes are permanently frozen on the surface, they support algal and other microbial growth in response to the small amount of solar radiation that penetrates the ice (National Research Council 2007). Deep lakes under kilometers of ice are kept liquid due to a combination of pressure and geothermal energy. Private interest is growing and expeditions funded by commercial enterprises (as opposed to governmental and private research and academic institutions) are becoming more frequent.

Given this uniqueness, the ATS established that the region should be maintained for cooperative scientific research. Article III (a-c) requires that parties to the Treaty shall exchange plans for scientific programs to permit maximum economy of and efficiency of operations; that scientific personnel shall be exchanged between expeditions and stations; and that scientific observations and results shall be exchanged and made freely available. While limited to scientific work, it is doubtful if commercial interests would not be "scientific" during initial bioprospecting phases; looking for unique organisms is scientific in nature. However, limited types of commercial actions regarding natural resources are also allowed, and many life patents have been issued from Antarctic discoveries as a result.[192,193] About 30 countries now maintain research facilities on the

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[191] The largest know subglacial water feature is Lake Vostok. Roughly the size of Lake Ontario, it lies beneath 3.6 kilometers of ice and is likely warmed by geothermal activity. Russia is completing their drilling into the lake to sample for life.

[192] AT Article II regarding the freedom of research and Article III which mandates exchange of scientific information.

continent and over 200 research organizations from 27 states are conducting research for commercial purposes, yet to date bioprospecting has had little impact on the Antarctic environment itself; sample sizes are small and prospectors are held to stringent low-environmental-impact standards.[194] Once a sample has shown potential, subsequent samples may be taken, but again, these are relatively small in volume and impact is minimal.[195] If, however, a resource was identified but could not be synthesized or farmed elsewhere, there could be a need for a greater volume of harvesting, and the impacts of such an operation on sustainability would have to be determined.

Bioprospecting is viewed by most AT administrators as being in accordance with the Treaty's purposes (UNU 2004, 2007; Antarctic and Southern Ocean Coalition 2012). But AT is insufficient in providing firm bioprospecting guidance, and lack of guidance stifles both research and business. A.H. Zakri, the Director of the United Nations University – Institute for Advanced Studies, stated:

> *The growing commercial interest in Antarctic research raises key policy, ethical and moral questions. Some of the issues that need to be addressed include: Who owns these resources? How should they be used? And how should the benefits of this research be distributed? Although some aspects of this type of use are adequately addressed by existing policies, there is uncertainty about the rules governing the use of Antarctic genetic resources outside of Antarctica. The specific arrangements examined in this report vary significantly, which is an indication of the lack of clarity in the rules. The absence of clear rules governing the use of genetic resources from Antarctica restricts use of these resources and this affects stakeholders in significant ways.* (Lohan and Johnston 2005, 5)

Christopher Joyner of Georgetown University's Institute for International Law and Politics warned of three issues that could destabilize the AT: claims by states to areas of continental shelf south of 60 degrees south latitude, whaling, and "widespread and unregulated bioprospecting" (Nature Editorial 2012).

Protocols guiding benefit sharing under the CBD and Bonn Guidelines are not overly helpful as a remedy. They were developed to protect and reward traditional "owners" and their indigenous knowledge and benefits are distributed based on the rights of those owners. There is no parallel in Antarctica (Nicol 2004).

Because there is no indigenous or other population in Antarctica or the deep seabed aside from the researchers, support personnel, visiting researchers and tourists, there is no direct claimant for benefit sharing; no indigenous culture "claims" Antarctica or deep ocean floors. Bioprospecting is described as "mostly confined to collecting … novel biological resources, thus remaining an activity that is largely scientific even if it is for

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[193] Over one-third of the patents are derived from krill.

[194] ATS began discussions of issues related to bioprospecting in 1999. The issue has received regular attention since by the Scientific Committee on Antarctic Research (SCAR), Committee for Environmental Protection (CEP) and the Antarctic Treaty Consultative Meeting (ATCM) (Lohan and Johnston 2005).

[195] This assessment of low impact would not be true with collections from very unique ecosystems that could be easily contaminated, such as Lake Vostok. Care must be taken to ensure that the integrity of the lake is not compromised through the introduction of foreign materials (pollutants) or organisms.

some ultimate commercial purpose (Lohan 2003). An argument that quickly evolves is why benefit sharing is an issue where no indigenous peoples "hold" the knowledge or otherwise aid the bioprospector. No native culture contributes to the resulting patent and, therefore, no indigenous group has a direct interest in profits generated. Such arguments have already surfaced regarding proposals for royalties on profits from extraterrestrial resources. The issue appears to hang on the question of ownership, not on discovery. If an area is truly a commons (as has been determined for Antarctica, the seabed and, as addressed shortly, outer space bodies) rather than a wilderness owned by no one, it is owned by everyone. This is a critical distinction that lies at the root of the concept of a commons in its original, centuries-old application (shared grazing and gathering areas). AT and UNCLOS/ISA are clear that the territories they manage are common to all peoples of the Earth. If the resource is owned by all, then all should share in a portion of the benefits. The question of how sharing is to be accomplished is much more difficult. Each document is relevant, but there is no single governing protocol that ensures they don't conflict.

ATS and CBD have differing standards for bioprospecting; ATS does not directly regulate bioprospecting activities, so it does not emphasize or require benefit sharing as does the CBD. Benefit sharing does occur for bioprospecting within ATS areas, but the protocols for such sharing differ with each nation that sponsors the expedition or the research. Each permit is negotiated independently, contributing to a general lack of consistency. Royalties or other benefits paid are difficult, if not impossible to track.[196]

Even with these inconsistencies, many bioprospectors seek some regulation and a requirement to pay royalties when they are acting within global commons, whether on the high seas, the seabed, or in Antarctica. Requiring royalties for such activities benefits the payer by providing a degree of *de facto* legal sufficiency of the claim. If the UN or ATS requires a royalty to be paid, regardless of the amount or to whom, it would be difficult to challenge the legitimacy of a resulting future patent.

5.5.2.2.3 Other protocols building the Antarctic Treaty System

The Antarctic Treaty was designed to meet pressing global security needs by preventing the militarization of the continent while creating a platform that would allow the emergence of cooperative projects. It was very successful. It was not originally designed to be a significant conservation tool regulating a global biological commons. Soon after the AT was ratified the integral nature of biological stability through cooperative regulation came into sharper focus. This precipitated a series of agreements among various AT parties allowable by AT's Article IX which provides the legal foundation for Antarctic administration.

- The Agreed Measures for the Conservation of Antarctic Fauna and Flora (1964) acknowledged the need for conservation of living biological resources in the form of a treaty within the AT, thus a component of the Antarctic Treaty System. It successfully established an administrative platform for initiating various programs and practices for environmental protection, transparency, information sharing, and

[196] Personal communication ATS, 2009. ATS source requested anonymity.

the role of international organizations such as the Scientific Committee on Antarctic Research (SCAR) (Jacobsson 2011).

- Convention on the Conservation of Antarctic Seals (1972) resembles a more traditional fishery conservation and management plan. It applies to all high seas areas south of 60 degrees south latitude, extending far north of the shoreline and land-based research stations. It also was the first treaty that addressed the management of a biological resource that had yet to be economically exploited. Third, there was no prohibition on parties signing the Convention to be parties to the AT, which allowed the "opening" of the system (Jacobsson 2011, 8).
- The 1982 Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) manages and conserves Antarctic marine living resources (those marine organisms other than whales and seals living south of 60^{o} south latitude -- mainly Antarctic fisheries and bycatch). It was initially established in reaction to increased pressures on krill from commercial fisheries. Although they acknowledge the difficulty in policing that expanse of open ocean, member states have the authority to enforce its provisions (CCAMLR 2012). CCAMLR is exceptional in that "when the Antarctic Treaty Consultative Parties took control of the situation and decided to tackle the question of marine living resources, they acted preemptively. Any attempts by third states to exploit marine living resources in a claimed area would most likely have disturbed peaceful Antarctic cooperation; to use the wording of the Antarctic Treaty, they would have threatened to make Antarctica a scene or object of international discord" (Jacobsson 2011, 9).
- The separate Convention on the Regulation of Antarctic Mineral Resources Activities of 1988 (CRAMRA) was adopted to regulate mining in those same latitudes up to the geographic point at which the Antarctic's continental shelf becomes deep seabed. Although it has not been implemented due to lack of support from party nations, CRAMRA is important in that it attempts to manage seabed minerals, a resource that may not exist. Like CCAMLR, it is preemptive and forward-looking. But it lacks clear provisions for how financial profits derived from mining in Antarctica might be allocated or taxed. Mining enterprises would not have been required to pay royalties or otherwise be encumbered other than by standard prohibitions on pollution and disruption of fishing stocks (Lohan 2003).
- The 1991 Madrid Protocol prohibits all forms of commercial exploitation in Antarctica except for tourism. All mineral exploitation was banned for fifty years and can only be lifted by unanimous consent of all the Consultative Parties to the Antarctic Treaty.

In sum, while there is proven value and great potential for biological discoveries in Antarctica and the waters south of 60^{o} latitude, there appears to be no provision in the Antarctic Treaty System, CCAMLR, or CRAMRA requiring payment of royalties or other benefit-sharing protocols related to bioprospecting. The Scientific Committee on Antarctic Research's Working Group on Biology noted in 2002 that "the Antarctic Treaty System might need to be extended to include regulation of bioprospecting, and indeed all the provisions of the CBD" so that there would be agreement among both the ATS and the CBD (Lohan 2003). The recommendation was not adopted.

5.5.2.3 The role of the scientist as bioprospector

As did missionaries, field biologists have a history of intentional or ignorant collusion in the expansion of empire (Brockway 1979; Crosby 1986). The botanist or other naturalist who hacked a path through the jungle in search of a rare orchid or bird often marked a trail for armies and a host of others with interests in timber, metals and other resources to follow. A more benign form continues today with scientists pursuing an elusive bacterium, only to invite the interest of prospectors of a different sort.

A problem common to regulating both bioprospecting in Antarctica and on the seabeds is that as more private and academic institutions form partnerships, the line separating research and commercial exploration blurs, making permitting and subsequent patenting especially problematic (Zakri 2004). First, it may take a decade or more before commercial products derived from the research begin to generate profits. Second, should profits be generated after such duration, the net profit due to that patent or invention is extremely difficult to calculate given the broad and often undocumented costs in its production. Third, in Antarctica, for example, linking any product to a specific bioprospecting mission or event is difficult as the ATS requires that data are freely shared not only among researchers but among the seven nations that claim territory there (plus the two states that reserve the right to claim territory in the future) and the forty-seven states that participate under the ATS.[197] Compounding this complexity is that no legal definition of bioprospecting has been agreed to under the ATS, making administration erratic (Hughes and Bridge 2010, 13). For example, should a researcher take a soil sample from nature and screen for unique organisms with the goal of securing a patent and eventual commercial production, that is clearly bioprospecting. However, if the same researcher with the same intent samples one of the thousands of soil samples already collected from Antarctica (whether her laboratory is in Antarctica or Kansas), that would likely not be considered bioprospecting. In a third case, a taxonomist working in Antarctica may be cataloging organisms he has collected from numerous ice cores that he produced. His intent has been purely academic and without expectation of profits resulting from patents. However, he discovers a unique species and passes the sample to a biochemist that recognizes that it has patenting and commercial potential. How or whether any scheme of benefit-sharing might be required for each of those scenarios is far from clear (Heidt 1998).

In addition, scientists are increasingly being expected to (obligated to) commercialize their work for the ultimate benefit of their sponsoring state or institution to aid in justifying the expense of maintaining an Antarctic presence (Hughes and Bridge 2010). Researchers may be encouraged to seek industrial partners. Holding biological samples close for possible future patenting and commercial exploitation conflicts with AT Article

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[197] The claim of territory is, however, not generally recognized by the international community (Rogan-Finnemore 2005, 199).

III's stated intent that scientific observations and results are to be freely exchanged and made available to others.

5.6 Bioprospecting and IPR in outer space

Intellectual property rights and patents in general are products of free-market capitalism implemented through political policy. In their original conception these are not necessarily counterproductive to open and fair enterprise; after all, it is a basic function of government to provide protection of private property. But over the past century they have increasingly demonstrated their potential to become tools for monopolizing information and access, antithetical to capitalism's flat playing field. While patents derived from ETBE may benefit the general population through the formulation of medicines, applications for industrial processes or other products, the standard US patenting process heavily favors the concentration of profits to a select few while indemnifying them from liabilities that are borne by the many (e.g., the "too big to fail" paradigm).

But perhaps what is most critical in arguing against exporting the rationales for life patents originating within Earth's global commons to outer space is the high probability of biochemical uniqueness of ETBE should it be found. Here on Earth, mapping a portion of the genome of a microbe discovered thriving beneath the Antarctic ice or developing an industrial process that employs an enzyme it produces are generally patentable, but in such cases one is patenting *only* one portion of one species from among hundreds of millions existing here. It is not patenting the biochemistry of DNA that is shared by all of those millions, the DNA base-pairing rules of their structure, how amino acids link to form proteins or their mechanisms of cell division. Should patenting of novel biological finds be permitted on Mars or elsewhere off of Earth there is the potential that the uniqueness of all Martian life might be collectively patentable by one legal entity (person, corporation, etc.) based only on that one specimen. By analogy, if some extraterrestrial traveler arrived on Earth and examined the DNA of one bacterium, synthesized and patented that biochemical process, it might be argued that the patent would be applicable to all life on Earth that exhibits that chemical function and structure. Such a patent could effectively block competing genetic research on all terrestrial species. Similarly, it seems likely (at least initially) that any ETBE discovered would be returned to Earth for research. As such, it would constitute a very limited resource; it may be years before there can be samples of other ETBE forms collected and returned to Earth. To allow the patenting of that initial sample could block all competing research on what would likely be the most important scientific discovery in history.

For extraterrestrial ventures, access is the primary key to exploitation (Hearsey 2008; Solomon 2008). Even if the journey is privately financed the enabling technology is a product of publicly-funded research and development.   In the comparable biomedical field, the US Treasury provided over $23-billion in Fiscal Year (FY) 2002 to support research and development (R&D) to the National Institutes of Health alone; $30-billion was budgeted in FY 2012 (American Association for the Advancement of Science 2012). For all R&D funding in FY 2002, approximately 60% was derived from Federal sources;

20% from universities; 6% from private industry; 6% from state and local governments; and the remaining 8% from other sources, including foundations and private donors (Koizumi and Turner 2003, 24). Public funding (including Federal, state, and local public sources) exceeded 66% of the total with additional public funds from universities. More in the extraterrestrial realm, NASA's Space Shuttle program and the International Space Station was/are funded nearly entirely by public funds. In the US, R&D over the past half century, launch facility construction and operation, assembly and launching of space vehicles, training, and the myriad of other requirements for the success of missions are publicly funded. Over 28,000 patents have been issued as the result of work conducted on the space vehicles, yet NASA's policy is to allow the patents to be owned by the private industries involved.[198] At a minimum, a portion of the profits must be required to be refunded to those who funded that initial investment. This strongly argues for royalties on net profits resulting from that class of IP.

To date, only launches funded by national governments have attempted to land on extraterrestrial bodies. That is rapidly changing. Most notably with the announcement of the Google X-Prize, private ventures are being encouraged to undertake expeditions independent of national sponsorship.[199] This indicates that it likely won't be long before private entities will regularly be engaged in extraterrestrial projects. While space "tourism" is an expressed goal, monetary return on the considerable investment would be required from other sources. It would be expected that bioprospecting will be a serious undertaking unless it is demonstrated early on that the areas are, and have been, lifeless.[200] As demonstrated by property rights and patenting issues and the complexity of management of biological resources found within the global commons of deep seabeds and Antarctica, it is likely that the establishment of property and patenting protocols will be compounded by any discoveries beyond Earth.

Neither bioprospecting nor questions of the legitimacy of or procedures for seeking life patents regarding ETBE is addressed in current international policy. Should such entities be discovered, however, answers will be critical to the future of both private and government-sponsored space exploration and exploitation. IPR is certainly a significant motive for private enterprise. To paraphrase Robert Richards, founder and then chief executive officer of Odyssey Moon (a competitor for the Google Lunar X Prize), "we are not investing in going there (the Moon) and returning just to claim the Prize. We have considered that patenting what life we may find there or elsewhere could be done in the same manner that allows us to patent life on Earth."[201] He anticipates that any

[198] Interview with Alex Wang of the University of Singapore, October 2011.

[199] The Google X-Prize, an open and international competition inviting any private enterprise to place a robot on the moon, travel 500 meters, and send photographs back to Earth with 90% or greater private funding, will award $30-million to the first place winner. To date, 17 consortia or enterprises have officially entered the competition. http://www.googlelunarxprize.org/lunar/about-the-prize

[200] The current presence of life on Mars is possible, but it is generally held that if it does exist it resides well below the surface where it would have access to liquid water and be shielded from damaging solar radiation. Importantly, if life existed there previously but is now extinct, there may still be patentable products that remain. Other bodies in our Solar System (e.g., the Jupiter moon Europa) may also provide conditions that would sustain life.

[201] Personal interview in 2009, Mountain View, CA.

extraterrestrial organism discovered will be patentable as a novel entity. Others argue that his optimism should be tempered with consideration of the form of life discovered (e.g., microbial as opposed to something more complex).[202] Such discrepancies exemplify the potential for problems generated by a lack of a consistent policy compounded by a diversity of assumptions among leaders in the field regarding what must, may, and cannot be done. While some existing treaties, accords, and agreements regarding exploitation of the biological and mineral resources of the global commons (notably Antarctica, the high seas and deep seabeds) have recognized the need for the regulation of life patenting and have attempted to answer calls for equitable sharing of benefits, they have met with uneven and limited success (Laird, Wynberg et al. 2006). This issue is further addressed in Chapter 6.

Consideration of the impact of intellectual property rights on extraterrestrial bioprospecting is no longer merely a philosophical thought experiment. How such rights will be applied will have a significant impact on planning space exploration in the decades to come. Prior to any commercial activity, initial academic research on the Moon, Mars and asteroids will have a direct influence on their subsequent exploitation (which is the overriding motivation for extending human presence to those areas), so the issue begs resolution well before patent applications are submitted.

A significant theme of this dissertation is to not waste that opportunity to re-question and re-invent. IP and the patenting process, like our relationships with life, are tightly bound to utilitarian and commercial interests. Even the threat of novelty shakes that structure, especially regarding concepts of ownership and the rights (and profits) they ensure (Halbert 2005). Space provides a rare opportunity to design a new protocol for relationships with otherwise patentable life that is not based on property and the rights and privileges of ownership.

5.7 Conclusion

The culture of allowing the patenting of life disregards the fact that each unit of life, here as species or bacteria, ignores the holistic nature of life itself. Species do not exist as singular units, as argued in Chapters 2 and 3, but as a continuum. Ecological webs cannot be maintained if managed as a series of discrete parts. As such, great care should be taken in how we philosophically approach the "ownership" of those units, or if ownership is appropriate at all.

Where addressed, each of the protocols outlined has specific strengths and weaknesses in recognizing the need for conservation and management of biological resources and in that the role of bioprospecting and IP rights granted through the patenting process is an established and legitimate method for securing commercial value. Not all would agree to that legitimacy. Many argue that the procedures lack ethical foundations, especially in consideration of biopiracy as a tool for outright theft of knowledge constituting a modern form of colonization (Shiva, Holla-Bhar et al. 2002). That aside, CBD, UNCLOS, ISA

[202] Interviews with George Alexander (attorney, San Jose), Jeffrey Nosanov (space law attorney, NASA) and Kevin Hill (life patent specialist, USPO).

and ATS demonstrate that existing systems of IP applied within international commons function best where there is broad international support, as would be expected. They are weakest where overlapping jurisdictions among the various protocols conflict, leaving gaps such as the management of seabed mineral mining without consideration of seabed biota, CCAMLR's founding concern for krill and other fisheries management but exempting management of the whales who depend on krill for their existence, and numerous other conflicts that largely result from individual state's cultural and economic priorities and biases. Such conflicts create opportunities for inappropriate exploitation of the resource and circumvention of required equitable reimbursement, where applicable, to those who may be considered the rightful (though possibly not legal from an IP perspective) owners of the property or knowledge.

Shortcomings in the drafting, application and management of international patenting and property rights protocols provide opportunities for developing more efficient instruments regarding extraterrestrial finds. Several suggestions for such improvements follow:

1. As demonstrated by the administrative problems resulting from the exclusion of deep ocean microbes within the definition of "living resources" in UNCLOS, it may be preferable to consider that *any* biological entity can be a member of the protected class. Taxonomic classifications are fluid, and even for well-described species with millennia-old relationships with humans, hierarchies are constantly challenged. As the ability to detect and recognize novel life forms is improved by advancing technology and as our reach to new environments (not only on Earth but elsewhere) expands, regulations, treaties and similar instruments should remain as adaptive as possible.

2. The International Seabed Authority, while not specifically charged with managing living resources or regulating bioprospecting, does provide for the "equitable sharing of financial and other economic benefits derived from" enterprises in the global commons. As such, it may provide a model for distribution and allocation of a portion of the profits from bioprospecting ventures in other commons, global as well as extraterrestrial. The parallel system established by ISA provides a possibly workable solution (the applicant identifies two areas for exploration/exploitation, and ISA chooses which one will be allowed to be used by the applicant; the other remains in "trust" for preservation or future exploitation as a revenue generator to finance conservation actions or be distributed to "humanity," however defined).

3. As developed by the WIPO's Intergovernmental Committee on Intellectual Property and Genetic Resources, Traditional Knowledge and Folklore, any living entity or biological material collected is required to be publicly vouchered and deposited in a public institution, such as a museum collection or public research facility. This does not imply free public access, but does require that the specimen or material be available for *bona fide* scientific research as opposed to sequestration at a private facility which may not allow such access. This seems an efficient, equitable, and totally appropriate requirement for extraterrestrial materials as well.

4. A common impediment to effective implementation of all of the treaties considered is overlapping and competing jurisdictions and protocols. Limiting the number of regulatory bodies is essential. An umbrella, such as the Outer Space Treaty or its equivalent, should maintain a position of dominance in a hierarchy of other specialized agreements, but subsidiary agreements must be drafted to be in accordance with those that predate them. This mimics the Antarctic Treaty's relationship to the Antarctic Treaty System. It appears intuitive that we avoid exporting conflicting IP protocols to outer space; they have caused enough problems here on Earth (Scuderi 1989; Balsano 1995). Should calls for the harmonization of laws, procedures and guiding regulations for space-related IP prove successful in that context, perhaps they can be applied to terrestrial issues as well.

5. The high seas, oceanic seabeds, and Antarctica have a commonality in that none is usually considered an indigenous cultural resource or is associated with a specific culture. While there are certainly prerequisite administrative requirements, a bioprospector does not have to seek the concurrence or consent of any culture prior to exploring or exploiting Antarctica as may be required for work in a remote but inhabited section of the Amazon Basin. Extraterrestrial bodies, such as the Moon, however, while far more remote than any part of Antarctica or the seabed may have a stronger cultural component. It is significant in many religions and other cultural contexts. Would (or should) potential future lunar bioprospectors need to seek the approval and informed consent of indigenous leaders prior to work there?

6. The standards of the nation providing the site of launching space vehicles and their return govern, to a large extent, the set of regulations that apply to that flight. While there are international regulations (UN charter), these are vague and unenforceable. With the entry of private enterprise into space exploration, launch sites in lesser developed and perhaps more administratively lenient countries may be both economically (e.g., cheaper labor and land) and physically desirable.[203] Similarly, launches from floating platforms on the high seas are a possibility. As such, protocols for determining the national jurisdiction and ownership of any patents derived from such missions need to be defined.

7. The Antarctic Treaty System has been deemed an excellent model for administration and governance of an extraterrestrial body such as the Moon or Mars (Andersen, McKay et al. 1990). However, such comparisons maintain a focus on management of an international group of collaborating scientists, engineers, and other professions in a harsh environment that requires close coordination and mutual cooperation. While conditions on Mars will also require similar management and collaboration, especially initially, more exploitive industries may soon begin to compete in the quest for resources and exclusive rights via intellectual property.

8. While most models of intellectual property rights applied to Earth's global commons appear to be fraught with contradiction and lack clarity, there is no need to duplicate those errors. In many ways, administering an intellectual property patent program

[203] E.g., equatorial launch sites are preferred due to the decreased energy (thus cost) required to reach orbital altitude or escape altitudes.

regarding biological entities off of Earth may be far simpler. First, the burden of hundreds of years of conflicting geopolitical approaches to patenting need not be perpetuated; the issue of overlapping legal systems can be avoided if there is one over-arching governance system. Second, concerns regarding traditional knowledge are easily dismissed; no human knowledge of the biota of extraterrestrial worlds exists and informed consent would obviously not be an issue.[204] Third, there will be no difficulty in proving novelty and the lack of prior art. The patent application will be uncluttered in that regard. Remaining, however, are how or if royalties on profits should be distributed.

A high degree of caution and challenge should be leveled against a defense of extraterrestrial bioprospecting if the goal is cast as something akin to breakthrough drugs or processes to reduce human suffering, for medicines and treatments. Millions die every year as a result of starvation, the lack of preexisting treatments, poor sanitation, limited access to safe potable water, and lack of shelter not to mention deaths due to violence. No amount of "space age" biomedical wonders will address these products of poverty and social strife. It is impossible to predict what the potential biomedical benefits of an ETBE find may be, but explorations in such exotic areas may produce only highly esoteric health-related products, if any at all, given the probable alien nature of the foundations of an alien biology and resulting incompatibilities with terran life. Perhaps a greater degree of hope would be given to industrial and engineering types of applications, but human health is an unlikely to directly benefit. Human health does have, however, considerable cachet when "selling" any government-sponsored program and space exploration is no exception. In concept it appears to be a universal (well, at least global) good benefiting all humans, not just a select few industrialists and their investors. In practice it may be quite limited. In addition, if patented, there is no overwhelming reason to believe that the biological find would be treated in a different economic way than those derived from Earth's biota. Like Henrietta Lacks' HeLa genes, it would likely be held close for use only in developing products with a high profit potential (Thieman and Palladino 2004; Skloot 2010).

[204] It is interesting to speculate how long humans may be resident on an extraterrestrial body (Mars, for example) before adopting a living Martian entity, even if on a microbial scale, into their culture. Prisoners on Earth have been known to adopt insects or even plants as pets and have become emotionally attached to them. One can imagine a point where bioprospecting Martian microbes may be considered a cultural affront to humans who share Mars with those entities.

CHAPTER 6
APPLYING BIOPROSPECTING, INTELLECTUAL PROPERTY RIGHTS and CONCEPTS OF THE COMMONS TO EXTRATERRESTRIAL RESOURCES

> *The world is nearly all parceled out, and what there is left of it is being divided up, conquered, and colonized. To think of these stars that you see overhead at night, these vast worlds which we can never reach. I would annex the planets if I could; I often think of that. It makes me sad to see them so clear and yet so far.*
>
> Cecil Rhodes (1902)

> *Freedom in a commons brings ruin to all.*
>
> Garrett Hardin - *The Tragedy of the Commons* (1968)

6.1 Premise

The Convention on Biological Diversity, the Law of the Sea Treaty and even the Antarctic Treaty System were considered nontraditional and, perhaps, radical when first conceived. Certainly, some nations still believe them to be an unreasonable hindrance to conventional commercial development within a capitalist free-enterprise context (e.g., the US has not ratified the Convention on Biological Diversity or portions of the Law of the Sea Treaty). However, while they may have originally been viewed as overreaching they are now generally accepted by over 100 nations. Their regulations and bureaucratic requirements have become routine with time and familiarity. Many would likely agree that the effort and expense of protecting resources of the global commons, especially the biological ones, are worthwhile regardless of whether the political instruments attempting to do so are the most efficient and fair for reaching those goals. Growing acceptance has also paralleled an increasing understanding that the Earth's environment is finite; human actions can adversely affect the global environment in significant, perhaps even catastrophic ways not believed possible only a few decades ago. However, many still do not believe we have the power to radically change the living environment of our planet, much less those of other worlds.

The two most significant treaties regarding the exploration and use of outer space have relied heavily on agreements here on Earth, most notably the Antarctic Treaty (AT) and the Law of the Sea. Yet potential extraterrestrial biological resources have not been addressed within any treaty framework. Our concept of the commons that helped shape AT and LOS now includes outer space, perhaps the ultimate commons in that it is boundless and, until recently, unaffected by human activity. It generally represents *terra nullius*, claimed by no sovereign and owned by no one.[205] However, if the outer space

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[205] The term *terra nullius* from Roman law refers to land that is owned by no person or claimed by any sovereign nation. Significant in its original meaning, the concept of "person" was limited, allowing areas where barbarians lived without formal land ownership customs to be considered *terra nullius* and, therefore, available for acquisition. In its more modern usage it refers to land that either has never been claimed by any sovereign state or where claim has been formally relinquished or abandoned. The modifier

commons is considered to be owned by no one, how might our approach to patenting ETBE differ from a consideration that it is the property of everyone, that it represents the "common heritage of mankind" described in CBD and LOS? Are concepts of ownership in that context appropriate or are they to be avoided? Are other options to ownership available?

6.2 Avoiding the tragedy of the outer space commons

With the earliest of orbiting space launches and the development of more advanced nuclear weapons in the 1950s the US and USSR recognized that outer space commons were threatened with militarization and exploitation. Both states expressed that a treaty or similar agreement regarding space was required. In his address to the UN in 1960, President Eisenhower specifically proposed that treaties guiding activities in outer space be modeled after the AT that had been signed just one year before. Although AT was new and relatively untested, the agreement that the US and USSR had signed provided a sound foundation for building space cooperation. Options for cooperation in the Antarctic other than a UN treaty open to all states had been considered, including having the treaty parties limited to only those states that were able to mass a significant presence in Antarctica and that the treaty or agreement exist among the signatories only, not under the umbrella of the UN. Had that been the chosen path it is possible that states other than the initial dozen may have been blocked from gaining access to the continent (Hanessian 1960). Similarly, had those drafting the 1967 Outer Space Treaty[206] (OST) chosen a similar approach, the US (and close allies such as Great Britain) and the states of the former Soviet Union may have had near-exclusive domination of outer space today, predictably working against international cooperation, open access and consistency.[207] A treaty among only two predominant parties is often more fragile and ephemeral than a treaty among many.

Progress in the technology of space flight has been punctuated over the past half century, but the long-term trend has been relatively steady. Launches have grown to be routine (launches of smaller payloads to position satellites, for example, are no longer significant news events). National programs within spacefaring nations (most notably the US and Russia) have plans well into the future timed more to availability of funds and engineering concerns than on international political appropriateness. The number of nations with active space programs has also grown to include China, India, Japan and consortia of states such as the European Space Agency (ESA). Missions returning humans to the Moon or venturing to Mars and beyond within the next few decades are likely, and China has announced that they plan to alleviate the pressures of their population through space colonization (Cooper 2003, 115). With the recent advent of successful private space ventures (such as Virgin Galactic's sub-orbital vehicles and the

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"generally" is inserted regarding Antarctica in that sovereign claims existing prior to AT remain, but no new claims or expansion of existing territories are permitted by AT.

[206] Formally, the "Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies" it is commonly shortened to the Outer Space Treaty or simply abbreviated OST. Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205.

[207] OST is administered by the United Nations Office for Outer Space Affairs. As such, it provides the basis for "international space law" (UNOOSA 2008).

servicing of the International Space Station by SpaceX's Dragon capsule in 2012) and economic incentives such as the Google Lunar X-Prize it is also likely that space exploration will be corporate- as well as state-sponsored. Unless there is a significant downturn in the US economy or some other unforeseen influence, US activities in space (as measured by the total number of US launches, exclusive of satellite launches) will not be likely to decrease over the coming two decades (US FAA 2011; US FAA 2012 [in draft]). When non-US launches (e.g., Chinese launches) are included, the total number will likely increase during that period.

6.3 Outer Space Treaty and Moon Agreement

6.3.1 Regarding real property

Presently, most concur that outer space and the planets, moons, and asteroids it contains represent a form of commons. As OST's Article II states, "Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means." However, various entrepreneurs and others interpret OST as silent regarding private ownership of real property and argue that the Treaty specifically prohibits sovereign claims only; private acquisition is not blocked (Hearsey 2008; Reynolds 2008; Wasser and Jobes 2008; Pop 2009).[208] Although "deeds" to real property on the Moon and other celestial bodies have been sold, these are held to be mostly novelties; they have never been endorsed in any court.[209] Still others argue that possession of areas such as Mars will be the key to ownership, and that those in possession can quickly form their own government and issue deeds (Joseph 2010). There is also the position that OST permits "functional" real property distinguishable from deeded real property. Under the concept of functional property a sovereign may *control* but does not own the land on which it builds or lands within a defined, occupied and used compound. This would not infer territorial sovereignty in any form in that no title would be provided, but would allow for their management (Dalton 2010). As we move from state-sponsored to private space ventures and commercialization, resolution of property issues becomes critical. Ownership of personal property, such as mined ores, is of great concern to private industries looking to space and the costs and liabilities it incurs. Legal and policy ambiguities are a disincentive to private investment (Cooper 2003; Hertzfeld and von der Dunk 2005).

Compounding this issue of interpretation is the second of the two overarching space treaties, the 1979 Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (the Moon Agreement), which applies to the Earth's Moon and all bodies in our Solar System except the Earth itself.[210] Placed in its final form a decade

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[208] The position of *expressio unis est exclusio* which holds that if a document does not expressly forbid or otherwise prohibit something, that action is permissible under that document.

[209] www.lunarembassy.com will sell you acreage on the Moon (higher prices for the "bright side" with a view of Earth. They are self-described as "The largest organization of space enthusiasts worldwide, and the official founders and leader of the extraterrestrial real estate market." There is also a registry maintained for ownership claims of asteroids.

[210] The Moon Treaty (also referred to as the Moon Agreement) was developed by the UN Committee on the Peaceful Uses of Outer Space (COPUOS). It entered into force in 1984.

after humans first landed on the Moon, Article 11 of the Moon Agreement is similar to OST in stating, “the Moon is not subject to national appropriation by any claim of sovereignty, by means of use or occupation, or by any other means.” But, it continues, “Neither the surface nor the subsurface of the Moon, nor any part thereof or natural resources in place, shall become property of any State, international intergovernmental or non-governmental organization, national organization or non-governmental entity or of any natural person.”[211] Intent here is clear, that “natural resources in place” and the land itself shall not become property. However, while OST was ratified by 100 nations, including all spacefaring nations, the Moon Agreement has been ratified by only 17, none of which are spacefaring, making it inconsequential from a regulatory standpoint. It is considered by many to be a failed international law that will have little relevance to space activities until tested in court by an attempt at a property claim (Listner 2012). While the Moon Agreement’s stated purpose is to place the governance of *all* heavenly bodies within Earth’s international community, its greater purpose is to reduce the potential for the Moon to generate international conflict.[212]

The legal aspects of ownership of real or any other kind of property are, in large part, metered through legislative, administrative, and customary law. When OST was signed in 1967 no extraterrestrial property of any kind had yet been collected and no attempts to claim territory had been initiated, so its provisions regarding issues of ownership were untested. Camps of thought regarding interpretation of OST, especially regarding Article II, became entrenched but remain academic and theoretical; they are legally untested. The UN holds that private appropriation of real property is not allowed in that Article VI is clear in its intent: “States bear international responsibility for national activities in outer space, including the Moon and other celestial bodies, whether such activities are carried on by governmental agencies or by *non-governmental entities*” (emphasis added). As private actors are governed by the specific states they cannot act independently of those states. It follows that private enterprises, under the laws of their respective states, cannot appropriate extraterritorial real property. In 2004 the International Institute for Space Law was clear in their endorsement of this conclusion:

> *Since there is no territorial jurisdiction in outer space or on celestial bodies, there can be no private ownership of parts thereof, as this would presuppose the existence of a territorial sovereign competent to confer such titles of ownership. The current international legal regime is binding both on States and, through the precise wording of Article VI of the Outer Space Treaty of 1967, which has been ratified by 100 countries, including all the space-faring countries, also on non-governmental entities, i.e. individuals, legal persons and private companies. The clear goal of such a regime is to preserve outer space, including the Moon and other celestial bodies, for the exploration and use of all mankind, not only for those States and private enterprises that are capable of doing so at any particular time.* (2004, pages unnumbered)

[211] Full text of both the OST and Moon Agreement are available at: http://www.unoosa.org/pdf/publications/STSPACE11E.pdf

[212] Some alien cultures may be surprised by this claim of putting governance of the universe under Earth’s jurisdiction.

Others are vocal in disagreement, especially those with more libertarian perspectives such as Rand Simberg (Competitive Enterprise Institute) and Alan Wasser (Chair of the Space Settlement Institute). Notwithstanding OST Article VI, Simberg, Wasser and others hold that development and exploitation will not occur *unless* private property rights are extended. They argue that there must be a guarantee that private investors in space projects will "own" their profits, and extraterrestrial land development, including resource extraction, is both too costly and too risky for any reasonable developer to proceed without the guarantee afforded by a deed or similar instrument of ownership (Wasser and Jobes 2008; Simberg 2012). They argue that the reinvested profits and subsequent growth of space-related industries will create wealth, enter the economy and "raise all boats." Many within this camp also consider such "trickle down" as fulfillment of claims that extraterrestrial resources are the common heritage of mankind and deserving of benefit sharing.

A third perspective on real property ownership places extraterrestrial places within trusteeships that exist apart from government or private control. This option is supported and discussed in Chapter 9.

6.3.2 Regarding the disposition of extraterrestrial mineral resources

Pertinent to mineral resources and issues of their ownership, OST is vague in referring to the "use" of the Moon and outer space in general and only stipulates that it be for peaceful purposes. "Use" of resources *in situ* or their removal (e.g., transport back to the Earth) is not prohibited, other conditions being met.[213] OST prohibits many military uses of resources. However, OST Article I is also clear that such exploration and use of space shall be for the benefit and interests of all countries. There is no consensus among OST parties regarding protocols for how minerals could be mined.

Article 6 of the Moon Agreement states (in part): "In carrying out scientific investigations and in furtherance of the provisions of this Agreement, the States Parties shall have the right to collect on and remove from the moon samples of its mineral and other substances. Such samples shall remain at the disposal of those States Parties which caused them to be collected and may be used by them for scientific purposes." It is clear that this was not intended to permit, for example, larger scale mineral mining activities or other industrial or commercial enterprises. Bolstering Simberg et al., without the security provided by an established legal framework, "nations or private entities might well be reluctant to commit the very substantial money, effort, and resources necessary to mine, process and transport the broad-scale terrestrial use of (mineral resources) sufficient to support the broad-scale terrestrial use (of those resources)" (Bilder 2009, 248).[214] However, the Moon Agreement's prohibitions are temporary and allow for the future design of regulations regarding such enterprises.

[213] I.e., in accordance with other restrictions, such as no nuclear weaponry, pollution protocols, etc.
[214] Bilder's paper provides a legal analysis of mining He-3 (an isotope of helium which can be used a nuclear fuel, very rare on Earth but found on the Moon in significant quantities), but the exact mineral is inconsequential to OST and Moon Agreement treatment of extraterrestrial mineral resources.

Both OST and the Moon Agreement recognize that extraterrestrial resources form a commons expressed as “the province of all mankind.”

Article I of the OST states:

> *The exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind.*
>
> *Outer space, including the moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies.*
>
> *There shall be freedom of scientific investigation in outer space, including the moon and other celestial bodies, and States shall facilitate and encourage international co-operation in such investigation.*

The preamble to the Moon Agreement states (in part):

> *Bearing in mind the benefits which may be derived from the exploitation of the natural resources of the moon and other celestial bodies…*

Article 4 continues, (in part):

> *The exploration and use of the moon shall be the province of all mankind and shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development. Due regard shall be paid to the interests of present and future generations as well as to the need to promote higher standards of living and conditions of economic and social progress and development in accordance with the Charter of the United Nations.*

Article 11 continues, (in part):

> *1. The Moon and its natural resources are the common heritage of mankind, which finds its expression in the provisions of this Agreement and in particular in paragraph 5 of this article.*
> *2. The Moon is not subject to national appropriation by any claim of sovereignty, by means of use or occupation, or by any other means.*
> *3. Neither the surface nor the subsurface of the Moon, nor any part thereof or natural resources in place, shall become property of any State, national organization or nongovernmental entity or of any natural person. The placement of personnel, space vehicles, equipment, facilities, stations and installations on or below the surface of the Moon, including structures connected with its surface or subsurface, shall not create a right of ownership over the surface or the subsurface of the Moon or any areas thereof.*
> *4. States Parties have the right to exploration and use of the moon without discrimination of any kind, on a basis of equality and in accordance with international law and the terms of this Agreement.*

5. States Parties to this Agreement hereby undertake to establish an international regime, including appropriate procedures, to govern the exploitation of the natural resources of the moon as such exploitation is about to become feasible. This provision shall be implemented in accordance with article 18 of this Agreement.
6. In order to facilitate the establishment of the international regime referred to in paragraph 5 of this article, States Parties shall inform the (UN) as well as the public and the international scientific community, to the greatest extent feasible and practicable, of any natural resources they may discover on the moon.
7. The main purposes of the international regime to be established shall include:
(a) The orderly and safe development of the natural resources of the moon;
(b) The rational management of those resources;
(c) The expansion of opportunities in the use of those resources;
(d) An equitable sharing by all States Parties in the benefits derived from those resources, whereby the interests and needs of the developing countries as well as the efforts of those countries which have contributed either directly or indirectly to the exploration of the moon, shall be given special consideration.
8. All the activities with respect to the natural resources of the moon shall be carried out in a manner compatible with the purposes specified in paragraph 7 of this article and the provisions of article 6, paragraph 2, of this Agreement" (which allows the collection and removal of samples from the Moon of minerals and other substances).

It is important to recall that in referencing the Moon, Article 1 states, "the provisions of this Agreement relating to the moon shall also apply to other celestial bodies within the solar system, other than the earth, except in so far as specific legal norms enter into force with respect to any of these celestial bodies."

Article 6(2) of the Moon Agreement, which is referenced in Article 11 (8), provides:

In carrying out scientific investigations and in furtherance of the provisions of this Agreement, the States Parties shall have the right to collect on and remove from the Moon samples of its minerals and other substances. Such samples shall remain at the disposal of those States Parties which caused them to be collected and may be used by them for scientific purposes. States Parties shall have regard to the desirability of making a portion of such samples available to other interested States Parties and the international scientific community for scientific investigation. States Parties may in the course of scientific investigations also use mineral and other substances of the Moon in quantities appropriate for the support of their missions.

While true that neither the US nor any other spacefaring nation signed the Moon Agreement, it does exist; it is a *bona fide* international agreement under the auspices of the UN. That alone gives it a degree of stature that demands recognition. Although it has no enforcement provision over either signatory parties or non- and is not binding in any legal sense, it will continue to be referenced as the increasing number of spacefaring nations tests the Treaty's limits.

The Moon Agreement mimics many of the tenets of the UN Convention on the Law of the Sea (UNCLOS), especially portions related to UNCLOS Section XI pertaining to deep seabed mineral exploration and exploitation. Like Section XI, the Treaty requires "that an international body administer any proposal for mineral exploration or extraction; That any state that collects any samples while conducting research make a portion of those samples available to all countries and scientific communities for study; and That the environment of celestial bodies not be altered." The US signed, but did not ratify, the Convention on Biological Diversity and did not agree to UNCLOS Section XI regarding the establishment of the International Seabed Authority in part due to perceived encumbrances placed on private enterprise. Both require, to some degree, benefit sharing and increased international oversight. Likewise, the US did not sign the Moon Agreement.

Debates at the Third UN Law of the Sea Conference regarding Section XI (which facilitated the flow of benefits largely from developed, seabed-mineral-exploiting states to lesser developed states under the auspices of the International Seabed Authority) and arguments regarding drafts of the Moon Agreement (which called for similar disbursements of extraterrestrial resources) were contemporaneous. Among the Reagan Administration's (1981-1989) official comments regarding the US decision to not agree to Section XI were opposition to "stipulations relating to mandatory transfer of private technology and the possibility of national liberation movements sharing in benefits" (Reagan 1982). "The U.N.'s Moon Agreement, which is technically in force, mimics the LOST's (Law of the Sea Treaty) common heritage rhetoric, but establishes no institutional regulatory framework. Subjecting private space exploration and development to a LOST-like system would discourage private ventures" (Bandow 2007, 13). "Its lack of acceptance is evidence that either many states saw the *Moon* Agreement as repetitive of the *Outer Space Treaty* or that they did not agree with the stronger emphasis on the common heritage of all mankind" (Dalton 2010, 10).

The Reagan Administration's position remained during the administration of President George H.W. Bush (1989-1993). The Democratic Clinton Administration (1993-2001) attempted to reverse the US decision regarding the rejection of portions of LOS/ISA but was unable to do so due to objections from the predominantly Republican Congress. In 2009, Secretary of State Hillary Rodham Clinton stated that the US is "committed" to ratifying LOS in the Obama Administration's efforts to decrease the impact of global climate change in the Arctic (Clinton 2009). As of August 1, 2012, however, that reversal of US position has not occurred and would not be expected given the current (2012) realities of a Republican-controlled House of Representatives.

6.3.3 Regarding extraterrestrial bioprospecting

Both OST and the Moon Agreement call for recognition that the resources of the Moon and other extraterrestrial bodies are to benefit all regardless of which state is sponsoring exploration. The UN General Assembly reiterated their position in 1996 with the Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries (UN 1996). Although it has no enforcement capability and no specific formulae for benefit distribution were provided, the declaration's title makes its intent clear.

While the UN has issued guidelines regarding forward and backward biological contamination, no position regarding the exploration for or disposition of extraterrestrial biological entities has been provided.[215] Treaties have focused on issues of territorial claims and, to a limited extent, mineral resources. But the documents provide guidance applicable to ETBE in that they would be considered natural, although likely not mineral, resources.

6.3.3.1 Bioprospecting and the Outer Space Treaty

Portions of OST are applicable to bioprospecting for ETBE although mineral exploration, not life, was clearly the focus:
1. As one of its purposes, international cooperation in the scientific exploration and use of space;
2. Article I, freedom of scientific investigation;
3. Article III, promotion of international cooperation;
4. Article XI, states parties "conducting activities in outer space, including the Moon and other celestial bodies, agree to inform the Secretary-General of the United Nations as well as the public and the international scientific community to the greatest extent feasible and practicable, of the nature, conduct, locations and results of such activities. On receiving the said information, the Secretary-General of the United Nations should be prepared to disseminate it immediately and effectively."

A conservative reading of these statements, especially those contained in Article XI, allows for the scientific investigation of ETBE (classed as "activities in outer space") along with other scientific pursuits. Requirements that the results of such studies be reported promptly to the UN may be problematic for the bioprospector, especially in consideration that the UN would, in turn, make such information, including the location of the find, broadly available. Because the OST ensures equal access to all extraterrestrial locations and does not allow the establishment of restricted access territories without the consent of the parties, those making the discovery would quickly lose a degree of commercial advantage. (However, given the remote nature of the Moon or Mars, it is doubtful that someone could make the trip unnoticed, as they might with a find in Brazil.)

[215] Forward contamination is the inadvertent transporting of organisms from Earth to extraterrestrial bodies. Backward contamination is the inadvertent transporting of extraterrestrial organisms to Earth. Article IX requires, in part, that "States Parties to the Treaty shall pursue studies of outer space, including the Moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose."

Regarding the 40th Conference on the Law of the Sea, which included space-related issues on its 1998 agenda, Smith and Mazzoli wrote that the UN's Committee on the Peaceful Uses of Outer Space (COPUOS),

> *should take the initiative in indicating how the provisions of the Outer Space Treaty (OST) should be implemented with respect to intellectual property (IP) legislation and its use before the courts. …However, in order to be efficiently implemented into national legislations, an agreement similar to the GATT/TRIPS treaty, and its implementation mechanisms could be proposed. The provisions of the OST will only be effectively implemented with respect to IP legislation and practice when the different national legislations are modified to take the OST provisions into account and a competent judicial body is designated for enforcement of the OST.* (Smith and Mazzoli 1998, 174)

Those are serious tasks to accomplish, and no such actions have been taken in the 14 years since the 40th Conference.

6.3.3.2 Bioprospecting and the Moon Agreement

1. In the preamble, *<u>Bearing in mind</u> the benefits which may be derived from the exploitation of the natural resources of the Moon and other celestial bodies* (emphasis as in original). (Note: The Moon Agreement is not limited to the Moon only; all references to the Moon also include other celestial bodies other than Earth within the Solar System.)
   Comment: Exploitation is explicitly acknowledged.

2. Article 4, *The exploration and use of the Moon shall be the province of all mankind and shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development. Due regard shall be paid to the interests of present and future generations as well as to the need to promote higher standards of living and conditions of economic and social progress and development in accordance with the Charter of the United Nations.*
   Comment: The Moon Agreement more closely resembles directives expressed in the Convention on Biological Diversity where benefit sharing is required. It also introduces the concept of future generations as beneficiaries. In the context of exploitation of ETBE, the intent was that a portion of profits so derived would be partitioned for the "interests of all countries."

3. Article 5, Information *on the results of each mission, including scientific results, shall be furnished upon completion of the mission.*
   Comment: Here, as with Article XI of the OST, the Moon Agreement requires the results of scientific investigations to be provided to the UN.

4. Article 6, *In carrying out scientific investigations and in furtherance of the provisions of this Agreement, the States Parties shall have the right to collect and remove from the Moon samples of its mineral and other substances. Such samples shall remain at the disposal of those States Parties which caused them to be collected and may be used by*

them for scientific purposes. States Parties shall have regard to the desirability of making a portion of such samples available to other interested States Parties and the international scientific community for scientific investigation. States Parties may in the course of scientific investigations also use mineral and other substances of the Moon in quantities appropriate for the support of their missions.

Comment: "And other substances" does not expressly exclude samples of biological interest, and other than biological samples there are few extraterrestrial substances other than minerals, gases and other compounds that could be collected. The Article also clearly allows that the samples constitute property of the state doing the sampling and not the UN or other Treaty parties. How the state would determine ownership (i.e., property of the state or property of a non-state actor) is not addressed. There is also no requirement for the discovering state to share the find with other parties to the Treaty.

Comment: While limited to scientific investigations and sample amounts that infer small quantities, collection of biological finds would most likely easily qualify; commercial mining operations would likely not. Bioprospecting on Earth has demonstrated that while many samples from various locations may be required, very small volumes of each are usually sufficient. It is notable, however, that what one state would deem commercial exploitation of a resource may be considered by another as "scientific" sampling, as evidenced by Japanese whaling.

5. Article 7, *In exploring and using the Moon, States Parties shall take measures to prevent the disruption of the existing balance of its environment, whether by introducing adverse changes in that environment, by its harmful contamination through the introduction of extra-environmental matter or otherwise.*

States Parties shall report to other States Parties and to the Secretary-General concerning areas of the Moon having special scientific interest in order that, without prejudice to the rights of other States Parties, consideration may be given to the designation of such areas as international scientific preserves for which special protective arrangements are to be agreed upon in consultation with the competent bodies of the United Nations.

6. Article 11, *The Moon and its natural resources are the common heritage of mankind.*

And—
Neither the surface nor the subsurface of the Moon, nor any part thereof or natural resources in place, shall become property of any State, international intergovernmental or non-governmental organization, national organization or non-governmental entity or of any natural person.

And—
States Parties to this Agreement hereby undertake to establish an international regime, including appropriate procedures, to govern the exploitation of the natural resources of the Moon as such exploitation is about to become feasible. This provision shall be

implemented in accordance with article 18 of this Agreement. In order to facilitate the establishment of the international regime referred to in paragraph 5 of this article, States Parties shall inform the Secretary-General of the United Nations as well as the public and the international scientific community, to the greatest extent feasible and practicable, of any natural resources they may discover on the Moon.

And—
The main purposes of the international regime to be established shall include:

(a) The orderly and safe development of the natural resources of the Moon;
(b) The rational management of those resources;
(c) The expansion of opportunities in the use of those resources;
(d) An equitable sharing by all States Parties in the benefits derived from those resources, whereby the interests and needs of the developing countries as well as the efforts of those countries which have contributed either directly or indirectly to the exploration of the Moon, shall be given special consideration.

Comment: Critical here is the prohibition of possession of natural resources "in place." Once removed from its "place" it likely can be possessed as with, for example, the rock samples returned to Earth with the Apollo missions to the Moon.[216] The provision strengthens prohibitions to claiming territories based on the natural resources they may contain.

The "international regime" envisioned was never pursued. In 1994, the recommendation to the UN was to "take no action at the present time" (United Nations 1994).

6.3.3.3 Common heritage of mankind

Concepts pertaining specifically to the "common heritage of mankind" (CHM) were applied to space in 1967 with OST, and were strengthened and drafted into the 1979 Moon Agreement and the subsequent 1982 Law of the Sea agreement regarding deep seabed resources. However, its definition remains vague and somewhat contentious. The term is never provided in a legal context and was likely inserted to represent aspirations for future policies and legislation (Viikari 2002, 21). When applied to redistribution of wealth, CHM tends to be highly politicized. The confusion is evident in Jennifer Frakes' assessment that "the manner in which the CHM principle will be used will depend on differing perceptions of reality" (2003, 409). While all interpretations hold that CHM requires common management to ensure resource conservation for the use and benefit of future generations and non-appropriation as real property or territory, if or how CHM is to be exploited remains an issue. In general, developed states hold that CHM areas are available for common use within the context of traditional freedom of the high seas and open exploration tempered with recognition that to guarantee the continued availability of renewable resources for future generations conservation and management may be required.

[216] This is similar to the high seas where the fish belongs to no one until it is caught. One does not own it "in place."

Lesser developed states (i.e., those without the access, technology or means to exploit CHM resources to a significant degree) understandably wish to see CHM applied in a way that prevents exploiters from monopolizing resources. In general they wish to actively participate in management and ensure that they benefit from any profits earned by exploited resources through benefit sharing (Viikari 2002; Frakes 2003). There is little question as to why there are conflicting interpretations of CHM considering non-treaty states', treaty parties', interest groups' and others' "differing perceptions of reality." A significant commonality among states, however, is that both developed and developing states ultimately wish to see a degree of exploitation; without exploitation, neither benefit; with exploitation, developed states likely will and developing states may. It is the disposition of exploitation's profits and the nature of its sharing that are largely in dispute.

Notably, the common heritage principle regarding resources was first formally introduced to the UN in 1967, the year of the OST, regarding ocean resources (UN document A/6695) (Payoyo 1997). It was presented as a request to the UN General Assembly to add it as an agenda item: "Declaration and treaty concerning the reservation exclusively for peaceful purposes of the sea-bed and the ocean floor, underlying the seas beyond the limits of present national jurisdiction, and the use of their resources in the interests of mankind." When similar common heritage language was added to OST regarding extraterrestrial resources its only support initially came from a small number of nations (including the United Kingdom and the US). It was recognized, however, that it would be extremely difficult to determine profits in consideration of the diverse sources of expenses and liabilities incurred in identifying, extracting, transporting and refining the resource. In addition, designation of a depository for royalties to be paid by those reaping commercial profits from space exploitation and methods for disbursement has never been determined. It may have seemed premature to focus on addressing these OST "details" in 1967 because of the likely perception that commercial exploitation would not be occurring anytime soon. With the Apollo Moon landing in 1969 the possibility of space exploitation may have seemed more of a near-future reality. The more stringent and restrictive language of the 1979 Moon Agreement may have been viewed as a significant threat impeding space development and so was largely avoided by potential signatories (Christol 1999). Politically, it is more palatable to agree to broad concepts such as CHM when details such as benefit sharing are likely decades away. When later included in the Moon Agreement and especially LOS the consequences were more palpable and immediate.

Although AT does not mention CHM specifically, it does include language reflecting the spirit of CHM.

- -Sovereign states and private actors are blocked from establishing territories or otherwise procuring real property;
- -There is freedom of scientific investigation that is not geographically confined by sovereign boundaries;
- -Information flow is encouraged both within and outside the scientific community that contributes to achieving a degree of benefit sharing;

-Mineral extraction for any but scientific purposes is prohibited; and
-Conservation requirements serve to acknowledge preservation of Antarctic resources for future generations.

Inclusion of these requirements, prohibitions and intents has not prevented developing states from having additional CHM concerns. Many still view AT as the government and management of a globally-shared resource by a minority of mostly developed states (Frakes 2003).

It is likely that ownership, private profits, intellectual property and other issues regarding discovery of ETBE are not currently of great diplomatic concern to those in national and international policy positions because there is no anticipation that such discoveries will be made. It may not be worth the political capital to negotiate compromises. That would be expected to change rapidly should, for example, the Mars Space Laboratory "Curiosity" (which has recently landed on that planet) report indications of past or present endemic life. At that moment, a great scrambling for international protocols of ownership and plans for the disbursement of potential profits will predictably move to the top of COPUOS's agenda. Until then, little will likely transpire regarding management of extraterrestrial bioprospecting and life-related IPR.

6.4 Revisiting the concept of the commons

Although the nature of a traditional commons implies that there is equal access to its resources, a reality is that there is equal access for those with access, those with the means to arrive at the commons and those with the means to exploit it. This was not much of an issue where grazing meadows surrounded a community of herders. When the figurative meadows are on Mars those few with the means of access are those who will profit most by its exploitation through *de facto* ownership. But even here on Earth the benefits of a commons are rarely shared equitably. Externalizing costs of industrial production through pollution of the commons of the atmosphere has resulted in proven negative global impacts.[217] Those who exploit a commons are advantaged over those who don't, but the adverse effects of exploitation are certainly shared more equally (Hardin 1968; Barnes 2001).

The term "commons" is used a variety of ways and by itself has no specific legal meaning. First, areas such as the high seas are considered a commons in that there are few prohibitions on access and use; they are not owned by any person, group of persons, state or any defined entity. Like Antarctica, the seas are a shared resource that may or

[217] Attributed to Aristotle (and popularized by Whitehead and Hardin) - Politics (Oxford: Clarendon Press, 1946, 1261b): "What is common to the greatest number gets the least amount of care. Men pay most attention to what is their own; they care less for what is common; or at any rate they care for it only to the extent to which each is individually concerned. Even when there is no other cause for inattention, men are more prone to neglect their duty when they think that another is attending to it."

may not be managed.[218] No one owns the fish in the sea until it is caught; no one owns a unique microbe in Antarctica until it is discovered, isolated and patented. Wealth is extracted through taking. In this sense it is akin to an uninhabited wilderness. A second type is the commons of rural England of past centuries. Here, specified lands and waters were owned (usually by the king or others by the largess of the king), but by custom and tradition the property was open for others (commoners) to use in specified ways, such as grazing, fishing, collecting wood, cutting turf and other extractions of renewable resources. Because ownership was established, one could not, for example, build a house on the commons without the owner's permission. Similarly, use was generally restricted to the taking of renewable resources (grass by grazing sheep, fallen wood, plants). It differed from a wilderness in that it was owned by someone and there were prescribed limits to activities (e.g., one could collect firewood but not the "king's deer" (Barnes 2006; Banner 2011). This kind of commons is very rare today. A subtle but significantly different third definition of commons is where the resource (land, water, the Internet) is equally owned by everyone. If the high seas were so considered, for example, each individual on Earth would own the fish *prior* to its capture. It could then be argued that the fisher would owe a debt to that fish's billions of owners as are mineral resources mined from the seabed under LOS. Most considering participation in the exploitation of outer space for mineral or other resources would likely favor a definition similar to that of a wilderness where there is no owner, where the hard claim of common heritage of mankind is less settled.[219]

6.4.1 Determining the limits of the extraterrestrial commons

With the extraterrestrial commons, the issue of whether it is owned by everyone or no one is unresolved. If it is held that outer space is owned by everyone (i.e., that it abundantly qualifies for consideration as CHM) it can be successfully argued that all have a right to a share of any net profits derived from its exploitation in the same way that CMH and benefit sharing are argued regarding profits extracted from commons such as the seabed on Earth. If, however, it is assumed that it belongs to no one, the claim of CHM and benefit sharing is not quashed, but it is weakened.

Does outer space constitute a commons? Like an unexplored wilderness on Earth, it arguably did not prior to human access or, more precisely, before it was potentially affected by human actions. It existed apart and was decidedly owned by no one. With the advent of rocketry and especially with high altitude geosynchronous satellites, concepts of ownership of outer space regions, places and resources were challenged.[220] OST was a response, in part, to ownership concerns, transforming space by adding attributes that more closely constitute a commons: guaranteed access, prohibitions on claims of real property, limits on use, duties to cooperate and declarations that it was for the common good. However, concepts of *res communis* implied that outer space resources were for the taking by whoever arrived there first and expended the effort to

[218] Under Roman law, *res communae* are areas that could be commonly enjoyed like the air and the sea.
[219] Such reasoning may contribute to the maintenance of the "frontier" myth as described in Chapter 4.
[220] The Chinese have argued that geosynchronous orbits are maintained within areas that constitute CHM and, as such, those maintaining such satellites should pay royalties (Christol 1999, 19).

extract them (Cooper 2003, 113). Space was not a commons until it became useful to humans in tangible ways other than as an object for observation, admiration or theoretical remote study. More remote, unused areas outside our Solar System (Alpha Centauri, e.g.) would not qualify as a commons under this definition. They may be included at such a time when they are used. In short, where we use space in concrete ways, it has the potential to become a commons and where we don't, it does not.

With the Moon Agreement, the principle of *res communis* was reinterpreted to explicit communal ownership of resources, to be shared among all.

These assumptions become philosophically problematic should ETBE be encountered, where they might compete with our concept of commons. While unlikely, should a sapient species with defined cultures and technology be discovered living under the surface of Mars it would be difficult to ethically conclude that Mars was the heritage of man, that Mars was an extension of a human "global" commons for the only reason that we have the technological ability to travel there waving OST and the Moon Agreement before us. To claim it a commons would harken again to the frontier wilderness mythology of the American West described in Chapter 4, discounting its indigenous populations. With sentient Martians whether we could benefit from Martian resources ("their" resources) or not would be irrelevant to the ethical argument.

And so we start down the slippery slope introduced in Chapter 2. At what developmental point or degree of chemical, structural or behavioral complexity does ETBE gain a status we deem sufficient to challenge a claim of CHM, to nullify Mars as a human commons? At what point can we discount such entities from any such calculation?

6.4.2 Commodification of the extraterrestrial commons

It is impossible to ignore the influence of capitalism and the generally-unchallenged call for continued growth over the coming few decades in any practical consideration of ETBE in the context proposed. As Callicott states as fact, "We seriously entertain farming, mining, and colonizing our Sun's planets or those of some other. We project routine transport and commerce between worlds. Why? Partly just because we can, or think we can, but more practically because we *must* if our civilization is to have the resources and real estate to continue to grow" (emphasis added) (1989, 249). Simultaneously providing both positive and negative factors for consideration, it is, and will likely continue to be, the predominant paradigm driving space exploration in the foreseeable future. Scenarios of exploration of extraterrestrial worlds are rarely described without their subsequent exploitation as the primary motivating factor. Most often, they are founded on a capitalist business model. Even where couched as purely scientific endeavors, the capitalist rationale still is anchored in the potential for investors to share in profits derived from any scientific discovery. As such, capitalism is an essential component to a productive and practical discussion of present-day property rights and their application to extraterrestrial biological resources. To be at all effective, policy will have to acknowledge this reality. However, such a conclusion is applicable to near-term development only.

As in past centuries of the American West, pioneering coupled with exploitation often precede environmental regulation; free range ranching was favored over fencing; Western water rights of first use contrasted to Eastern practices of best and highest use, riparian rights and preserving flow for downstream users; mass wasting brought about by hydraulic mining and clear-cutting timber preceded calls for the maintenance of water quality and soil conservation.[221] In each case a commons was exploited to the degree where environmental degradation decreased its ability to be self-sustaining. Resources of the commons believed to belong to all were commodified in the process. At the moment of that shift from nature to commodity, where profit is the predominant motive, human relationships with both the living and inanimate environment change significantly. Whether commons or wilderness, nature becomes a commercial enterprise, changing our relationship with a place and dramatically morphing it into an exploitable resource. It is certainly not a new phenomenon (Eckholm 1976, 34).

Capitalism contributes to the commodification of nature; it is imbedded in the nature of the economic system (Leone 1995; Mrozowski 1999). Considering the predominantly capitalist models most often used to describe future space exploitation, especially among the private sector, similar patterns may emerge. The process may be exacerbated in space in that there would likely be little, if any, immediate perception of the adverse social impacts that frequently accompany such developments on Earth, such as displaced populations, pollution, exploitation of labor, and other. Another compounding reality is that humans working on another planet or moon will necessarily live quite apart from its environment, sheltered in every way by an artificial environment. The history of colonization on Earth is grounded in that it is clear that the environment provides the water, air, food, and other resources for survival. When those elements of the environment are destroyed it adversely affects the colonizer as well as the colonized. While the colonizer may choose to dismiss such deterioration and ignore it to a degree, diminished environmental conditions eventually cut into profits and the colony is abandoned or the costs of remediation must be factored. Conversely, concerns for safeguarding alien natural systems, whether ambient atmospheres or landscapes, may be small. With a near-total artificial environment there may be little motivation to avoid adverse environmental impacts.

Inherent in this commodification process, whether terrestrial or not, is that the land and its resources become abstract. They lose their place and purpose in an environmental sense and are folded within the constructs of capitalism (Mrozowsky 1999).[222] This was evident in conversion of commons in Britain through the process of enclosure, where fences, hedgerows, and other boundaries transformed land (with its environmental

[221] The evolution of extraterrestrial water rights will be interesting to watch. On Mars, for example, while we know that water ice exists just below the surface in some of the areas tested, there is no evidence that such ice is evenly distributed across the surface. Should large volumes of ice exist below the surface in certain limited areas, it would be a valuable resource. Should liquid water be sequestered in some stratum somewhere below the surface it would be a profound find with huge economic impacts on the development of the planet, as pondered in Frank Herbert's *Dune* series.
[222] Colonization and subsequent commodification of nature often begins with mapping, or abstraction of the place so it can be assimilated by capitalist systems.

attributes or soil, water, organisms, etc.) into "space" (a two-dimensional abstraction on a map). It could then be more easily commodified through division into acres, squares, or other units allowing management for profit. Such abstraction also served the purpose of placing a boundary between uncommodified land and society. With current motivations, practices and policies, there is little reason to believe it would be otherwise in our futures regarding the exploration of space.

6.5 The modest proposal of patenting ecosystems

The pressures of free market capitalism influence the patenting process, especially in the area of life patents (Krimsky and Shorett 2005). A significant focus of this dissertation is on biotechnology and extraterrestrial patentable finds, but the scope extends well beyond what would normally be considered the limits of life patents regardless of the source of that life. This is a futures project. As developed in Chapter 2, organisms here on Earth are intimately entwined not only with other organisms, one flowing into the other, but with the ecosystems that support them, with landscapes, the organic blending with the inorganic. The courts have an established history of supporting applications for patenting organismal sub units, such as DNA, once removed from the organism and artificially engineered for some useful purpose.[223] Similarly, they generally supported patents for biological processes that have been biochemically described and then employed to some different task, such as the use of enzymes removed from especially cold- or heat-tolerant bacteria. Patents have been granted for whole organisms that have been purified, such as Pasteur's strain of yeast that although found abundant in nature had not, until the addition of his labors, been removed from its contaminating environment. And courts have ruled the patenting of genetically modified organisms (e.g., the cancer-prone "oncomouse" and a myriad of plants) to be legitimate.

Two centuries ago, extending patentability to such life was not imagined; today it remains controversial but has grown routine. In *Should Trees Have Standing* (1996) Christopher Stone poses that extending legal rights to non-humans is no longer beyond consideration, and that thought should be given to providing rights for sectors of the environment that are not classed as organisms at all, such as rivers, mountains, and ecosystems. This reflects, in part, Leopold's earlier philosophical approach in *A Sand County Almanac* and other works (1949). On other worlds, the Western concept of distinctions between life, broadly defined, and the landscape components of ecosystems may be especially difficult to discern; the line may blur. Would such a condition tempt the application of IPR? If described processes of life *in vitro* are generally patentable, might the processes of an ecosystem be equally as patentable? The seeming ridiculousness of this prospect may be tempered by the consideration of novelty. Earth's ecosystems are composites of prior knowledge and natural processes that are discovered, not invented; one cannot patent lichens etching rock, the carbon cycle or the bio-environmental interactions required for photosynthesis unless artificially modified for a different yet useful purpose. But the processes of living extraterrestrial environments would offer novelty in abundance. If the "natural processes" discovered there could be

[223] Useful, here, includes for research, making almost any removal of cellular material potentially a subject of further research.

modified in some way analogous to genetic engineering, might they then qualify as inventions? More futures-oriented architects and others have imagined ecosystem-based, but synthetic worlds, such as those suggested by Gerard O'Neill (O'Neill 1976). Where living systems are co-opted to provide industrial uses, might they be patentable? [224] Would there be a disincentive to IP considering that the action would generate profits without the terrestrial accusations of biopiracy and claims of prior knowledge; who would be disadvantage? Practice, not terrestrial treaties, would likely drive policy, not the reverse.

[224] "That's no moon. That's a space station!" from Star Wars IV, A New Hope (1977) (Thanks to Taylor Dalton for the reference).

CHAPTER 7
EXPANDING ETHICAL CONSIDERATION

We shall never achieve harmony with land, any more than we shall achieve absolute justice or liberty for people. In these higher aspirations the important thing is not to achieve, but to strive.

Aldo Leopold, *Round River*
(Leopold and Leopold 1993, 155)

The first step towards philosophy is incredulity.

Denis Diderot (1713-1784)[225]

7.1 Premise

Three themes are explored in this dissertation: First, that as the biological sciences have progressed there is less evidence supporting the discrete individuality of organisms; we blend and are less unique than centuries of Western science, philosophy and theology have sought to maintain. As Carl Sagan mused, "this oak tree and me, we are made of the same stuff" (Sagan 1980). Second, Western bioethical practices and standards have been shaped in part by this perceived degree of separation among organisms, including our own. As the focus shifts from identifying differences to seeking commonalities, the degree of bioethical consideration provided non-human organisms has grown. Third, protective political practices regarding the ownership of life through patents have been aided by advances in biotechnology. Commercial ownership of life will likely increase as advancing expertise allows the biochemical dissection of life into ever smaller units. The same processes are acting on larger units of life at the landscape level through the practices of real property ownership within the corporate model. The ability to claim ownership of life from the molecular to the landscape levels results in the commodification of nature which, in turn, limits bioethical consideration.

Among humans, systems of classification contribute to discrimination; they serve the purpose of Othering, a political as well as social tool for gaining and securing power. When applied to non-humans it can serve a similar purpose that may be expressed through the metering of scientific as well as cultural bioethical status.

Biology and ethics are trending toward consilience, yet presiding protocols for patenting life are antithetical to such a goal. The tension among the three is irresolvable. As an invention of capitalism, patenting can serve to achieve political agendas especially supportive of capitalist economies requiring continued growth (Hawken 1993; Tokar 1997; McKibben 2007; Schramm and Litan 2008). There cannot be coherent bioethical standards as long as subjugation of nature is essential to maintaining a capitalist or any other economy. Space, however, provides an opportunity to experiment with new approaches to our relationship with the natural world we share. It may provide a venue for bringing about conciliation.

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[225] Diderot's alleged final words to his daughter, quoted from Jim Herrick, *Against the Faith* (1985, 84).

This chapter assumes the discovery of extraterrestrial biological entities and poses hypothetical responses conflating the three themes to answer how we might grow ethically as we grow spatially. It suggests that while we are far from achieving a perfect bioethics there is hope for improvement.

7.2 Extending ethical consideration "all the way down"

> *We don't hear much in the West about insect rights, and although declining populations of bees are beginning to attract attention the concern is largely instrumental. We don't generally speak about the rights of plants. What is more serious, perhaps, is that we do not hear about the rights of oceans or marshes or jungles, which are treated as containers (habitats) for the species that capture the imagination. -- Rights may belong more appropriately to systems than to individual species.*
>
> Mary Catherine Bateson, *Why Should I Inconvenience Myself?* (2010, 211)

Traditional discussions of extending ethical consideration frequently begin with how it has evolved in practice over the past 30,000 years to approach the inclusion of all humans (Stone 1993; Stone 1996). This tight circle has been expanded to welcome a small number of non-human organisms with arguments including justifications and apologies (Singer 1981). There are predictable nods to the humane treatment now afforded farm and research animals that did not exist only a few decades ago. Qualifiers such as sapience and sentience are often applied to limit consideration, inferring our determination of the mental capacities of other species has a direct bearing on the issue (Silliman 2006). Almost all Western philosophical treatments end well short of extending ethical consideration "all the way down" to plants, fungi and microbes. In his Nobel Lecture *The Problem of Peace*, Albert Schweitzer stated, "Compassion, in which all ethics must take root, can only attain its full breadth and depth if it embraces all living creatures and does not limit itself to mankind" (1954).[226] Whether he intended to include microbes is not known, but his sentiments are obvious. Such regarding all life is generally cast as absurd and consideration of landscapes, apart from their possible individually-ranked sentient and sapient components, would appear to many as equally bizarre. Arguments routinely cite that to have ethical consideration for organisms that are harmful to humans (tsetse flies, malaria-carrying mosquitoes, and even smallpox) is beyond logic, that it would be self-defeating to invite their participation in any consideration of possible futures (Cockell 2007). But discussions of changing the philosophical as well as biological approach to the "lower" forms are growing, and discussion, even if mostly denigrating, is a step in that it recognizes the possibility of change.

This is not the first time that seemingly extraordinary statements arguing for ethical inclusion (and exclusion, to be sure) have been made. Nathaniel Ward, a lawyer in the Massachusetts Colony, argued for a law requiring ethical consideration of "bruite

[226] Schweitzer received the Nobel Peace Prize in 1952.

creatures" in 1641 (Granucci 1969). And as described by Peter Singer on the first page of *Animal Liberation* (1975):

> *When Mary Wollstonecraft, a forerunner of today's feminists, published her Vindication of the Rights of Women in 1792, her views were widely regarded as absurd, and before long an anonymous publication appeared entitled A Vindication of the Rights of Brutes. The author of this satirical work (now known to have been Thomas Taylor, a distinguished Cambridge philosopher) tried to refute Mary Wollstonecraft's arguments by showing that they could be carried one stage further. If the argument for equality was sound when applied to women, why should it not be applied to dogs, cats, and horses*?

While having rights does not immediately equate to ethical consideration or moral obligation, and while equality (as used in a legal sense here by Singer) provides a significant degree of deference, all are philosophically linked; ethical consideration generally precedes rights among humans with legal equality possibly following. Regarding consideration and rights there is little but emotion to argue that the relationship differs when the subject is non-human species. The theme of extending ethical consideration to non-humans is no longer subject to the derision that it suffered in the late 17th and 18th centuries, but it has been slow to gain the degree of respect required for serious debate among most.

It is interesting to note that extending ethical consideration to robots has been the topic of social speculation on futures in both fiction and non- for many decades. It is growing in interest as technology brings artificial intelligence into everyday lives (Asimov and Jones 1982; McNally and Inayatullah 1988; Levy 2009). If we do provide such consideration to machines, it further erodes the defense of not providing consideration for other life forms as well as systems, living or otherwise (as well as challenging many other norms). This topic is discussed in greater detail in Chapter 8.

7.2.1 Giving voice

One of the most difficult aspects of defining an ethical standard applied to non-humans is that while we intimately share our lives there is very limited dialog among species, and certainly none at a philosophical level that I am aware of (Haraway 2008). Humans do the analysis and derive ethical standards focused through the lens of human perception; other species have no say in the process. This makes it extremely difficult for humans to not be biased in our favor and anthropocentric, to not depend on the relative utility of other species and our long history of viewing most other life as a means to further our own survival and pleasure. As a result, bioethics among both humans and other species has had a strong utilitarian component. Compounding this difficulty is the questionable validity of our assumptions about non-humans' degree of sentience and, perhaps, sapience that are largely based on our technological ability (and psychological willingness) to detect and measure those abilities. How might we develop a just bioethical standard that would guide our actions affecting extraterrestrial life that has no voice, much less extraterrestrial entities that may not exist or have yet to be discovered?

Giving voice to the voiceless through guardian *ad litem* representation is a standard legal practice for those people whom the courts determine cannot adequately represent themselves in a legal context, such as the unborn, children, the comatose and the mentally incompetent. Similarly, appointed ethics committees and religious counselors provide voice for many in homes, hospices and hospitals (Webb 1997). The practice is, however, not limited to people. Units of government, such as states and municipalities, and corporations, trusts and estates all have legal standing; they have voice. Humans can speak of their interests as their guardian or representative. Corporations, for example, can successfully sue an individual or another corporation if harmed and likewise be sued. It is far more difficult for legal action to be taken by non-human organisms. But that, too, is changing in the West. In 2012, the Parliament of New Zealand granted "personhood" standing to the Whanganui River (Berman 2012). "A spokesman for the Minister of Treaty Negotiations said Whanganui River will be recognised as a person when it comes to the law - 'in the same way a company is, which will give it rights and interests'" (Shuttleworth 2012).

Whereas corporations are considered extensions of humans in the eyes of the courts, non-human organisms are generally not (with some exceptions, such as through anti-cruelty laws or specific acts protecting endangered species or marine mammals).[227] Constitutionally-mandated standing principles require evidence that a human has suffered "injury-in-fact" to gain legal standing (Hogan 2007). It has been argued by some against such animal "rights" that not only injury to humans must be generally demonstrated, but that at a policy level the legal system in America is "ill-equipped to fully recognize the rights of nonhuman animals because their pain and suffering is an unfortunate requirement of progress;" that an increase in rights for nonhumans will necessitate a subsequent decrease in humans' rights (Hogan 2007, 517 citing Schmahmann and Polachek 1994, 748).[228] Such a dismal argument could be applied to any bioethical standard, and it has not been demonstrated that providing more universal human rights has decreased the rights of others -- the opposite is observed repeatedly.

Providing legal standing for the adversely affected (whether human or other) is critical to just determinations. Given the range of attitudes toward possible ETBE, representation in some form is a minimum requirement for any coherent bioethical policy; its lacking has been a significant, if not fatal flaw in previous attempts regarding nonhumans. Giving voice is a required step in balancing the claims of those who view ETBE's "pain and suffering" as an "unfortunate requirement for progress." The question becomes, how do you give voice not only to non-humans who are unable to speak or respond in a conventional sense but to entities that may not exist?

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[227] Consider the Supreme Court's decision regarding First Amendment rights in *Citizens United v. Federal Election Commission*, 558 U.S. 50 (2010) providing broader "free speech" protections for political action committees (PACs).

[228] This demonstrates a very significant problem with bioethical thought that surfaced in Chapter 3: If we exhibit more humane standards toward nonhumans there is the perception that there will be significant economic consequences. The ethical standard by itself has little to do with the realities of cultural and economic application.

7.2.2 John Rawls

John Rawls (1921-2002) challenged classical utilitarianism by exploring theoretical issues of judicial and ethical practice and revisiting social contract theory (Rawls 1971; Rawls and Freeman 1999; Rawls 2001). While not specific to providing voice for the voiceless in an *ad litem* context, he proposed theoretical methods for improving administrative practices in political theory regarding distributive justice. He specifically restricted his analysis to human persons, but he did not foreclose expansion of that class and, arguably, baited such consideration. In *Theory of Justice* (1971, 512) he states:

> *Last of all, we should recall here the limits of a theory of justice. Not only are many aspects of morality left aside, but no account is given of right conduct in regard to animals and the rest of nature. A conception of justice is but one part of a moral view. While I have not maintained that the capacity for a sense of justice is necessary in order to be owed the duties of justice, it does seem that we are not required to give strict justice anyway to creatures lacking this capacity. But it does not follow that there are no requirements at all in regard to them, nor in our relations with the natural order. …I shall not attempt to explain these considered beliefs. They are outside the scope of the theory of justice, and it does not seem possible to extend the contract doctrine so as to include them in a natural way. A correct conception of our relations to animals and to nature would seem to depend upon a theory of the natural order and our place in it. …How far justice as fairness will have to be revised to fit into this larger theory it is impossible to say. But it seems reasonable to hope that <u>if it is sound as an account of justice among persons, it cannot be too far wrong when these broader relationships are taken into consideration</u>* (emphasis added).

While doubtful that Rawls ever extended his thoughts to such an extreme, the theoretical methods he proposes may be helpful in theorizing relationships not only among humans but among all organisms, including potential extraterrestrial entities. Admittedly, it is not a perfect extension of his work, but he provides a model for conceptualizing such cases. Especially in the context of employing scenarios as tools to develop and critique desired futures, discussions of justice as a grail are essential. Extraterrestrial worlds provide ideal testing grounds for such concepts. As opposed to Earthly scenarios where the "devil is in the details," leaving Earth reduces the number of variables, allowing simpler analyses. Such an ethic would provide the foundation for the development of policy.[229]

[229] It is difficult for me to imagine any preferred and enlightened futures where ethical theory has not evolved to be more inclusive of non-human species and non-living entities. The progression (especially in the West) allowing inclusion of such species and entities is well documented and continues to expand (Banner 2011). With advances in xenotransplantation, the development of artilects (the synthesis of artificial intelligence and human intelligence) and the increasing use of technological implants and robotics in humans already underway, it may become increasingly difficult to differentiate between "human" and other categories. Ethical consideration of extraterrestrial worlds and their biological components provides an excellent platform for thought experimentation.

7.2.2.1 The original position

In *Justice as Fairness* Rawls states that citizens "cannot agree on any moral authority, say a sacred text or a religious institution or tradition. Nor can they agree about a moral order of values or the dictates of what some view as natural law. So what better alternative is there than an agreement between citizens themselves reached under conditions that are fair for all?" (2001, 15). He cites tradition as intrinsically unfair and thus inappropriate in seeking justice, and the traditional relationships between humans and other organisms certainly have a history of the "unfairness" he references.[230] To achieve a more coherent and balanced bioethical policy, then, tradition-based bioethics must be questioned if not abandoned.[231]

Rawls' concept of the foundation of justice lies in equality of consideration. Self- or group-interests will bias equal consideration of other individuals or groups and preclude just outcomes. Any population of people will exhibit varying biases regardless of the degree of homogeneity within the group. Should any group approach uniformity it then becomes distinct among other groups, rendering it incapable of unbiased consideration of those others. While structured to theorize the formation of just institutions within human populations, this aspect of Rawls' theory is applicable to non-human species and, arguably, to considerations of ethical relationships with ETBE. The thought experiment he proposes begins with his concept of the "original position."

He asks that we consider a hypothetical group of humans sequestered in a room.[232] They are tasked with drafting a set of principles of justice for the basic structure of society, principles that "free and rational persons concerned to further their own interests would accept in an initial position of equality as defining their association" (Rawls 1971, 11). This constitution they would produce would function to design and guide a society, its governance, its laws, and all other similar categories of constructed political life. The participants are to assign basic rights and duties and determine the division of social benefits. They are to debate and negotiate in determining how to regulate their claims against one another.

That is not a novel model for designing; it was attempted, in part, in Philadelphia in the late 18th century with some practical success but without enduring and perfect justice or fairness. However, Rawls adds rather serious caveats that are novel, for the hypothetical group inhabits this "original position" behind what he terms a "veil of ignorance." They are unaware of their personal present or future status within the society, their abilities, psychological state, physical stature, race, culture, beliefs, or other factors that would bias

[230] Here, "fairness" and "unfairness" are provided in their vernacular sense, not in any deeper philosophical or even legal sense.
[231] For example, the recent outlawing of bull fighting in Catalonia was challenged by some only on the grounds that it was a traditional cultural practice. Similar cases are attempted for other blood sports involving only animals, such as dog and cock fighting. http://www.bbc.co.uk/news/world-europe-10784611 Dated: July 28, 2010
[232] It must be emphasized that Rawls' conception is that this group is hypothetical; as a thought experiment the group and its members neither have nor could exist in real form. This mimics, in part, Kant's hypothetical "original agreement" (*The Metaphysics of Morals*, Part I, §47)(critiqued in Timmons 2002).

them in their self-interest and detract from equal application of justice. The veil removes all mirrors from the room. The group would gain, as Rawls describes in the last paragraph of *Theory*, the "perspective of eternity."

Participants in the original position (Originals) are to:

- Have no knowledge of their future station in life, status, role, or any other attribute or descriptor (e.g., they are ignorant of their race, gender, sex, age, education, intelligence, physical or mental strengths or weaknesses, nationality, etc.). They are "unformed but fully sapient," yet disinterested in their individual future condition.
- They have no knowledge of their individual, personal past, but they are fully aware of the conditions of the world, societies, and governments.
- They are rational and reasonable.
- As they are rational, their product would be a set of rules and criteria for ensuring just (but not necessarily equal) division and distribution of social and political goods. Because of the ignorance afforded by the veil, they would be free of favoritism or other personal or group biases. As such, they would strive to ensure that their list, described as a set of "first principles," is just and fair.
- Each person in the resulting community has a claim to equal basic liberties.
- Economic and social inequalities are resolved in that they are to be attached to positions and offices open to all under conditions of equality and fair opportunity.

From these evolve two principles. First, the "liberty principle" which holds that freedom of speech, participation in government, and freedom of conscience are to be maximized by the social institutions of governance. This leads to the second, the "difference principle." Rawls acknowledges that in the resulting society there will evolve those with advantage over others, in every way. This would be expected where liberty allows choice to seek fair advantage; some will choose wisely in their best interest, others will not. However, while there is nothing intrinsically unjust regarding economic inequality (I have $10, you have $100 as a result of our personal choices in life) or social advantage (I was able to go to a better school than you), where that inequality is leveraged to create injustices, the just and fair system that has been constructed is stressed and begins to fail.[233] Accordingly, Rawls postulates that actions of those better situated are just if and only if they cooperate in schemes to improve the expectations of the least advantaged members of society. It maximizes their prospects for justice.[234] More importantly, where institutions within societies adhere to those same precepts, the society will tend to be just. Accordingly, he describes a balancing between competing claims, assigning both duties and rights among the divisions of social advantages.

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[233] For example, the party with $100 buys political influence which nets a gain of $50. That gain is used to buy additional influence that adversely affects the balance of equality within the frame of justice to the disadvantage of the poorer person. Rawls terms those poorest as the "least advantaged representative person," or LARP.

[234] Rawls' *Theory of Justice* was published in 1971 during President Lyndon Johnson's administration. A cornerstone of Johnson's social policies was the creation of programs supporting "the Great Society," giving that period a decidedly liberal social welfare agenda. Rawls' theories both influenced and were influenced by that period.

The original position, veil of ignorance, liberty and difference principles and other aspects of his theory describe not so much what a perfectly just society would be like, but how a social structure that maximizes justice and fairness can be achieved. While Rawls himself compares this hypothetical situation to the social contract theories of Rousseau, Locke, and Kant, he cautions that his theory is not one drafted to organize a *specific* society, government or economic system; it need not be a democracy or operate within a capitalist economy (Rawls 2001, 16, 136).

7.2.2.2 Expanding consideration behind the veil

The veil of ignorance prevents those in the original position from knowing their future station in life, status, role, or any other attribute or descriptor (e.g., they are ignorant of their race, etc.). As Rawls describes, they are "unformed." As they deliberate on a just constitution, they are disinterested in their potential individual condition or role in any subsequent society. Had someone considered constituting such a group in 1776 would their considered potential futures have included slaves or indigenous Americans in addition to being wealthy or poor, able or sickly? Would they be able to imagine such an outcome? Had being born a slave been a potential outcome for one of the Originals, how might the Constitution have differed from its final form? It likely would have been a better document for addressing the problems of justice regardless of the more pressing need for practicality as an 18th century political instrument for a British colony. Rawls appreciates that unless the Originals consider all of those potential futures categories the resulting precepts of justice (his First Principles) will be flawed.

He specifically requires that all possible future individuals are included as potentialities in the deliberations. Further, Originals do not know the timing of their arrival or the circumstances of their own society into which they will emerge, the level of civilization and culture it has been able to achieve (Partridge 1976). They do not know to which generation they belong. "They must choose principles the consequences of which they are prepared to live with *whatever generation* they turn out to belong to" (Rawls 1971, 137) (emphasis added).

For example, Originals do not know if they will be male or female when the veil is lifted, so they will attempt to structure the rules of justice to be equally fair to both. It is in their best personal interest to do so.[235] But Rawls requires us to include potentialities from future generations as well. To continue the example, the individual may be male or female living in 2012 or 3012. However, while we recognize that future humans likely will live in a world far different than the one we experience today, justice and fairness are universal and durable. The principles of justice as fairness will be just as applicable in any of those possible futures.

[235] Consider two children who are to divide a cookie between them. They cut the cookie behind a veil of ignorance in that they do not yet know which of them will receive which half. In this situation they will want to ensure the cookie is very evenly (fairly) divided in that it is in their individual best interest to do so.

The concept of fairness that Rawls seeks is eternal, not relative. As he states regarding the original position in *Justice as Fairness, A Restatement* (2001, 16-17), "it is nonhistorical, since we do not suppose the agreement has ever, or indeed ever could actually be entered into. And even if it could, *that would make no difference*" (emphasis added). As such, a perfect justice based on fairness that may be drafted the year his book was published would be equally as perfect in 2012…or 3012. Similarly, when Rawls explicitly includes obligations to future generations, one might imagine those living in 2012, or…3012. This grappling with more distant futures is significant in that it assumes that the tenets of justice as fairness in its perfect form (which is the purpose and goal of the Originals) possibly extend temporally beyond common conceptions of what it is to be human.

Rawls' concept of future generations is admirable in its recognition that we have a moral and ethical obligation to future humans that is expressed through a hypothetical contract (1971, 284). However, his framing of the concept appears flawed in that it is overly conservative by limiting the definition of "humans" to humans in a traditional sense; he certainly isn't alone in this conservatism. Future human generations have been, understandably, limited by definition to the subspecies *Homo sapiens sapiens*, the same creature that has populated the world over the past 200,000 years and is existing today largely within the philosophical or taxonomical hierarchies described in Chapter 3 (McDougall, Brown et al. 2005). Assuming this same subspecies alone will comprise future human generations seems shortsighted.

If justice is eternal, then it must apply to post-humans as well.

We have already begun to experience previously unexpected divergences in our singular species concept and it is likely the trend will not only continue but accelerate over coming decades and centuries; new forms and taxa will emerge, challenging our definition of what it means to be human. There are at least four overlapping processes currently at work affecting us in this regard: (1) direct control of evolution at a biochemical level, well beyond artificial selection and the eugenics that have been ongoing for millennia; (2) genetic engineering; (3) altering somatic cells and gametes through gene-level xenotransplantation; and (4) artificial physical supplementation, creating cyborgs.[236] There are certainly those who oppose such tinkering for a number of biological, theological, sociological and philosophical reasons, but the process has clearly begun (Kurzweil 1990, 2005; McKibben 2003). All but the fourth are currently common with non-human species; the first two are commonly applied to humans, the third is biologically possible with humans but is legally limited, and the last has begun and incorporates new technology as it becomes available.[237]

How would the dynamics of Rawls' original position change if future societies contained and accommodated these variations under the umbrella of the justice as fairness he seeks? Behind the veil of ignorance, what if Originals were ignorant not only of their gender,

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[236] Combinations of artificial intelligence and/or robotics with animals (and other Kingdoms?).
[237] Existing technology verging on cyborg-ization include cochlear implants, artificial limbs, and various brain implants that assist and amplify other processes, such as vision.

sex, race, etc., but also were unaware if they were human in blood and bone or something quite different, something "enhanced."

This elevates the question that Rawls importantly acknowledges in one paragraph out of 600 pages of text but does not (nor would be expected to) address, namely, can a society be just if the fairness Rawls requires is limited to "traditional" humans. He states, "Not only are many aspects of morality left aside (from his consideration in his theory), but no account is given of right conduct in regard to animals and the rest of nature" (Rawls 1971, 512). "A correct conception of our relations to animals and to nature would seem to depend upon a theory of the natural order and our place in it." And so, we are brought back to homocentric systems of hierarchy and concepts of the existence of a natural order.

Will Rawls' theory of justice as fairness still be relevant when we are no longer singularly defined as *Homo sapiens sapiens*? If so, then those in the original position must be ignorant not only of whether or not they will be rich or poor or talented or dull, but mortal or immortal, a biomechanically enhanced cyborg, male, female, both or without gender, or any other imagined or yet unimagined possibility. More intriguing, other descendent species must be included as future potentials within Rawls' hypothetical consideration. In addition to a singular descendent of our present subspecies there may be an array of not only artificially created new hominid subspecies but full species, genera, or newly created taxa as well, products of human-nonhuman intercrosses, directed mutations and genetic engineering -- humans sharing significant portions of genomes with other species with strong physiological consequences.

If justice as fairness would not apply to these possible future permutations of traditionally defined humans, Rawls' hypothetical experiment and its resulting theory would be flawed by being fixed in the present condition, violating his established precept or regard for future generations. Rawls would undoubtedly argue that an Original behind the veil of ignorance must consider justice and fairness for a child with severe autism because that Original may find that they *are* a child with severe autism once the veil is removed. As Rawls states, Originals "would have no knowledge of their potential physical or mental strengths or weaknesses." Accordingly, Originals would ensure that policies would affect an autistic child justly and fairly, that they would have equal claim to basic liberties. Considering genetic engineering and other potentials, would the same reasoning apply to a different species descended from today's humans? Rawls has inadvertently opened the door to such a consideration.

7.3 Taking Rawls to Mars

We are making some major assumptions by extending the heart of Rawls' theory of justice to species other than humans, but if one accepts that his original thought experiment has merit, that imagining the original position provides a tool for designing principles that nurture justice through fairness, the exercise is worthwhile for considering applications to bioethical practices regarding ETBE.

7.3.1 First steps of consideration

Let us assume that Originals are ignorant as to their biological kind. This would generate a lengthy list of potentialities. If, say, a single additional consideration for Originals is that when the veil is lifted they may not only find themselves either male or female, but human or a bonobo. How might that change the principles to ensure justice and fairness? We could speculate that the Originals would agree that bonobos would not be tortured or killed by humans for sport, that their family structures would not be fractured by capture for research or other purposes and that they would have sufficient space in their favored habitat to live unmolested lives. Rawls' First Principle may then include a condition that a bonobo has a "right" to live as a bonobo. There would be no government program to guarantee that a bonobo would not be eaten by a predator, mauled by another bonobo or suffer starvation, but that human behaviors would not decrease the natural quality of their bonobo lives. This may be sufficient to meet the terms of justice as fairness.

Bonobos would not participate in the Originals' debate and negotiations any more than a comatose human would. In accordance with Rawls hypothetical, Originals are neither bonobos nor the comatose (nor men, women, rich or poor) because the veil prevents them from having such knowledge. While an ethereal council, they are fully aware of the conditions of the world, and that world would now include the world of the bonobo.

The deliberation among the originals regarding bonobos would result in an ethically-defensible resolution. As Rawls maintains that First Principles would be enduring, they would be free from the relativism that has plagued our relationship with other species for millennia.

7.3.2 ETBE behind the veil

Bonobos are far enough outside our daily consideration that they fit more easily into this kind of analysis than the species we interact with daily, the species that pose significantly thorny bioethical dilemmas such as livestock, edible plants, trees cut for lumber or fuel and the myriad of species that literally plague us. Our utilitarian relationships with them are too entrenched, at least for now. This is where ETBE can provide a bridge to bioethical resolution. As stated in Chapter 3, ETBE have yet to be discovered; they have no utility or utilitarian value or worth. We share no history with them; they are neither heroes nor villains in our cultures, so their place within the context of our cultures has not been established. They have no taxonomic status and have not, therefore, fallen into a possibly prejudicial preconception of "place" or ranking. And we have no measure of if they suffer physically, emotionally or in any other manner. Perhaps those qualities of suffering are not even appropriate or applicable. ETBE are free in that they are unknown. They affect us far less than bonobos.

Consider that the Originals place ETBE within their hypothetical experiment, that they consider that when the veil is lifted they may find themselves existing as a bacteria-sized entity on Mars. What might their debates and negotiations conclude to resolve questions of justice and fairness and how might that provide a basis for bioethical consideration?

NASA's Chris McKay wrote, "There is an issue of moral consideration to indigenous Martian life. In the approach to terraforming that I am proposing, Martian life has rights. It has the right to continue its existence even if its extinction would benefit the biota of Earth" (MacNiven 1990, 194). As with the bonobo, at a minimum the Originals would afford ETBE a right to exist in its habitat. The habitat would not be diminished in size, character or capacity below the conditions required to allow its existence. Rawls' concept of the Least Advantaged Representative Person (LARP) requires that any actions taken cannot further disadvantage the least advantaged, for example, the poorest of the poor (Rawls 1971, 97f). Even actions that may disadvantage some should not be structured so as to widen the gap between those most advantaged and those least. In the context of ETBE, actions that may adversely affect ETBE, say mineral exploration, must be mitigated such that the actions have a net zero or positive impact.[238]

While this scenario addresses populations of ETBE it obviously ignores the position of the individual ETBE that is destroyed by human action. Consider a scenario where a mining site on Mars will require destruction of 10% of the known range and population of that entity. How would such a model ever be considered just from the perspective of those destroyed? A first requirement would be to determine how adverse impacts could be reduced to the greatest extent possible. Is the mineral found elsewhere where its mining would not conflict with ETBE? Assuming that it is not, a second consideration would be to attempt to create new habitat for the entity. Are other sites available for translocation? Admittedly, such actions on Earth have met with limited success -- if the entity could exist in some other location it would likely already be found there. Creating new habitat is extremely problematic. Still, with severely restricted populations those may be options to be considered. Where taking 10% cannot be avoided, in keeping with best practices, not only should all avoidable adverse impacts (e.g., pollution from tailings and liquid spills) be minimized and monitored, but full remediation of the area to conditions that would allow the entity's population to reclaim disturbed areas could be required. There is no obligation to grant mining rights at all if the entity is greatly imperiled or especially unique. We have done this many times where endangered species are likely to be adversely affected by an action.

7.4 Changing perspective on bioethics

It may not be possible or practical to avoid the destruction of ETBE considered in the above scenario with foreseeable technology within the next few decades. Beyond that, it is impossible to speculate. Even with the application of Rawls' model, bioethical fairness may not be possible. However, Originals may determine destruction of an individual may not be significant from that Martian entity's perspective. Their concern may be survival of the group, and conservation actions for the group may fairly compensate for their losses. That may be all that is required for fairness.

[238] Perhaps Rawls' LARP should be reworded as LARE (Least Advantaged Representative Entity).

7.4.1 Two approaches to bioethical behaviors

An important distinction arises regarding ETBE that is critical to discussions of bioethics. There is a significant difference between human actions (1) harming a biological entity and judging the action ethical because we have deemed the entity inconsequential or below some perceived threshold of ethical consideration; or as a result of traditional utilitarian calculations of a greater good for greater numbers (as we have generally done here on Earth for millennia), and (2) determining that any human action resulting in harm to any living entity (regardless of assigned status) is unequivocally unethical but presently unavoidable given our culture or circumstance. The approach we choose is critical to futures work.

7.4.1.1 Ethical relativism

In the former case of ethical relativism we are forced to constantly redefine the constituent elements and obligations of ethical behavior to match all but our most egregious actions. For Descartes, nailing dogs to planks was ethical because he believed them to be non-sentient, that they did not feel physical pain and that the scientific value of his contributions to human anatomical knowledge were superior to any adverse effects on his subjects. It is later determined that yes, dogs feel physical and psychological pain and vivisection is then believed to be unethical. An ethical basis for slavery in the Americas is argued as defensible because Africans are believed biologically inferior to Caucasians, that they exist on a lower evolutionary stratum and are therefore, to a degree, ethically discountable; the claim is later found to be without moral or biological foundation and slavery is then considered unethical.

Housing thousands of hogs in deplorable conditions is believed by many to be ethically defensible, but now practices regarding industrial husbandry for many species is being challenged on bioethical grounds. There is a strong incentive to believe that we are ethical beings, so we maintain the illusion that our behaviors are ethical; we cannot imagine ourselves to be otherwise in our daily activities and choices and we fine-tune the world around us to support that perception. We enjoy bacon. It is readily available and supports a significant industry. We have a culture that encourages it so we place hogs below a threshold of ethical considerability in spite of simple observation that they are likely as aggrieved as Descartes' dogs (Herzog 2010). *Ergo*, raising hogs in deplorable conditions is ethical -- for now. In a few decades or a century our descendants may view our ethical behavior to be as defenseless as we view Descartes'.

Many cultures revere old trees, not because of their taxonomic classification or their particular contributions to ecosystem maintenance but just because they are old. [239] Battles are fought when they are threatened. Yet one never hears of someone chaining themselves to a sapling. In a sense, ancient trees have transcended the ethical status of their species by virtue of age. In the West, this marks a relatively recent reversal in ethical provisioning. A century ago loggers took pride in posing on the giant stumps of

[239] A few individual ancient oaks, hemlocks or pines in a forest of younger trees provide little unique ecological service that we know of, yet people become emotionally attached to them because of their age.

their efforts and frequently made a point of the great age of what they felled (e.g., captions such as, “this tree was over 100 years old when George Washington was born”). Today’s equivalent is the fisherman posing on the dock next to their record marlin. However, while weight and length are of great importance, few would brag about killing the oldest fish.

Accepting ethical relativism obviates the need to lower the threshold of consideration or improve our ethical behaviors. We have determined those actions ethical, so there is no incentive to change. We are without guilt, and any attempt at lowering the threshold or campaigning to change behaviors is, therefore, superfluous; an acceptable ethical standard has already been met. As such, calls for higher ethical standards (e.g., more space for egg-laying hens) serve as indictments of practices already deemed acceptable. They are, therefore, often viewed with contempt.

7.4.1.2 Ethical objectivism

In the second case, we acknowledge that many of our intentional and unintended daily actions are unethical, that yes, we *do* routinely participate in unethical practices both knowingly and unknowingly but see no reasonable behavioral, cultural or biologically possible alternative at present. We step on ants when we walk across a field; we poison rats in the granary. This approach affords us countless opportunities to both identify unethical practices and choose to correct them or not. It accommodates our history of seeking a more perfect bioethical practice as a long process of gradual improvement. It provides philosophical room for the reform and ethical advancement provided only grudgingly when we maintain the first option that current practices *are* ethical and acceptable.

This second approach holds simply that any harm done to any living entity, directly or indirectly, is unethical regardless of whether there are alternatives. The standard is unaffected by whether we determine the entity as having a theory of mind or whether it is sapient, sentient, succulent, useful to humans or useful to maintaining the environment, cute or microscopic or pathogenic. We continue to do unethical things because we have not yet developed ethical alternatives and behaviors. We presently condone unethical actions because they serve cultural functions that are slow to fade into history, but that use does not make them less unethical. We are socially and technologically ignorant of how to conduct our lives in a fashion that is entirely ethical. But like Rawls’ goal of a perfect standard of administrative justice based on fairness, here there is a goal of a fully defensible bioethical standard that is not relative to our present condition. It is an enduring truth.

Drawing again on the example of raising hogs for slaughter, rather than maintaining an illusion that it is an ethical practice we might identify it as an action that is unethical but currently unavoidable given the aforementioned reasons (cultural, economic, convenience, personal diet, etc.). Over coming decades we can choose to improve the conditions of hogs’ treatment and, perhaps, reach a point where we remove them from our diet and no longer need to employ them at all. A predictable rebuttal may be, we need to eat; is eating unethical? We fall back to the baseline question of harm. Do our current eating behaviors harm biological entities? Absolutely. Therefore, yes, eating other life is unethical. It also answers the debate-ending question, "but don't we kill bacteria by the millions every time we brush our teeth? Are you saying we should just let them go on creating cavities; should we just let wounds fester?" The response in this second approach would be, yes, it is unethical to kill those millions of living things, but we have no alternative at this time. This approach does not seek to damn, praise, forgive or bless such practices, but requires us to simply acknowledge them. It also includes considerations of the ethical consequences of following the strictest of vegan diets. Plants, as biological entities, are included as life, as are the yeasts in the bread we eat.

This approach is not based on concepts of "animal rights." It is about human potentials for better bioethical behavior. Similarly, we have no obligations to other species, terrestrial or ETBE. Obligation implies a deontological duty to a higher court, a directive that must be followed regardless of the merit of the action. Rather, it is about attaining a better condition for all living entities, to have a goal of being free of human-perpetrated physical violence directed at all life and, following, the environment we share. As yet we do not know how to circumvent these biological as well as cultural necessities. Can we imagine a time when we might? Yes. This approach provides room to imagine preferred futures.

CHAPTER 8
ALTERNATIVE FUTURES IMPLICATIONS

In dreams begins responsibility.

William Butler Yeats (1914)[240]

8.1 Premise

This dissertation draws heavily on concepts of alternative futures. This chapter provides a deeper discussion of futures studies in general and explores how those alternatives both affect and are affected by the potential discovery of ETBE.

The suggestion that bioethics can be based on not harming any living entity may seem absurdly naïve. Most would argue that it is neither possible nor even desirable, that it is a utopian dream without merit. While this chapter certainly affords no "proof of concept," it offers arguments in the areas of health, food, and intra-human violence with the purpose of initiating a conversation.

8.2 Futures studies and ETBE

It is likely our ancestors have imagined a minimum of at least a singular future since we developed sapience, even if that temporal future was limited to only a few days, a season, a year or perhaps a generation. Certainly in pre-agrarian and likely during the early millennia of the agrarian period options for change were greatly limited; life continued unchanged for scores of generations. The interior of a farmer's shelter would look the same, contain the same implements, tools and art for thousands of years. Concepts of religious, cultural, or political change were relatively unknown; what was, is -- what is, will be. Technological change was imperceptibly slow, measured in centuries if not millennia unless punctuated by trade or the slow migration of ideas. Progress was measured largely by survival and fecundity. In that there was little evidence of intergenerational change, thoughts of alternative futures were likely few. The cores of many of today's cultures still reflect (and even celebrate) these vestigial tenets of permanency and many of our modern struggles are abetted by that paradigm. But what was is not now. Change has become a significant factor in Western and many other cultures and our world of today is fleeting, with "permanence" defined by a few years if not shorter periods. Novelty on all fronts allows us to do and imagine what we could never do or think before (Dator 2002; Kurzweil 2005; Friedman 2005). With the advent of rapid change (especially rapid technological change), antiquated concepts of a static condition generally fail and are replaced by the freedom to imagine a diversity of possible alternative futures.

Speculation on the nature of extraterrestrial space is ancient and ubiquitous among cultures. We can assume that we have known for millions of years that the sun has dramatic and immediate positive and negative effects on us and our environment. Such

[240] From "Responsibilities" by WB Yeats (1914). Yeats attributes the origin of the line to an "old play."

recognition is clearly demonstrated by many other species that behaviorally respond to diurnal, lunar and seasonal cycles without knowing much about the constituents of our Universe. Our general ignorance created fertile ground for imagination as evidenced by elaborate astronomical and astrological mythologies. While more recently we could imagine the use of space (e.g., Jules Verne's *From the Earth to the Moon*, 1865), no data supported the validity of our assumptions. Over the past century, however, we have gained enough understanding of celestial worlds (especially the Moon, Mars, and other bodies within the Solar System) and the technology that allows proof-of-concept that we can successfully send people there (with a demonstration of that proof provided by the Apollo Program). Tools provided by futures studies allow us to construct scenarios to aid in planning for such events and better understand the kinds of impediments we may face. Similarly, those same tools may suggest that we redirect our energies to more mundane tasks. Such are the natures of alternatives.

An early contribution that joins scientific knowledge with such imagining was provided by Konstantin Tsiolkovsky (1857-1935), a pioneering Russian rocket designer and engineer (he wrote of the possibilities of functioning satellites in the 1880s and in 1903 he published a theory of jet propulsion as a means for accessing space, well before Goddard's work in the US more than a decade later). Unlike the ungrounded fantasy of Verne's earlier work, Tsiolkovsky's science fiction classic *Beyond the Planet Earth* (1920) drew on his practical knowledge of cosmology and engineering to describe the requirements and potentials of such a journey. It helped to establish Soviet interest in space by providing a purpose to the effort: "By and large, this first visit to the alien world evoked a great deal of hope and enthusiasm, and aroused a spirit of adventure. Habitable or not, the Moon was a thing mankind could use," and the use of "things," for better or worse, is what mankind is frequently about (159).[241] Most importantly, he described both a rationale and direction for futures in space. As he wrote in a 1922 letter, "A planet is the cradle of mind, but one cannot live in a cradle forever."

Imagining alternative futures founded on present day knowledge from a diversity of fields allows us to proceed with describing the possible, evaluating potential consequences and choosing the direction of what may be most worthy, practical, expedient, or other qualifier. Many methods exist to assist this process (Glenn and Gordon 2009). Six theories for guiding this process have been suggested by Jim Dator (1999; 2009; 2012b):

- How created images of alternative futures influence and direct actions;
- How present and projected technologies will affect options for alternative futures;
- How age cohort groups among humans influence trends;
- Cyclical analyses of social and other variables;
- How to identify and assess emerging issues of all kinds (social, environmental, technological, etc.); and
- Social intervention and design.

[241] Of note is that Tsiolkovsky envisioned space exploration to be an international effort. His fictional crew included a Frenchman, Englishman, German American and an Italian in addition to a Russian.

For the issues at the core of this dissertation regarding ETBE, several tools have been especially useful: imaging alternative futures, the potential impact of technology, and the identification of emerging issues.

8.2.1 Four generic images of the futures

The future cannot be predicted, and those who claim the talent offer little for constructive analysis or planning. However, although *the* future or a set of alternative futures cannot be predicted, we can imagine classes of possible futures based on our assumptions about the world (and beyond), our histories, the likely consequences of our past, present and future actions and other factors. The six theories listed in the previous section can all be employed to varying degrees. Although each individual has their own personal vision and image of futures or a suite of overlapping and interdependent social, political, and economic futures, this range can be categorized into one or a combination of four dominant themes: continued economic growth; social, political, and/or economic collapse; sustainability; and transformation that transcends the present condition(Dator 1998; Candy, Dator et al. 2006; Bezold 2009). Various exercises directed at expanding this list (identifying more that these four) have failed; they have proven to be generally inclusive.

8.2.1.1 Continued growth

The present will grow into the future fueled by “more;” more wealth (including financial wealth by all its measurements as well as natural resources and raw materials), increasing population, and limitless opportunity. This constitutes what may be called the “official” view of the future in the US and all industrialized countries. It is the dominant aspiration of most lesser-developed countries, as well.[242] Many governments nurture this image of the future and do whatever is necessary to support it (including using it to justify war, e.g., securing resources to support growth and various concepts of *Lebensraum*). Many tend to view other images that conflict with continued growth as somehow subversive to the general societal (and political) good, perhaps to the point of considering it unpatriotic if not seditionist or even traitorous.[243] Reactions to Meadows’ *Limits to Growth* and the casting of the Club of Rome as a dangerous cult provide strong evidence of this aversion to conflicting theory (Meadows, Meadows et al. 1972; Meadows, Meadows et al. 1992). Growth is the foundation of Corporatocracy, the subversion of democracy by corporate co-opting power to influence government (Wolin 2008). In large part, many mainstream

[242] Bhutan has taken the novel approach of balancing the concept of Gross National Product (GNP, a measure of economic growth) with Gross National Happiness (GNH) in an attempt to add the negative externalities of economic growth (e.g., pollution, depletion of scenic resources, displacement, health, meaningful employment and other social conditions) to the overall calculation. Tracking GNH was initiated in 1972 by Bhutan’s King Wangchuck as part of the country’s five-year planning process. Rather than falling into the transformational futures category, however, the GNH is used as a planning tool for sustainability and, where contributing to GNH, growth.

[243] The suggestion that continued growth is not the only model is often viewed with suspicion and contempt. For example, the negative connotation propelled by such epithets as “tree hugger” or “flower child” arguably support the contention that those opposed to continued growth are somehow out of touch with reality or are subversively working against the common good.

Western religions also tend to support this model (go forth and multiply; the "Protestant work ethic;" demonic problems with idle hands, etc.), although there are certainly exceptions (e.g. Mennonite, Amish, Hutterite, and similar sustainable commune-based societies).

A supporting tenet of the continued growth model holds that as a resource is depleted as a result of economic growth, a superior substitute or more efficient process will be found: a "techno-fix" will evolve. For example, when global supplies of gold could no longer support the "gold standard" (backing currency with the valuable -- by agreement-- mineral), the standard was dissolved and economies adjusted to a new system not based on a limited resource, but on paper. This perpetuated growth. Today, not even the physical presence of paper poses a hindrance as money has become virtual.

William Stanley Jevons' *The Coal Question* (1865) concluded that as efficiencies in resource extraction or use are gained, the demand for that resource will increase. His analysis was specific to the relationship between the more efficient use of coal in James Watt's steam engine and the corresponding increase in the demand for coal in England. A more modern application of Jevons' "paradox" is that as electrical energy becomes both more efficiently produced and more efficiently used (e.g., the use of photovoltaic converters), consumption will increase, not decrease, and costs per unit may rise in response to that increased demand. Conservation of electricity (in terms of greater efficiency in its use, such as appliances labeled under the US government's "Energy Star" program) therefore increases demand, requiring greater electrical production, the inverse of what one would assume to be the outcome of such conservation programs. Similarly, recent surpluses of natural gas decreased the price and stimulated consumption in the US. Prices are increasing. Again, this functions to perpetuate growth through the "need" to increase electrical production and drill increasingly more-expensive gas wells.

Continued growth is the easiest to project into imagining alternative futures in that it is abundantly visible and easily measured; it can be graphed. It surrounds us. It permeates Western and many other cultures in all their forms and we are familiar with it. It appears seems natural, "right" and justifiable and it is affirming. But while closely associated with capitalism, it is not confined to capitalism. It nests well with various other economic and political models, including communism, socialism and fascism. All depend, to a large part, on the promise of growth.

Finally, growth also appears compatible with natural models of ecological succession, population dynamics, increasing taxonomic complexity and evolutionary theory…to a degree. What is ignored in this analogy, however, is that even in a "perfect" environment growth that exceeds space and resources is followed by a readjusted equilibrium or collapse. These lead us to the next two categories.

8.2.1.2 Collapse

This set of alternative futures is the antithesis of continued growth. Current social, political, and economic institutions either disappear quickly or enter a state of steady decline as they feed off the dwindling resources of other decaying structures. It may be accompanied by, or triggered by, environmental collapse (a significant factor in some past collapsed societies). Collapse stabilizes as a new equilibrium at a lower energy level is established and may, therefore, show a stair-step process of punctuated decline. The process of conversion from continued growth to collapse may be swift.

Examples of collapsed civilizations in our past are abundant (Diamond 2005). By the nature of their failure, there are likely many that left no significant treasure of detectable artifacts, no archeological evidence of their collapse triggered possibly by overuse and depletion of resources, disease, localized famine, attack from hostile neighbors, fires, earthquakes and other natural disasters, genetic bottlenecks, and other factors. Those whose collapse resulted from environmental imbalances that have been well documented include Easter and Pitcairn islands in the eastern and south Pacific, the Anasazi in southwest North America, the lowland Maya, Norse settlements in Greenland, Angkor Wat, societies in the Fertile Crescent and elsewhere. But failed attempts are not limited to the historical, and more modern examples of societies in decline would include (but hardly be limited to) Haiti, Columbia, several African nations and, perhaps, Nepal. Likewise, examples of societies that survived for thousands of years without any sign of a major collapse and have remained somewhat stable as a result of successful cultural interaction and established harmonies with their biological components include Java, Japan, Tonga, and others.

There is no *one* reason for societal collapse or a single reason for success, and there are lessons to be learned from each.

As with continued growth, images of future social, political and economic collapse are shared by many in that collapse has been experienced periodically in our past and is detailed in historical accounts, art, religion, and current media. It has happened before so could happen again; history repeats itself. There is a fascination with global climate change, terrorism in all its forms, "peak" oil, and other forms of "Armageddonmania" (as termed by Bezold, 2009). Collapse scenarios (at least temporary ones) are also supported by theories such as "boom and bust" business cycles, long wave theory (e.g., Kondratieff waves) and others, even to include solar flares, ice ages and geologic cycling (Dator 2006). As such, while most would consider collapse a condition to be avoided, the general population is accepting of the *concept* that it is certainly possible, whether probable or not.

But importantly, images of collapse serve as warnings, modern parables of what will happen should we *not* keep the continued growth model enshrined and fed. Without keeping the image of collapse alive, the public's willingness to tolerate the costs of growth (e.g., pollution, stress, defined class distinctions) may wane. Images of collapse may be essential to the maintenance of images of continued growth.

8.2.1.3 Conserver society/Disciplined society

A third category of alternative futures images recognizes that unlimited and continued growth is not sustainable. However, rather than a peak in the upward curve of continued growth followed by a precipitous collapse, a conserver society is characterized by a more gradual and controlled decline to seek a new equilibrium enabled by inspired planning and group commitment to the goal. An economic, social, and political steady-state is achieved through a stable, if not shrinking, population coupled with a decline in per-capita consumption, efficient use of resources (both renewable and non-renewable) and decentralization of distribution requiring fewer investments in transportation infrastructure. Control of much of the government is shifted from central to local levels. Implicit is a return to local, subsistentance-level agriculture. Likewise, manufacturing would be limited to the regional, if not local level, including increasing reliance on cottage industries. The goal is a sustainable economy with social institutions shrinking in size and scope.

Conversion from the current growth model to a conserver one would not likely be a smooth one. First, the power of interests vested in growth will hardly shrink into the night to avert collapse, and second, enforced conservation may not be welcomed by the general population that has been groomed to be consumers.[244] Accordingly, the "conserver" society is also termed the "disciplined" society in recognition that authoritarian control may be required to force change to avert a more dramatic collapse. Policies implementing the transition to negative population growth, decreased use of resources and mandated "getting by with less" will not likely be welcomed, especially in a democracy such as the US where those elected are frequently chosen based on their ability to describe and implement scenarios of growth as their primary political motivation.[245] Change to a conserver society may require a more oppressive, non-representative government with substantial enforcement capabilities.

The form of that enforcing authority is hardly fixed, and governance could take a variety of forms. Fascist styles readily come to mind, as do oppressive forms of democracy, socialism and communism; we've experienced them all before. We have also experienced theocracies and monarchies, both of which have proven their ability to supply the resolve to enforce a conserver/disciplined society.

8.2.1.4 Transformational

This last of the four categories of futures arises from the recognition of the following:

1. The continued growth that has defined the past several centuries (especially in the West) is unsustainable. Dwindling resources, increasing populations, critical

[244] There are certainly attempts by Continued Growth to co-opt Conserver, such as urgings to "Go (grow) Green." There is a lot of profit to be made in the process. Many such initiatives are growth, not conserver oriented.

[245] This anticipation of a requirement for an authoritarian transition is reinforced by the current 2-, 4-, and 6-year terms served. If growth, in some form, is not realized during those periods, an individual's chances for re-election to office are diminished by those who can describe such a future (i.e., the proverbial election question, "are you better off now than you were (2, 4, 6) years ago?").

dependence on a precarious agricultural network and other factors coupled with inflated economies and a culture founded on consumption are not attributes favoring a stable and just system. We live in a house of cards. We are a resilient species, and our potential to rise above the current stereotypes of the self-defeating behaviors we have been taught to support the *status quo* should not be ignored or underestimated.

2. We are at a unique point in human history. The rate and novelty of technological advances challenge our preconceptions of the possible on all fronts: energy, industry, health, adaptation, and many others. However, whereas the continued growth model that nurtures technology also views it as a "fix" to perpetuate growth with diminished regard for its detrimental effects, a transformational view holds that technology provides a means to escape the need for material growth.
3. Progress is no longer measured by gross national product. Technology thus becomes a liberating factor rather than merely a source of products that distract us from our transcendental natures. Through such elevated technology we will no longer need growth to justify ourselves and the systems that support us.

In the transformation paradigm, technology has not only come into the home, it has entered our being. It provides a means for humanity to recreate and redefine itself as something socially, psychologically, spiritually, and, literally, physically different. Artificial intelligence, robotics and artilects, genetic engineering, nanotechnology, extraterrestrial and extradimensional modes of living and life extension technologies combine to allow such visions of futures to flourish. As the other three scenario categories have prominent economic and political drivers, transformation is technologically based and would change the nature of politics to its core.

The four generic images all currently coexist to varying degrees. We certainly have an abundance of those whose futures are based on images of continued growth; there are many who live day to day under conserver and collapsed regimes. And although rare, societies founded in spiritual transformation have existed for centuries and continue to exist today. Transition to post-human has begun with the advent of biotechnology and related fields. All four scenarios can and do coexist in a plural society, even if they are not necessarily cooperative.

From these four we select preferred images and begin to plan strategies to achieve them. That is the heart of futures studies. It is a continuous process with constantly fluctuating targets and goals as new information emerges along our course.

8.2.2 ETBE scenarios

The following speculates on how each of the four futures may affect the search for and potential discovery of ETBE.

<u>Collapse and Conserver</u>
Of the four, both Collapse and Conserver societies would generally not affect ETBE. In either, economies would have reverted to subsistence levels. Governments, where they

exist, would be local and likely unable to have the resources or technical abilities to sustain space missions for the purposes of scientific investigation or discovery -- Haiti has no space program. For a global condition of Collapse or Conserver, ETBE, should they exist, would remain untouched by humans' sphere save missions launched previous to the collapse or prior to the transition to Conserver.

<u>Continued Growth</u>

The Continued Growth scenario supports the search for ETBE. Should they be discovered it seems doubtful that their presence would have a significant negative effect on growth regardless of the restrictions placed on its exploitation. Such a discovery likely would be used to further justify growth, perhaps spurring the growth required to venture farther into our Solar System and beyond.

The presumption of the presence of a valuable ETBE resource, the high cost and liabilities of exploration and exploitation and the keen competition that would be expected among space-faring nations and private enterprises for access and exploitation fit easily into the continued growth image of a possible alternative future. While the potential for lucrative exploitation and international competition are certainly key factors in their value, more important to the model is that profits and products serve to maintain continued economic growth, not sustain the *status quo*. For example, terrestrial thermophile bacteria collected from hot springs possess enzymes capable of metabolizing at temperatures far higher than other known organisms. The catalysts they produce have been used in high temperature industrial processes ranging from DNA segment amplification (DNA polymerase chain reaction that has become prevalent in thousands of laboratories around the world) to aiding in the manufacturing of industrial dyes. Organisms are discovered, new products are imagined and developed, they are advertised as a need, and the cycle of growth is perpetuated. The same may be likely with ETBE discoveries, especially given that only *after* ETBE are isolated can their processes be studied, cataloged, and marketed. Only after their discovery would a need be identified and their value subsequently justified. True, it could be argued that we certainly cannot determine a use for ETBE before we know it exists, but that is a feature of continued growth: novel uses need to be identified and then characterized as needs. New markets will be cultivated and anticipation of continued exploration and exploitation will perpetuate continued growth.

A stated priority of NASA's program is the search for extraterrestrial life. The action of the search, in itself, is a component of growth. If living entities should, however, be discovered, they may affect growth in either or both of two significant ways in addition to the scientific work that will be generated by their existence.

-First, with less than preservationist protocols, should the entity be found to possess valuable attributes they may be economically exploitable. Impacts to native ETBE and their environment would be expected to be small if processes or products can be synthesized or if the entity itself can be propagated *in vitro*. If such exploitation is profitable, ETBE may contribute to Growth as another product line of the pharmaceutical or industrial sector. If, however, ETBE should prove to not be exploitable or profitable but exploitation of its habitat would generate profits (e.g., through mining or other extractive industries, tourism, construction or research), the presence of ETBE may negatively affect such growth by potentially triggering various regulatory restrictions and prohibitions similar to Earth. For example, species listed pursuant to the Endangered Species Act are largely believed to depress economic growth by generally limiting the scope, location, or duration of actions that may adversely affect them. It would follow that mining and similar sectors may be restricted. However, the ESA has likely created as much if not more economic growth than it has stifled. As with NEPA (National Environmental Policy Act), new enterprises have grown in response to the need for action proponents to meet the acts' requirements and undertake the additional work of mitigating adverse impacts, not to mention the federal, state and local governments' administration of the process. These have become significant growth-supporting industries in themselves. Losses due to restriction of mining on Mars may be at least partially offset by the emergence of those other industries.

-Second, should the presence of ETBE trigger implementation of strict regulations effectively blocking any commercial use of the area, while it may slow growth it would likely not stop it. Growth may be intensified on Earth or directed at other celestial bodies that do not support ETBE.

Consider a Martian bio-exploitative venture within the continued growth scenario. While mid-level managers and production staff may be physically located on Mars, corporate managers would likely remain on Earth. This assumption is based on the likelihood that (1) for any corporate entity to be able to successfully initiate exploitation of an extraterrestrial location or resource it will have to be well established and financially secure on Earth. It may be multinational and involved in a broad range of enterprises, only one of which would be extraterrestrial exploitation; and (2) while corporate directors may visit Martian field sites they would not stay there any longer than the current CEO of BP would visit an oil field in the North Sea. It would be difficult to manage the other industries and subsidiaries for which they are also responsible. Ambitious corporate personnel who are living at the extraterrestrial site will likely find that to advance within the corporate structure will require their moving back to Earth (at least at first, until such a time as Mars develops considerable infrastructure and offers amenities.) As such, the field site will not be viewed as much as a "home" as a temporary assignment, a stepping stone within the corporation. This changes the relationship of the individual with the environment to a brief one, diminishing the responsibility one might feel toward the environment. The lesson that emerges from this brief scenario is that where there is a drive for continued growth, conservation of the environment becomes secondary. This is amplified in situations where managers are remote.

Should we discovery ETBE during a period of Continued Growth but then enter either the Collapse or Conserver scenarios, our direct impact on ETBE would likely diminish. For example, a mining operation on Mars may cease when the demand for its ores decreases as a result of the Earth's (and Mars') failing economies. Without support from Earth, human colonies on Mars may not be able to survive. However, should we have introduced forward-contaminating organisms to Mars the adverse effects of that introduction may dramatically challenge ETBE for centuries to come regardless of our physical presence.

Transformation

A transformational set of potential futures is more difficult to visualize than the other three due to its broad range of possibilities. Humans have, perhaps, speciated due to genetic interventions and technological enhancement; enhanced intelligence has transcended what was considered impossible only decades before; and the rate of change is accelerating. Post-humans, in every sense, are transcending previous social, political, and cultural boundaries in addition to biological ones. Here we meet a point of divergence. With transcendence, the need for a sense of physical place may be vanishing as more ethereal pursuits become prominent. Is Mars still the exploitable concern it was a century before? What could it offer that we do not already have, what we can already imagine and fabricate with our technologies or simply do without? If we have become truly spacefaring societies, would existing on the island of Mars be preferable to voyaging beyond our Solar System? Should ETBE exist there, unobtrusive and passive research may be all that we require, or perhaps we would not be overly interested at all, content to keep our distance and watch it evolve in its own way. If we have transformed we could perhaps live more lightly on Mars by adapting to its environment if we choose. Our relationship with ETBE may be based on commensalism or perhaps mutualism.[246]

Within a transcendent, transformational society, humans will likely evolve spiritually as well as technologically to reach higher states of spiritual awareness. It would seem that redefining our bioethical relationships with other species as well as among our now plural selves would be expected. As we merge more seamlessly with the hardware and software of technology paired with what has been considered in the past to be inanimate, new definitions of life will be required. Once the ethical gap between the living and inanimate has been closed, applying ethical consideration "all the way down" (as suggested in the preceding Chapter) may likely follow.

8.3 Future generations

Rawls and many others have addressed the ancient concept of justice between generations. Many cultures and traditions maintain that we, those living in the present, have a moral obligation and general duty to those yet unborn to leave the Earth in as good a condition as we find it (Brown 1989; Partridge 1976; Leopold 1949; Gyatso 2010, 15-20). Language to that effect is found in many founding legal documents, such as the US and many other states' constitutions and similar pronouncements.[247] The obligation

[246] Commensalism refers to the ecological relationship between two different species where one is benefited by the relationship and the other is unaffected. In mutualism, both are benefitted by the relationship.

[247] The constitution of Pennsylvania states that public natural resources are the "common property of all the people, including generations yet to come. As trustee of these resources, the Commonwealth shall conserve and maintain them for the benefit of all the people." It is not an option, but an affirmative duty (Barnes 2006, 34).

originates from many of the same criteria justifying our moral obligation to the present -- that we are stewards of the Earth because it is within our power to radically change it, for better or worse; that we maintain a concern for future peoples by the same motive that we care for our own children, as an extension and continuation of our humanity and identity; that a disregard for our futures negates our attempts for any physical, social or philosophical action that strives to survive into those futures; and that caring about future generations is the best way to care for our own.

Ethical concern for future generations is clearly a futures project. As succinctly stated by E.O. Wilson, "Any ethic worthy of the name has to encompass the distant future" (Wilson 1984). In the spirit of the long view, Allen Tough adds to the list of obligations that we do not set in motion catastrophic events that will diminish future prospects, to which Bruce Tonn adds, including human extinction (Tonn 2009, 227-435); that environments supportive of healthful living are, at a minimum, maintained; that general conditions of peace and political stability are provided (Tough 1993); and that options for future choice remain open (Brown 1989). Wendell Bell advises, however, that we must recognize our ignorance of the ultimate impacts of our actions and, in the spirit of humility, proceed with extreme caution (Bell 1993). This argues well for our proceeding in space exploration with a high degree of caution and reserve.

The qualifications for membership in future generations are changing, and changing rapidly. As described in the preceding chapter, our descendants may no longer necessarily be limited to traditionally-defined *Homo sapiens*. Rather, our species is becoming less distinct and singular as evidence of close natural interrelatedness and blending with other species at the cellular and molecular level grows and as techniques and processes allowing artificial sharing of genomes among species, xenotransplantation (using non-human biological materials in humans, such as pig valves, to correct malfunctioning human hearts), mechanical and cybernetic augmentation and other modifications shatter the singular definition of human.

Two significant volumes published in 1994 by the Institute for the Integrated Study of Future Generations comprise a series of papers presented in Kyoto that year addressing alternative futures with a focus on future generations (Kim and Dator 1994; Kim and Tough 1994). Many of the contributors spoke directly to expanding definitions and liberating past analyses of our obligations by articulating a futures perspective. An underlying message was that yes, we have obligations to future generations, but those generations may not mirror those of the present, ideologically, politically, socially, culturally, or even biologically. As expressed by Richard Slaughter, we can best recognize and fulfill our obligations if we accept that we in the present and those in our futures are linked in much the same way as we are to past generations. Our actions in the present have consequence. As such we have the moral obligation to consider their impact on future generations and whatever they comprise. Slaughter concludes that establishing a culture of foresight is "arguably the greatest gift the present generation could give to futures ones" (Slaughter 1994, 1078; 1996).

In Buddhist thought, the concept of future generations decidedly embraces a multitude of species and recognizes life as a shared process among species. As described by the 14th Dalai Lama (Tenzin Gyatso), "Even though there is a chance you may be reborn as a creature, perhaps *even on a different planet*, the idea of reincarnation gives you reason to have direct concern about this planet and future generations" (emphasis added) (Gyatso and Rowell 1990, 77; 2010). The implications regarding ethical consideration for ETBE here are clear.

8.4 Bioethics for the futures

Concepts of not harming any life begin with considerations of not killing any life. We likely started down that very long path with the utilitarian notion that a specific, considered killing was not in our individual best interest. A lion may choose to not chase a gazelle because the distance to the target is too great, the terrain is uneven, the physical energy required for the kill is high and the potential of actually bringing down the prey is low. These outweighed the benefit of potential protein. It seems unlikely that any such thoughts are weighed by the cat in any formal analysis; as a successfully-evolved predator such calculation has likely become subliminal and routine.

Humans do roughly the same, both subconsciously and with great premeditation. So to suggest that not killing any life should become the norm appears as an affront to that history of utilitarian calculation. An expected reaction would be that life on this planet has involved killing for over 3.5 billion years and "decisions" to kill, whether automatic and biochemically triggered or the products of sapient reflection have been critical to our evolutionary progress. They have sharpened our skills as organisms designed to survive. All true. But drawing back to that utilitarian cost/benefit analysis, can we envision futures where any and all killing would be to our disadvantage? Can we envision futures where harming any other life would be to our disadvantage? I would argue, yes.

These are not futures of *Peaceable Kingdom* scenarios with lambs sleeping at the feet of lions. Here, the focus is limited to human and post-human behaviors, not prescriptions for how other species could or should interact; I am not advocating that the lion is in any way "wrong" to stalk gazelles or that such actions are unethical or unnatural.

While we still have plenty of work left to do, we have generally learned how to live without killing other people. We are practicing these skills and are fostering communities of nonkilling (Gyatso 1990).[248] All cultures have evolved to include customs and institutions designed to decrease inter-human harm, and living in relative harmony has proven survival advantages. While many can imagine futures where humans no longer kill other humans, it is far more difficult to imagine times where humans will not kill any life, and not harming any life lies beyond that. But we are taking quicker steps toward those futures as discussed in Chapter 3.

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[248] The term "nonkilling" is attributed to Glenn Paige as a concept of the opposite of killing. It can be used as an adjective, such as a nonkilling society. In Paige's usage it refers to nonkilling among humans only, not to other species. (See Section 8.3.3).

As stated previously, the most prominent utilitarian arguments challenging the nonkilling of all life involve our biological survival as individuals. We must eat and we must kill pathogens to survive.

8.4.1 Food

Animals are incapable of making their own food from inorganic materials. We rely on eating other animals or plants for the nutrition required for growth, maintenance and reproduction. Regardless of breatharians' claims, deep breathing and sunshine have never sustained us for very long. As autotrophs, plants are able to build sugars from inorganic compounds through photosynthesis and convert them into the starches, oils and proteins that animals consume.[249] As animals, we are dependent entirely on nutrition originally produced by plants. As described in the previous chapter, if we maintain that to achieve a perfect ethic we would not harm any living entity, including plants, then we must either tap their nutritional components without harming them or starve. Those options are changing.

Research on synthetic photosynthesis has made considerable progress in demonstrating that sugars can be produced using only those same raw materials used by plants: water, carbon dioxide and solar energy (Panasonic Corporation 2012; Royal Society of Chemistry 2012). If synthetic sugars can be produced on an industrial scale, synthetic manufacturing would not only produce food but would serve other beneficial functions such as sequestration of atmospheric carbon. The process could be operated where ever there were sunlight, carbon dioxide, water and the energy to drive the synthesizing process, on Earth or elsewhere (e.g., in outer space). While ostensibly less efficient at lower temperatures, it would not be limited by climatic zones, seasons, soil conditions, soil microorganisms, pollinators, weather or the other factors critical to traditional agriculture. No fertilization or pesticides would be required and existing acreage dedicated to agriculture would be freed for other purposes including reversion to native habitat.[250] We are no longer completely dependent on animal hides, fur and bone, sperm whale oil or even wood for fuel and building materials. Synthetic products and other alternatives have proven in many cases to not only be cheaper to produce but more durable and practical. In the coming century synthetic food production may prove even more efficient at replacing our need to harm plant and animal life, not to mention the potential impact on alleviating human starvation.

Consumption of plant and animal foods would likely remain for cultural or ceremonial purposes, but such use may decline as a socially-acceptable practice and fade into our histories. Given the rapid increase in the preference by many (especially in the US) for processed foods, learning to avoid harming for the purpose of nourishment may not take long to become a cultural norm. More distant futures where no life is harmed through

[249] Other autotrophs are also capable of synthesizing organic forms of energy without photosynthesis, such as bacteria that thrive on radiation energy to fuel the process (Monastersky 1997; Onstott 1997)

[250] This assumes that the synthetic production would require less acreage than plants to produce the same number of calories.

our nutrition may be an achievable goal. The impacts on every aspect of our lives and environment would be dramatic.

8.4.2 Health

Our personal health is affected by the balance of both beneficial and pathogenic microorganisms. For example, we all carry *Clostridium difficile*, a naturally occurring bacterium. While it is a natural component of our intestinal flora, it can cause severe diarrhea and a range of other symptoms possibly leading to death when populations of other resident bacteria are depressed, such as with antibiotics. The resulting bacterial imbalance allows *C. difficile* to reproduce unchecked without competition, leading to systemic toxicity and other pathogenic conditions. Rather than disturb the balance of resident bacteria with broad spectrum antibiotics, other methods for treating infections by controlling bacterial habitat are proving to be, in many cases, more effective in restoring health (Naaber, Smidt et al. 2004). Forms of medicine that focus on maintaining internal balances (such as Indian ayurvedic medicine, the yin and yang considerations of Chinese traditional medicine, herbal practices and others) are gaining in Western practice as they have proven to be more effective than Western approaches in restoring health in some cases with fewer and less severe adverse side effects.

This change in approach is mirrored in wildlife management. It was not until relatively recently that managing wild populations was largely based on purposefully harming some species and favoring others (e.g., bounty systems to eradicate wolves, bears, lions and other "undesirable" species while simultaneously planting crops to encourage desired huntable species such as waterfowl and deer and stocking non-native fish) (Giles 1969). Resulting imbalances generated disease outbreaks among crowded populations, crop depredations and other unforeseen conditions (Leopold 1948). It also became apparent that, for example, removing a predator such as wolves from an area to increase the deer population had unintended and undesirable ecological ramifications. Wildlife management today is more focused on correcting these imbalances through habitat management that restores natural balances within the ecosystem. This parallels modern medicine's decreasing reliance on radiation therapies and pharmaceuticals devoted to unbalancing bacterial populations, such as broad spectrum antibiotics, and replacing them with treatments such as prescribed probiotics (Sanders Jr and Sanders 1984; Huovinen 2001).[251]

Medical treatments are likely centuries away from practices that do not involve killing pathogenic organisms, but achieving that goal is not beyond consideration. Arguments against the survival of such pathogens as anthrax or smallpox are difficult to challenge at this time, but effective non-harming alternatives to destruction may become available in the futures.

[251] Fecal transplants are now used to restore lower gut flora when the microbial mix is unbalanced.

8.4.3 Nonkilling in the context of outer space

> *In Buddhism practice we get so used to this idea of nonviolence and the ending of all suffering that we become accustomed to not harming or destroying anything indiscriminately. Although we do not believe that trees or flowers have minds, we treat them too with respect. Thus we share a sense of universal responsibility for both mankind and nature.*
>
> Tenzin Gyatso (14th Dalai Lama)
> *A Question of Our Own Survival* (2010, 18)

In *Nonkilling Global Political Science,* Glenn Paige cites that when a group of 20 American political scientists were asked, "Are nonviolent politics and nonviolent political science possible?" virtually all responded, "It's absolutely unthinkable" (2009, 23). He describes nonviolent politics as a society characterized by "no killing of humans and no threats to kill, neither technologies nor justifications for killing, and no social conditions that depend upon threat or use of lethal force." As he explains, we have lived in a society where killing is accepted as a function, if not a right, of many governments and that few challenge its legitimacy or need. Yet, nonkilling is thinkable. Conceptions of futures where killing is not only illegal but where it no longer plays any role in culture are conceivable. In our more distant futures, it appears to be a desirable and expected behavioral evolution.

Few people actually kill other humans, so visualizing futures where killing is not only no longer considered a political or personal option but is not culturally tolerated is within our imaginations. It is closely linked to the concept that given our weaponry, killing is really not favorable to our survival as a species, yet we continue, all the same (Kumar 1969). To visualize futures where no life is killed, however, is likely impossible for most to envision. If a question similar to that asked the 20 political scientists, "Is it possible to not kill other living entities?" the answer would predictably be "absolutely not" followed by a range of reactions of disbelief far surpassing that expressed when asked about nonkilling humans.

Regarding killing people, Paige continues, "The implied normative shift is from the killing imperative to the imperative not to kill. One way this can occur is by a cumulative, value-added process of interacting ethical and empirical discoveries. Ethically the implied progression is from killing is ethically imperative, to killing is questionably imperative, to nonkilling is hypothetically explorable, to nonkilling normative commitment. The parallel empirical progression is from nonkilling societies are impossible, to nonkilling societies are problematical, to actual and hypothetical exploration of characteristics of nonkilling societies, to scientific commitment to seek knowledge to create and sustain nonkilling societies in a nonkilling world" (2009, 78). Substituting "harm" for "killing" in the context of human interactions would describe a possible next step. Addressing all life, nonkilling would be an extremely difficult goal to achieve considering the depth and complexities of our relationships with other life and the absolute need for technology to allow us the option of nonkilling. While nonkilling humans is likely achievable with cultural and social consensus, nonkilling all life requires technologically mediated alternatives. Nonharming life lies beyond that. The concepts are difficult to imagine within the context of our general lives due to the deep complexities of Earth's ecosystems.

Space, however, offers far less complexity and fewer cultural requirements for harming life, whether terran or alien. Consider, for example, the more achievable goal of nonkilling humans as Paige described. Those who could not imagine nonviolent and nonkilling political systems on Earth cited a number of reasons why they believed it unachievable, grouped to:

- Humans are by nature killers;
- Competition for scarce resources will drive people to kill; and
- People will kill in self-defense or to protect others from being killed.

In the context of outer space, however, most of those same responders may more easily imagine that that homicide in any form could be entirely avoided. This would be facilitated by abandoning terran cultures and their permitted lethal behaviors. Those going to Mars would be chosen, not self-selected. They would be trained that cooperation would be the key their survival; they would be held to a higher behavioral standard than on Earth. There would be no armies and no need for the kinds of weapons specifically designed to make killing or harm remote, efficient and instant (e.g., firearms, toxins, etc.). While true that one can kill without weapons, perhaps other methods of controlling violence before it results in killing could be technologically mediated. After several generations, expectations of nonkilling other humans may become so ingrained within their outer space cultures that killing would no longer be thinkable (Fabbro 1978). While difficult for most to accept the possibility of a culture of nonkilling humans on Earth, on Mars or any other outer space location it can be more easily envisioned.

Although more difficult, progress toward a culture of nonkilling of any and all life is also easier to envision in space. The most accessible circumstance would be where human life (including the trillions of other organisms we personally carry) was the only life there. By not killing people, you would largely meet the standard of planet-wide nonkilling. This assumes progress toward medical treatments that avoid killing your internal microscopic community and production of synthetic foods. Within the confinement of controlled habitats there would be no need for pesticides; control the habitat and you control potential pests. Sewage may be compostable and recyclable. While there are still many issues where life on the bacterial scale would be harmed as a result of intentional human actions, adverse impacts could be reduced significantly and, most importantly, the loss would be acknowledged. It could continue to be reduced with experience and technology.

Should ETBE be encountered, human activities within enclosed habitats would not likely have significant uncontrollable effects, especially assuming the recycling of wastes. Likewise, activities outside the confines of a sealed habitat may have minimal or no effect. As on Earth, large volume resource exploitation would have the highest potential for adverse impact on ETBE. Mitigation could be accomplished through identification of ETBE range and avoidance, and where avoidance is not compatible with exploitation, reassessment of the need for the resource or mitigation to the net benefit for ETBE could be sought.[252]

It is hard to overemphasize the essential role of culture in progress toward nonkilling and nonharming, whether of other humans or all life. In space, cultural variables are more easily controlled than on Earth. There need not be support for a culture of violence fed by myth, fiction, play and all the other traditions that glorify violence on Earth. While demonstrated for centuries that we can be trained to be numbed to inter-human violence, to accept, celebrate and perpetuate it, there are also examples of the opposite (Bonta 1996). Space allows us the opportunity to more easily distance ourselves from negative influences and replace them with new ethical approaches in our relationships with the biological universe.

8.5 Matters of scale

While NASA and others have stated that the search for life is a critical component of their programs, current research is not overly intrusive. We do not yet have the technology that would enable significant physical impacts and currently planned astrobiological research efforts such as the Mars Science Laboratory "Curiosity" are modest regarding their physical impact. The search for biochemical signatures and more physical traces of past or present life require only small sample sizes, perhaps only a few grams or cubic centimeters (DiGregorio 1997). Regrettably, harm would be expected if ETBE are encountered either as a result of the physical trauma of the collection process (e.g., grinding rocks) or during testing phases; reaction chambers are sterilized between samples. While admittedly an extremely small percentage would be adversely affected given the likely range and population of ETBE should they exist, admitting harm is an important step. As argued in the preceding sections, any harm is unethical, however small the percentage of the total are affected. The admission provides a framework for gradual improvement; denial does not instigate positive change.

As on Earth, our best expectations would be that we minimize adverse effects through reasoned restraint. As with food and health, we do not yet have the technological or cultural means to do more. That should improve as we gain precision in our actions.

We do, however, have the potential to have a devastating impact on ETBE through forward contamination, and it is regrettable that NASA has reduced its standards for sterilization of the robotics and probes we are now sending to the surface of Mars and other celestial bodies (National Research Council 1992; 2006; McKay 2009; de Vera et al. 2012). Currently, the highest standards of sterilization are required only for those missions that are looking for life (like the Mars Science Laboratory), and even with those missions only the hardware that is part of the life-detection mission (e.g., the robotic arm that gathers the sample, but not the motors that drive the wheels) is required to be sterilized; other parts carry higher terrestrial bacterial loads. However, parts to be sterilized can be inadvertently missed due to human error or, far worse, through

[252] Proof of the efficacy of mitigation should be required prior to any resource exploitation, not contemporaneous with or as a promised action after exploitation.

premeditated actions in violation of protocols as demonstrated by contamination aboard the Mars Science Laboratory (David 2011, Sahagun 2012).[253] While the ethics of forward contamination on ETBE are certainly part of the consideration, the overriding near-term concern among the astrobiological community is that terrestrial bacteria could potentially confound research goals by generating false positives (Lupisella 1997; 2006; Rummel, Race et al. 2010); we may detect life on Mars, but the life may have originated with the craft delivering the detection sensors. More importantly, instrumentation may detect ETBE but it may be discounted by researchers as a false positive. Any forward contamination contaminates the data as well as the Mars environment.

As described by Cockell (2005), planetary protection policies (protocols for minimizing forward and backward contamination) can be approached from three different premises. First, in that we are seeking extraterrestrial life, forward contamination could confound that search. Sterilizing spacecraft reduces the potential of false positive results. Thus, the motivation for reducing forward contamination is driven by scientific need. Second, limiting contamination reduces the chances that ETBE may be adversely affected. While possibly evolving from ethical concern, the motivation may also be founded by instrumental motives -- adverse impacts of contamination may reduce their potential to be exploited.[254] Lastly, the motivation for preventing forward contamination could be derived from purely ethical calculations. Allowable levels of contamination would be related to the ethical value we place on ETBE we may be affecting.

8.6 Marsophilia

Humans routinely exhibit a deep attachment to the Earth through biological, spiritual, cultural and other pathways. Biophilia, referring to humans' almost universal fascination with our natural world, is well documented (Wilson 1984; Kellert and Farnham 2002; Kellert 2005). When coupled with Leopold's "land ethic," a spiritual bonding with landscapes, our current natures are clearly of the Earth. But such attachments may be challenged dramatically within the coming decades as space travel, especially multigenerational space travel, becomes common.[255] While original space travelers and settlers may maintain their emotional attachments to the Earth, the sentiments of subsequent generations not born here will likely begin to diverge, bonding with new environments in ways similar to 2nd and 3rd generation immigrants on Earth; they may reject "Earthy" sentiments as inappropriate, nostalgic and counterproductive. Such

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[253] "The issue involves a set of drill bits carried by the Curiosity rover…. When project developers made an internal decision not to send the equipment through a final ultra-cleanliness step, it marked a deviation from the planetary protection plans scripted for the Mars Science Laboratory mission. That judgment, however, didn't reach NASA's chief protector of the planets until "very late in the game," said Catharine "Cassie" Conley, NASA's planetary protection officer" (Sahagun 2012). "They didn't submit the request for the deviation not to comply with their planetary protection plan until several months ago, she emphasized" (David 2011). The contamination was later determined to be inconsequential because the target on Mars, Gale Crater, likely does not contain ice or water, and contamination of water is the overriding concern (Conley 2012 - radio interview).

[254] Cockell cites Rummel 1998.

[255] The joint NASA/DARPA 100-Year Spaceship Study is planning research into multi-generational space voyaging.

adaptations are hardly unexpected – it is a common theme explored in science fiction.[256] More pertinent to this dissertation, however, is that should settlement of other worlds not include a suite of imported Earth species, especially companion animal species, humans' ethical relationship with their new environment may be decidedly different.

Those living in an extraterrestrial world devoid of all but human life (excluding the bacteria we carry and employ) may begin to exhibit forms of egocentrism and hubris. There would be little to check the growth of extreme homocentrism, and an extraterrestrial world void of its own indigenous life may make adoption of a land ethic far more difficult than if ETBE exists. Without an object of biophilia, without life other than human life, the planet may rapidly come to be viewed as a cold commodity and little else. If that world is occupied for purely utilitarian purposes, if it is a "job" and not a home, that commodity view may not matter to humans. But if the intention is to stay for generations, a homocentric viewpoint may rapidly become problematic.

Should some extraterrestrial place, say Mars, be found to have no biological component of its own and should humans establish multi-generational populations there, it would seem critical that other Earth life or a substitute be included among the settlers.[257] If not actual animals or even plants, then virtual or robotic substitutes should be included; they can be almost as effective, especially for children (Shibata, Mitsui et al. 2001).

8.7 Political perspectives and privatization

> *Remoteness negates responsibility, for consumers, workers and shareholders. In rationalist commodity culture, we are actively prevented from exercising care and living in ecologically-embedded and responsible ways.*
>
> Valerie Plumwood, 2002 (p16)

The capabilities for space-to-earth targeting were seriously contemplated soon after commencement of the Second World War and the reality of the German V-2 rocket attacks on England and Holland, the first objects humans have ever put into space. References to space being the ultimate "high ground" from a military perspective were, and remain, abundantly true. The rockets highlighted the extreme difficulty of defending against such high speed aerial delivery systems. The OST was ratified by Cold War factions as a deterrent to keep conflicts on Earth from spreading into space.

Dean Rusk (later to be US Secretary of State from 1961-1969) wrote that in 1952 he canvassed several US universities asking if would be a "good idea… to begin thinking about the law and politics of man's entry into outer space" (1986, 316). "I could summarize the reaction as colossal indifference." He continues, "One professor of

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[256] Kim Stanley Robinson's "Mars trilogy" (*Red Mars, Green Mars, Blue Mars*), Frank Herbert's *Dune*, Ray Bradbury's *Martian Chronicles* and many others (Robinson 1993; 1995; 1997). The theme is critical to the 2010 film *Avatar*.

[257] The needs would be similar to the benefits of companion animals in hospitals, where patients are not only generally happier with the animals nearby but show more rapid healing (Cole and Golinski 2000; Fine 2010).

international reputation told us at that the future is not the business of the university, even though the laboratories of his own university were hurling us into the future at a breathtaking pace." Then came Sputnik 7 years later and the world changed.

The most significant actors in the Cold War, the US and USSR, were well aware of the potential for an incremental dominance in space to equate to absolute dominance on Earth. As with the Antarctic Treaty, OST's primary purpose was to maintain peace by keeping space relatively demilitarized and by fostering cooperation on tasks lacking direct military implication.[258] They have both been successful. Cooperative efforts, the most notable of which has been the ISS, appear to have transcended much of the stronger political posturing back on Earth. Although ISS certainly supports an array of nationalistic goals, international crews have largely maintained a record of personal and ideological cooperation among the principals (Russia, US, ESA, JAXA and Canada) and other participating states.

Concurrent with the shared management of ISS has been an increased US reliance on private sector support. Most notable has been the termination of the active Space Shuttle program and the conversion to foreign or private craft for ISS access and other space transportation needs. As mentioned previously, the growth of the private sector in space transportation and exploitation demonstrates both the government's decreased priority and budget for such activities and increased corporate interest in space as an investment opportunity.[259] The two have very different agendas. The US government's primary purpose for a national presence in space has been to demonstrate both military strength and a high degree of national resolve in reaching goals. A secondary purpose has been, as with military spending, to channel funds to private industry and support local (and politically vocal) economies (e.g., Huntsville, Houston, and Cocoa Beach). NASA's more recent budget decreases have been matched with increased calls for restoration of those funds from both government and private sectors (Borenstein and Chang 2010). Organizations such as the National Space Society, Humans to Mars, The Mars Society, and Explore Mars initiated Mars One in 2011 to seek corporate sponsorship toward their objective of a piloted mission to Mars in 2023. Their primary short-term interests are public relations and lobbying the US Congress to restore both NASA's and the private aerospace industry's funding. Additional financing through such schemes as charges for the prominent placement of corporate logos on space vehicles, crew patches, etc., mission-related retailing franchises and "reality show" format commercial television contracts that would track a voyage to Mars and "celebritize" the crew have been suggested.[260]

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[258] A possible exception was the Strategic Defense Initiative (a.k.a. "Star Wars") proposed by Ronald Reagan which tested the limits of non-proliferation in space.

[259] At least decreased appropriations for NASA's budget. Department of Defense appropriations for space-related research are more difficult to track.

[260] As was suggested at a Mars Society Conference in 2011, "Imagine how many people would love to tune in every night to see how the crew is doing? Imagine the amount of money that sponsors would be willing to pay to be associated with such a show? It would be like *Lost* in space" (referring to the popular television series *Lost*). "It is estimated that $10 billion a year can be raised by clever marketing and advertising thereby generating public awareness and enthusiasm, and through the sale of Mars' merchandise ranging

In the US, space exploitation is in the process of morphing from a predominantly state-controlled agenda to a corporate one. This is in keeping with the general emphasis since the Reagan Administration to privatize as many government functions as politically feasible. For example, the public-sector functions formerly performed by the U.S. Postal Service, many military activities (e.g., Blackwater [Xe]), prisons, and even Homeland Security/Transportation Security Administration have been privatized. As traditionally governmental functions are weaned, private industry fills the void.

In space, this process was dramatically demonstrated in May 2012 with the successful launching of SpaceX's Dragon craft for provisioning the ISS. Other entrepreneurs have entered the field, such as Planetary Resources (with plans to mine asteroids), James Cameron (space tourism), Blue Origin ("We're working to lower the cost of space flight"), and others. Many receive government funding for portions of their work through contracts and grants, but they evidence a hybrid form of government/private industry partnership (PPV, public-private venture) that is becoming common throughout government. With gradually decreasing emphasis on public funding, they become entirely private enterprises.

Comparisons to the Pony Express, continental railroads and the aircraft industry are sometimes applied to space to demonstrate the natural function of the government to foster fledgling industries that will predictably stimulate subsequent growth and have positive impacts on future generations. In such instances, the government takes the considerable risk and liabilities at the front, often operating at a loss for decades to develop infrastructure (e.g., airports and rights-of-way). As the enterprises become profitable, private industries take on additional subsidiary functions and provide services in the most profitable operations within those sectors. Governments frequently maintain responsibility for the least profitable aspects of the operation (e.g., subsidizing the delivery of mail to remote locations) while other, lucrative aspects of the service are entirely privatized (e.g., Federal Express and UPS).

Space offers potentially significant differences that make the analogies less applicable. While Dragon's support of ISS is remarkable from an engineering perspective, hauling supplies to a government outpost on a privately owned and operated vehicle is hardly novel. However, many of the aerospace exploration companies are clearly planning on exploitation of celestial bodies themselves. As discussed previously, these areas constitute commons, the common heritage of mankind (regardless of whether "mankind" needs modification to include "all life"). Issues of how that commons is to be managed and by whom are critical.

While the government provided railroads the land and resources for their rights-of-way and commercial aircraft fly through the commons of the sky, anyone with an interest in the management of those commons may monitor, assess, and direct those actions through respective government agencies, including judicial functions. There are ample

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from toys to clothing. …Naming rights to Mars landing craft, the Mars Colony, etc., would yield an estimated $30 billion" (Joseph 2010).

opportunities to bring suit for infractions. Practiced American democracy, regardless of its weaknesses, provides a conduit for oversight and comment. Such a process would not likely be available on Mars. While corporate actions here on Earth may be scrutinized, the remoteness of extraterrestrial locations would not make them accessible except with the approval of the governing corporate structure. Should corporations, not governments (and lacking unbiased, uncoerced oversight by governments), launch expeditions to such remote places, opportunities for democratically-driven initiatives to monitor would likewise be remote. Management and governance of areas such as Mars have the potential to be dominated by corporate totalitarian systems (a not uncommon theme in science fiction). This has been demonstrated on a much smaller scale by mining and oil operations in remote areas of Africa, South America and the Pacific.[261] It was also experienced in the US with "company towns" that were most prevalent in the late 19th and early 20th centuries. Corporate objectives largely ruled everything from the price of food to education and religious policies to law enforcement and the courts (Green 2010).

There are instances where public monitoring and policing of commons has been necessary when government oversight is unavailable (e.g., the efforts of Greenpeace, Earth First, the Environmental Defense Fund, and the Sea Shepherd Conservation Society). Whether forms of legal concern and action or vigilantism would evolve to monitor operations on Mars is difficult to foresee, but such practices may emerge with a more permanent Martian population that has an interest in protecting its (now their) environment.

Political power flows between governing and corporate structures (Wolin 2008). Should governance of an area such as Mars be privatized or should public oversight be so weak (whether through regulation, insufficient access and enforcement resources, or resolve) that it cannot properly monitor to the extent to maintain the purposes of the commons, ethical and environmental regard would likely suffer. Regardless of ETBE protocols or prohibitions, there is little to guarantee that such entities would be afforded protection under a corporate governance structure without close monitoring. Experiences here on Earth consistently prove that a reality. This becomes especially problematic as global conglomerates on Earth grow in wealth, distribution, and power. Their present influence over governments is profound.

If, as indicated by current trends, governments take a more reserved role in space exploration and corporate enterprises gain traction, especially trans-national corporations, conglomerates and trade associations, it would be difficult to control extraterrestrial exploitation of any kind. Should industrial processes (e.g., mineral processing) also be relocated to space, government control would be extremely difficult.

[261] For example, the Ok Tedi copper and gold mining operation in Papua New Guinea released 30 million tons of polluting tailings into the watershed each year, but corporate domination of local governments allowed the violation to continue for more than a decade (Ghazi 2003). .

8.8 A final thought about post-humans

When considering normative bioethical behavior of future humans it is critical to remember that post-humans may well include not only other biological permutations (*Homo sapiens* _?_, *Homo* _?_, or even _?_ _?_) but cyborgs, robots and androids (humanoid robots) as well (Moravec 1998; Kurzweil 1999; Moravec 1999).

Isaac Asimov suggested three "laws" for robots in his 1942 science fiction story *Runaround*:

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey the orders given to it by human beings, except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.

But there is little to indicate that these 1942 "laws" drafted during the depth of the Second World War have remained pertinent (Bainbridge 2012). Asimov correctly predicted the arrival of rudimentary robots and their rapid evolution, and if their rate of advancement continues there is a high probability that they will become autonomously-functioning human surrogates in this century. However, the trend we are experiencing today is accompanied by sectors that require robots to conduct military and policing functions. Many are far from benign. Prototypes can carry weapons for battlefield use, and although they have not been directed to do so, some have the capacity to autonomously identify and fire on human targets. While drone aircraft are directed by humans, with retooling they, too, could have the capability to identify and target humans. The US Department of Defense is investing in expanding the capabilities of robots in these areas. For example, DARPA has contracted studies for the Energetically Autonomous Tactical Robot (appropriately acronymed EATR) that can replenish its energy needs by grazing on vegetation (Lin, Bekey et al. 2008; Lin, Abney et al. 2011). While advertised as a vehicle, a presentation by Robotics Technology, Inc., the DARPA-contracted developer, describes that EATR is "able to occupy territory and perform missions with sensors or weapons indefinitely" (Finkelstein 2009). More directly related to bioethical issues, machines have been programmed to inject a lethal "cocktail" of drugs into the condemned at executions. The machines had to be developed because physicians determined it was unethical to do so personally.

But is it in "our" best interest to allow robots to purposefully injure or kill? We have crossed that threshold and, at least for the military and for capital punishment purposes the answer is yes. When robots themselves are included within the family of "our," that conclusion may change.

CHAPTER 9
RECOMMENDATIONS

9.1 Premise

The considerations presented regarding biology, concepts of the ownership of life and bioethics are now joined to formulate suggestions for guiding our initial relationships with ETBE. How might our exploration of another world such as Mars, Europa, Ganymede, or even our own Moon provide an opportunity to consider new relationships with non-human biological entities? How might this work in that we don't know if such entities even exist? And what are the futures implications of developing a culture of nonviolence and the avoidance of killing both in outer space and here on Earth?

9.2 Dangerous ideas

Preceding chapters have challenged broadly-held assumptions by arguing the following:

- That species and other taxonomic classifications do not designate discrete units.
- That life and death are not easily defined and that boundaries separating animate and inanimate are not distinct.
- That the concepts of human as a species and the cultures of being human are not immutable; that humans will likely change, both biologically and behaviorally, as we adapt to range of possible futures.
- That ethical consideration cannot be justifiably metered according to taxonomic classification and that traditional assessments of such factors as a theory of mind, sapience, and sentience are of diminishing relevance as our technological ability to perceive them advances.
- That utilitarian equations applied to bioethics do not provide consistent remedies for determining the distribution of ethical consideration.
- That ownership of life is indefensible in consideration of the principles of justice.
- That extraterrestrial life discovered within our solar system or beyond cannot be classified for ethical consideration in the same manner as life on Earth.
- That a culture founded on nonviolence is conceivable.

Debating these in a philosophical context may be ignored by most as a quaint or even naïve thought experiment; the theoretical outcomes are generally not considered especially consequential to social, political or economic life. Challenging the assumptions gains in potency, however, when raised from a theoretical to a policy level. In the context of space exploration and exploitation where potential profits in the billions of dollars may be negatively affected, they become dangerous concepts. Policies that potentially foreclose options for exploitation or that require royalties or similar distributions can result in political as well as financial turmoil (Ridgeway 1970; Ophuls 1977; Benveniste 1983; Brown 2006). Uncertainties regarding such policies can be just as upsetting as their realities.

9.3 Recommendations and considerations

Bioethics and intellectual property rights regarding life (broadly defined) are closely related. The following are offered as recommendations and considerations for outer space exploration and development to guide policy regarding the search for and possible relationships with ETBE should they be encountered. The suggestions are not intended to be conclusions; quite the opposite. It is hoped they will serve as starting points for generating discussions that re-evaluate assumptions regarding ETBE exploitation, namely, that existing relationships with the exploitation of life on Earth will apply seamlessly to extraterrestrial entities.

9.3.1 The business of ETBE - management policy considerations

9.3.1.1 Business as usual?

The paucity of current policy regarding the above-listed issues can be approached in two significant ways by space industries.

First, that lack of policy allows for positive speculation and adaptation. The general impression from the vantage of the space investor and proponent tends to be an optimistic one.[262] The majority opinion is likely that the same protocols that a business faces on Earth would be expected on Mars or elsewhere in space within the framework of the Outer Space Treaty. While only a few hold to the belief that real property ownership is permitted, most seem to agree that sovereignty claims of real property would not be an option given the reality of OST and the Moon Agreement. Exploitation would likely be guided by the set of current regulations regarding Antarctica, the deep seabed, and other global commons in addition to current practices on public lands, such as within US National Parks.[263] Any life discovered would be subject to patenting in an identical manner as on Earth (i.e., extraterrestrial "microbes" removed from their natural environment could be patented as well as their processes once other requirements for patenting are met). Assuming any ETBE discovered would not also be found on Earth, documenting novelty would certainly not be a problem. Profits generated from such a discovery may be substantial assuming the biological entity evolved in a Martian environment. It would have adapted to survive the rigors of that environment. As such, it may demonstrate mechanisms that would assist human (or other terran life's) survival there. The range of potential patentable processes may be large and lucrative.

The assumption that regulation will mirror that encountered on Earth provides the industry a sense of stability and predictability for investors; they can maintain a degree of assurance in an otherwise extremely risky and expensive venture. However, it rests on an

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[262] In a presentation to the inaugural meeting of the 100-Year Starship Symposium in 2011, Sir Richard Branson, CEO of Virgin Group and its space-going subsidiary, Virgin Galactic, voiced strong optimism regarding the coming decade in space.

[263] The 560-page *Benefits-Sharing - Final Environmental Impact Statement* produced by the US National Park Service provides an excellent review of the issue (US National Park Service 2009). It is available on line at www.nature.nps.gov/benefitssharing/

assumption. Industries will likely proceed until blocked by some new policy or determined older terran protocols do not apply.

Within this scenario, assume a private venture returns a sample of Martian soil to Earth, identifies that it contains microscopic ETBE and subsequently discovers that the entity produces a unique enzyme allowing rapid DNA repair and regeneration. This enzymatic process allows the entity to rapidly fix damage resulting from intense Martian ultraviolet radiation. The company is able to describe that enzymatic process and proceeds to patent it. Only at that point does public or governmental pressure culminate in policies barring any such patenting. Years of safety sufficiency testing may be required. The project is stalled and funding begins to drift to other, more assured, R&D programs. State or UN determinations will likely redefine those legal and procedural points.

A second, more pessimistic approach is that the lack of clear policy makes it extremely difficult to assess probabilities for the success of a space venture and accordingly dissuades initial investment. Why, from a business perspective, invest possibly billions of dollars seeking ETBE if the business has the potential to be blocked from bringing products to market in a timely and financially successful manner? It would be far better to let government-sponsored expeditions make the investment and endure the liabilities and place private investment dollars in projects back on Earth. If and when ETBE are found, then undertake the venture. A libertarian perspective maintains that without clear rights of ownership (of both intellectual and real property) there will be little incentive for investment (White 1998; Simberg 2012).

9.3.1.2 Regarding legal priority and standing

Many active in the aerospace field believe journeys to the Moon, Mars, and elsewhere in our Solar System should be considered a national priority, both in the US and elsewhere.[264] However, rationales for such ranking are often weak, citing such generally vacuous evidence as “space is humanity’s next step” or “space is humanity’s next dream” (Japan Aerospace Exploration Agency 2012). More likely, motivations are founded on maintenance of the space industry itself as a capitalist venture vested in process and continued growth, not on ideals; the industry *is* the industry. “Private (space industry) firms owe their success not to the utilization of space resources but to the vague pursuit of space resource utilization” (Marshall 1995, 41). Searching is the industry of space. While true that there has been an amazing list of patents and research accomplishments derived from work in space (most notably aboard the International Space Station - ISS), except for the benefits of zero gravity many argue that much of the work may have been accomplished more efficiently and far cheaper on Earth.[265]

[264] This group includes many private and government astrobiologists, space engineers, and others who have written about space as a priority or who have spoken on the subject. There are also lobbyists employed by various space industries and public non-profit organizations (e.g., The Mars Society and 15 other space advocacy groups are listed at: http://en.wikipedia.org/wiki/Category:Space_advocacy_organizations). They actively campaign to make space exploration a priority.

[265] The majority of the patents granted for work done in the ISS have been awarded to the non-governmental entity doing the work, not to the governments sponsoring the mission. Because the ISS is

There is a general perception within the space industry that a more aggressive timetable for space exploration is needed (e.g., sending humans to the Moon or Mars within the coming decade) (Zubrin 2011).[266] Many voice with a high degree of urgency that, at least in the US, the government is remiss in not funding a more aggressive program. The unspoken rationale appears to be driven by a capitalist system in need of growth, and space provides the literal space and resources that may be critical to enabling that growth.

A quite different aspect on immediacy, however, regards ETBE. It appears that unless there is a considerable economic downturn in the developed world, space exploration and exploitation will continue to gain both proponents and momentum. This is especially true in consideration of Chinese and Indian space endeavors coupled with the strong entrance of private ventures into the business of space. "Already China has declared its intent to alleviate its growing population and decreasing resources through space colonization" (Cooper 2003, 115).[267]

As described in 2011 by a NASA attorney specializing in space property, should biological entities be discovered, our relationship will likely be determined by the courts modeled on our experiences and legal precedence established with life here on Earth. While non-human entities on Earth may have legal standing (e.g., corporations, states, and certain rare species), their interests are limited. For example, in environmental law a non-human species is more likely to be granted legal standing where harm to a human interest can be demonstrated and humans have an established relationship, a special interest in, that species. It helps greatly for that species to be granted standing where a continuing human interest in that species has been demonstrated over time.[268] For example, in a 1985 California legal case regarding the shooting of goats on Navy lands, Animal Lovers Volunteer Association (ALVA) organized to seek an injunction of the practice.[269] The Federal 9th Circuit determined that ALVA did not have standing as it did not, as an organization, have a history of pursuing such cases; it could not demonstrate a history of "commitment to the dispute independent of its desire to pursue legal action" (Hogan 2007, 518). The case was dismissed due to lack of standing. The Court's written

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largely subsidized by government funds, this represents a boon to private industries, universities, etc. and does little to fund the operation of the ISS or related government-sponsored space programs.

[266] 2012 Presidential candidate Newt Gingrich called for a more aggressive space program (establishing installations on the Moon), but while supported by the space industry it was generally ridiculed by the media and public, demonstrating the possible sea change in public opinion since the days of the Apollo program. Although Apollo was not considered a national priority at the time, NASA had a stellar public image. Perhaps the luster of the novelty of space has grown dull. Launches are no longer news; astronauts are no longer heroes; it is no longer a competitive game with the USSR; and competing realities of a sluggish economy cause the public to question the costs.

[267] A more recent (2012) general economic downturn in China may postpone some of the more aggressive space goals set during the last decade.

[268] A frequent link to human harm is through tourism. *I.e*., there will be fewer birdwatchers if the species at issue were to become extinct and tourism-related businesses in the area will suffer financially. The opposite was unsuccessfully argued -- that because a federal action had the potential to decrease the number of birds, the birds would therefore become rare, increasing the pleasure of those birdwatchers who might chance to see one!

[269] Animal Lovers Volunteer Association v. Weinberger, 765 F.2d 937, 938, 9th Circuit 1985.

decision continued that had another organization with such a history initiated the case (e.g., the well-established Fund for Animals), standing may have been granted. The significance here is that if some form of human-mediated guardianship or demonstrated interest in ETBE is to be effective, it cannot be an *ad hoc* or spontaneous call for representation, but must be an established institution of demonstrated concern and resolve.

Recommendation:

- Consideration of ETBE within the context of an international agreement (likely within the UN framework of the Space Treaty or under the auspices of the UN Committee on the Peaceful Uses of Outer Space) may assist in demonstrating the "commitment to the dispute" the Court was seeking in the ALVA case. Similarly, an organized group could be founded to represent the interests of ETBE before the fact of their potential discovery. Discussions of guardian *ad litem* representation, assessments of potential harm and other issues would establish a precedence of interest, possibly making demonstrations of harm to ETBE more easily established in some future court and aiding in the granting of standing in such procedures.

9.3.1.3 Regarding benefit sharing and patenting

Rawls founds his work in *A Theory of Justice* on the premise that to achieve the highest level of justice a society must seek to craft its decisions to not further disadvantage its least advantaged members. Ideally, political and social decisions would go further and improve the condition of those least advantaged. Social inequalities would be justified if and only if they serve to raise the position of the worst-off group within a society in circumstances where without those inequalities the worst-off group would be further disadvantaged. Distributive justice serves as the vehicle for achieving those ends.

These positions can help guide policy regarding the distribution of benefits derived from the exploitation of resources claimed as the "common heritage of mankind" described in Chapter 5. Any damages done to the commons would be mitigated by the action industry, e.g., a mining company. As an option within the Convention on Biological Diversity regarding benefit sharing, funds can be applied to minimize taking or ensure no net loss of biological populations or habitats. Lands or habitat buffer can be purchased or otherwise secured. Such actions fulfill obligations for the taking of resources that are "common heritage" without requiring direct payments to people or funding programs directly benefitting people (e.g., resource-related training programs or support of research institutions).

If we consider all life, including ETBE, as having ethical status in keeping with our expanded hypothetical Original Position, we accordingly need to expand our definition of the class included in "common heritage of mankind" to include all biological entities; rather than space being the "common heritage of mankind," it becomes the "common heritage of mankind *and* all extraterrestrial biological entities." ETBE on Mars would have a shared interest in Martian resources. Folding that back into Rawls' concept of the least advantaged, if we are mining on Mars and should Martian entities be adversely affected by that action, they could be judged the "least advantaged representative entity" and, therefore, such adverse effects would be mitigated or the entities otherwise compensated through allocation of benefits for their conservation. Royalties generated from the mining would, therefore, be used to benefit ETBE as well as humans back on Earth. This is not because the ETBE itself is the common heritage of mankind but because it has standing in the class of all affected entities. We share the profits of the mining operation with ETBE in a manner similar to CBD benefit sharing programs, such as an established trust or similar instrument. Trusts have a record of legal sufficiency and, when established correctly, transparency. They have provided a valuable tool for not only independently managing money but also land and other types of property and resources (including air) within the context of capitalist and most other systems (Barnes 2006).

The International Seabed Authority requires that those seeking to mine the oceans' floors submit two proposals for the action, each for a different geographic area of roughly equal size. ISA issues a permit for mining one of the areas and reserves the other for conservation. As the mining creates profits, royalties from profit sharing schemes may be banked to aid in the conservation of the reserved area or for acquiring additional tracts. After Mars' resources are assessed similar schemes could be applied, perhaps with an even greater ratio than one-to-one; a mining proposal may, for example, include three or four sites to be conserved for every permit issued.

<u>Recommendations:</u>

- Require that any proposal to adversely affect an area of any extraterrestrial body be balanced with the reservation of similar areas for conservation or designation as "wilderness." This requirement would be fixed regardless of any separately required remediation or other on-site mitigation.
- Assess the efficacy of requiring that any application for substantial extraterrestrial construction operations, mining, or similar activities include a minimum of two or more proposed development areas. As with the International Seabed Authority, the permit issuing agency would randomly select one for development and the others for conservation in perpetuity.

Social and environmental welfare programs are generally more palatable during periods of economic growth, when the costs of administering and funding such programs are smaller than the percentage of projected growth. Robert Nozick, generally a critic of Rawls' theories, cites that this works well when, as he puts it, the "pie is getting bigger" during periods of economic expansion (Nozick 1974). In a scenario where ETBE are discovered and show potential for economic exploitation, the most-advantaged industries may view the added costs of mitigation, benefit return and benefit sharing as a simple cost of doing business. The costs of mitigation could be factored with other expenses, such as research and development costs, marketing, and return on investment to determine product price. With a resource as novel as ETBE, where there is neither a history of pricing nor significant competition, prices would likely support the costs of benefit return and mitigation. However, as with most commodities, competing products and producers would be expected to place downward pressure on prices and, if volume of sales remains unchanged, mitigation and benefits may soon become a significant factor eroding profits.

Unlike mineral resources it is possible that the small percentage of ETBE that would likely be removed from its habitat could be cultured on an industrial scale *in vitro*. The original habitat need no longer be accessed or exploited.

Recommendations:

- The 1977 Budapest Treaty on the International Recognition of the Deposit of Microorganisms for the Purposes of Patent Procedure established a system of International Depositary Authorities (IDAs) for vouchering. Prior to applying for a patent for a biological entity, such as a bacterium, a voucher specimen is sent to IDA. However, the collection is not a public facility, and specimens generally remain under the legal control of the depositor. Others wishing to use the specimen must have the permission of the depositor. This favors the patent seeker by aiding in establishing that they were the first to record the find, but it also sequesters the find, making it unavailable for study by others. While it may be argued that the extraordinary effort required for, say, a private enterprise to venture into space, collect the specimen and return it to Earth justifies singular control of the specimen, it can also be argued that decades of government sponsorship allowed the private investor to make the journey.
- As developed by the WIPO's Intergovernmental Committee on Intellectual Property and Genetic Resources, Traditional Knowledge and Folklore, any living entity or biological material collected is required to be publicly vouchered and deposited in a public institution, such as a museum collection or public research facility. This does not imply free public access, but does require that the specimen or material be available for *bona fide* scientific research as opposed to sequestration at a private facility which may not allow such access. This seems an efficient, equitable, and totally appropriate requirement for extraterrestrial materials as well.

Recommendations:

- In such cases where patents derived from ETBE generate profits, a portion of those funds could be directed to a trust fund to be applied to conservation and similar actions beneficial to ETBE.
- Referring to intellectual property and living organisms associated with bioprospecting within the context of the Convention on Biological Diversity, Oldham and South state, "Some resources are too important, in terms of the present and future public benefit, to be subject to strong intellectual property protection" (2004, 39). They continue, "This is especially true for deep seabed genetic resources, the status of which as open-access or common heritage of humankind is still disputed, but the potential commercial applications of which are numerous." This sentiment may amply apply to ETBE. While many in the space development industry do not question their ability to patent life they may

discover as they would microbes on Earth, it is only their assumption. Prohibiting the patenting of ETBE outright is worthy of consideration.

Recommendations:

- Consider policies to not permit the patenting of ETBE, its products or processes. Alternatively, consider patenting but with conditions, such as limiting the life of the patent.
- Allow patents on derivative products of ETBE and the synthetic duplication of metabolic processes and similar actions, but do not allow IP protections for ETBE DNA, RNA or equivalent genetic material.
- A problem with many terrestrial international protocols and requirements is lack of policing and enforcement. For IP in space, where there are infringements of any agreements regarding royalties, mitigation, or other requirements, reserve the absolute right to revoke ownership of the permit. All subsequent profits ensuing from the IP could be added to the ETBE trust account.
- Uncertainty regarding patent procedures stifles research as well as commercial activities. The two must work collaboratively in remote areas; they cannot have separate agendas. To insist that the two limit their cooperation would be inefficient to the point that they would, in fact, cooperate "off the record," adding a competitive component to what critically requires cooperation.

9.3.1.4 Funding mechanisms

The Convention on Biological Diversity and the International Seabed Authority provide for benefit sharing. These are models most often drawn on when considering space exploitation.

Recommendations:

- Recognize the expansion of the Common Heritage of Mankind to include all life on Earth and ETBE. It could be considered simply Common Heritage of Life. Establish a trust fund or similar instrument to collect and invest a portion of profits derived from all extraterrestrial commercial activities having any impact on the Outer Space environment. Tourism, mining, energy production and all other profit-generating activities would be assessed whether or not their activities are shown to directly or potentially affect ETBE. These levies would be collected prior to any demonstrated proof of ETBE to establish funding and investment mechanisms. For ETBE-related patents, a higher rate could be required.

  Another potential source of funds may be launch fees, where payments to the fund would be required prior to any launch with the objective of placing an object on the surface of any planet or moon within our Solar System. A panel of guardians *ad litem* (Guardians) would administer the funds. A fixed percentage would be allocated to finance administrative tasks with remaining funds applied to research directly related to the conservation of ETBE. Funds would not be used for the purposes of enabling their exploitation, such as bioprospecting.

9.3.2 Provide a voice for ETBE

We are already discussing how ethics may be applied to machines and artilects; do robots have rights? Do they warrant our ethical concern? (McNally and Inayatullah 1998; Dator 2006; Spennemann 2007). That seems to be a far more remote question than considerations of "do pigs have rights," but it is far less problematic in our daily lives. While there are strong opinions regarding rights for robots and related ethical issues, we can consider them in conversation without threatening most people's culture or appearing to criticize their personal habits, ethics or morals. There is no blame or guilt, actual or implied, when they speculate on robots -- not so with pigs. But, like robots, we should be able to easily consider ETBE in the context of ethics because they remain an abstraction. Like sapient robots, they do not exist… yet. There is no immediate consequence of our opinions. Now, therefore, is the time to initiate that discussion. Once ETBE become "just another pig," we will not be nearly as free to discuss their status.

A significant difference when speculating on ethical consideration for robots is that when artificial intelligence (AI) has progressed to the point where ethics will be a tangible issue, the machines will, by definition, have the capacity to express their own opinion; it will be a marker of their sapience, a true indicator of their intelligence. It will blur the line separating artificial from organic intelligence and likely renew debate on the meaning (and privilege) of sapience. AI will participate *directly* in negotiations regarding their status (whether we welcome their opinions or not). "It is not unlikely that at some point in the not-too-distant future, robots will demand rights -- and get them" (Richard Slaughter quoting Jim Dator 1991). Humans will have a vested interest not only in how we view robots, but in how robots ethically view humans – a troubling thought with considerable consequence. If they mimic the history of our bioethical treatment of other humans and the rest of the life on this planet, we may be in serious trouble. I hope they are nobler than us.

Alan Tough and others have created an open Invitation to Extra Terrestrial Intelligence to facilitate their communication with humans should they detect the offer and wish to do so (IETI 2012). While the focus is firmly on intelligent extraterrestrial life, the website describes itself as "an informal group of approximately 100 scientists, artists and futurists … (with interests in) establishing a constructive dialog between humanity and our cosmic companions." Here, like intelligent robots, the sapient extraterrestrials would clearly represent themselves. But neither of these issues is likely to surface in our relationship with ETBE we may discover in our Solar System. They will likely not be able to directly participate in the negotiations. We will need to provide a voice for them.[270]

[270] Perhaps in the futures sapient AI can provide representation for ETBE; a robot as their guardian *ad litem* or trustee – an interesting thought to pursue.

As described in Chapter 7, Rawls' Original Position allows those in the present to represent the interests of those in the futures in an unbiased manner, without knowledge of their condition. The hypothetical is impossible to implement, but we can gain from Rawls' position in a practical way by appointing humans who can represent ETBE now, before we know if they exist, where they exist, or any details of their environments or histories. As evidenced by ALVA v. Weinberger, early action before the fact may assist with gaining greater traction with some future court.

Representation for ETBE, whether in the guardian *ad litem* context or other, would best be international in membership and most productive if inclusive of a diversity of human cultures and value systems (Young 1987; 1987b). It is significant that IETI includes futurists and artists in addition to scientists, recognizing both the legitimacy and need for their participation and vision in addition to scientific and political perspectives. "Issues regarding non-sentient extraterrestrial life are of global relevance. An international, interdisciplinary commission may be appropriate for determining guidelines regarding the issues outlined above. COSPAR, an international Committee on Space Research, or a higher level commission of the International Council of Scientific Unions could satisfy such a need. Better yet, the UN could address these issues as they relate to existing and/or new treaties and agreements. "These kinds of issues are too important to be handled by a select few" (Lupisella 1997, 92).

Regardless of the specific model of representation, however, in that extraterrestrial sites that may be home to the entities here addressed lie outside any national jurisdiction the Outer Space Treaty and similar UN instruments would apply (United Nations Office for Outer Space Affairs 2008).

<u>Recommendations:</u>

- Provide legal standing for ETBE through an instrument similar to the US Endangered Species Act (ESA), Marine Mammal Protection Act (MMPA) or similar statute. A weakness, however, would be that while protections could be offered after ETBE is discovered there would be no provision for conservation actions prior to discovery.
- Provide a voice for ETBE. The framework of the United Nations would provide a likely home for such a function, especially in consideration of the UN's established legal status among nations and its existing Office for Outer Space Affairs. Assemble a group to serve as guardians *ad litem* (Guardians) to represent the interests of ETBE. Membership should be broad and strive to represent a variety of human cultures. It is critical that representatives seek membership from indigenous cultures as well as those from highly developed states.
- Allow the group's participation in developing related policies, research, and implementation of programs that have the potential of affecting ETBE.
- While it may seem initially that the Guardians be administered as a function of the Committee on Space Research (COSPAR 2012), this may be inadvisable in that their mission statement includes that it:

    - Strives to promote the use of space science for the benefit of mankind and for its adoption by developing countries and new space-faring nations, in particular through a series of Capacity Building Workshops which teach very practical skills enabling researchers to participate in international space research programs; and
    - Promotes, on an international level, research in space, much of which has grown into large international collaborative programs in the mainstream of scientific research.

  ETBE interests may not be adequately represented considering COSPAR's promotional purposes. Another organization within the United Nations structure may be more appropriate.

  Within the UN General Assembly is the Fourth Committee, Special Political and Decolonization, which "deals with a variety of subjects which include those related to decolonization, Palestinian refugees and human rights, peacekeeping, mine action, outer space, public information, atomic radiation and University for Peace" (UN Special Political and Decolonization Committee 2012). It may provide a more appropriate vantage in that its primary focus is on decolonization as well as peace and outer space issues, possibly giving it a perspective more receptive to the purposes of the Guardians. Especially pertinent is their policy on encouraging broad participation among nations and indigenous peoples in outer space affairs with a focus on participation of non-spacefaring nations. For example, in October 2011 the Fourth Committee issued a statement supporting cooperative, not competitive uses of space, "ensuring that its peaceful uses remained cooperative and not competitive to avoid setting spacefaring nations against non-spacefaring ones."[271]

- Similarly, the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) and the UN Office for Outer Space Affairs (UNOOSA) may provide a logical and effective administrative home for the Guardians. COPUOS was established in 1959 (Resolution 1472 (XIV)) to "review the scope of international cooperation in peaceful uses of outer space, to devise programmes in this field to be undertaken under United Nations auspices, to encourage continued research and the dissemination of information on outer space matters, and to study legal problems arising from the exploration of outer space."[272] Their legal guidance may be especially helpful. UNOOSA is closely related and implements actions of COPUOS.

Nesting within the UN hierarchy would provide a degree of pushback to counter private and state-sponsored space pressures for exploitation. However, while a Guardian function may be initially tolerated by the space industries as a minor annoyance, should ETBE be encountered it would need to have a firmly established legitimacy to maintain its standing. This argues again for the formation of such an *ad litem* group as soon as possible.

[271] UN Press release: GA/SPD/485 of October 2011, at: http://www.un.org/News/Press/docs/2011/gaspd485.doc.htm
[272] Details provided at http://www.oosa.unvienna.org/oosa/COPUOS/copuos.html

Another option for the Guardian function may be within or as an independent private organization, such as the International Union for the Conservation of Nature (IUCN). IUCN is funded by governments, bilateral and multilateral agencies, foundations, member organizations and corporations. It would benefit due to the independence provided, but would be disadvantaged by not having enforcement capabilities or international authority.

9.3.3 Provide a place for ETBE

One method for enabling planetary protections prior to the identification of ETBE would be through the designation of a series of protected geographic areas similar to national or international parks or wilderness areas on Earth or a scheme such as the UN Educational, Scientific and Cultural Organization's (UNESCO) Geopark system (Cockell and Horneck 2004; Cockell and Horneck 2006). On Earth, these areas have generally been successful in meeting their stated goals and purposes. Describing such areas on Mars or other bodies would be a much simpler process in that there are no people or other conflicting social or cultural interests. Large areas representing significant planetary features (e.g., canyons, mountains, impact craters, and poles, including subsurface areas) could be mapped and delineated remotely and provided with a range of restrictions from prohibiting any intrusion whatsoever to allowing only sterilized robotic access to other non-consumptive uses. The only costs would be those of lost opportunity. Designation similar to wilderness areas on Earth would serve to protect ETBE (should there be any) and, if none are present, would reserve areas in an undisturbed state for potential future human use, meeting obligations to future generations (Uhlir and Bishop 1986). Perhaps most importantly, reserving large areas would better allow planetary processes to continue even though we may be totally unaware of them. Confining human activities to, say, 1 percent of the surface of a planet such as Mars may not be unreasonable (1.5 million square kilometers, or 600,000 square miles). Experiences with successful conservation actions on Earth have generally demonstrated that protecting habitat is far superior to protecting individual species or groups of taxonomically related species or protecting specific geologic features (such as a bay or canyon) rather than larger systems incorporating many such features (such as a watershed or region). If the habitat is intact, the species will likely be conserved.

There has been an increasing effort in the US to assess the potential impacts of actions before (rather than during or after) implementation of broad classes of actions. Further, the goal is to not only design mitigation as part of project planning, but to consider the costs of such mitigation and identify entities responsible for bearing those costs. This is most notable in the requirements of the National Environmental Policy Act of 1969 (NEPA) and its requirements for environmental assessments and environmental impact statements. The process is open to public review and assists in decision making. In a broader context, these requirements trigger anticipatory preventive action, the core of the precautionary principle (Viikari 2008). The application of these approaches may aid in identifying potential impacts to ETBE.

Recommendations:

- Create a mechanism for establishing extraterrestrial geographic areas similar to international parks or wilderness areas on Earth. These need not be uniform in the level of protection provided. A diversity of areas could be considered for inclusion based on their unique planetary attributes or their special nature as representative of climatic zones (e.g., polar region or equatorial zone) or geologic extremes (e.g., altitude).
- Do not fragment ecosystems and their suite of species into separate management plans based on legal jurisdictions (e.g., UNCLOS addressing mobile species only). An extraterrestrial body, like Mars, is still unblemished by legal borders. Even if no ETBE are found on the planet, land management can take a whole-Mars approach rather than a jurisdictional approach. Should ETBE be discovered, management could be based on a whole ecosystem basis.
- Mars and possibly other bodies are believed to have once had environmental conditions more favorable to life in their past (e.g., thicker atmospheres, higher temperatures, less UV radiation). It is possible that should ETBE be discovered it may represent a remnant of a form that existed in more robust numbers and range in the past. As such, it is likely that such a remnant would be more susceptible to adverse impacts that would have little impact on larger populations. Greater care would be needed if populations are small or show signs of steady decline.

The Law of the Sea created the concept of Economic Exclusion Zones for international waters off coastal states. The EEZ designation prescribes certain rights to that adjoining state, such as exclusive rights to mineral exploration and development.

Such a concept as the EEZ (although strictly terrestrial) is suggested by Rawls (1971). While he likely did not consider it in an extraterrestrial context, he distinguished between the pre-distribution of property and the redistribution of income as a method to help prevent the accumulation and control of great wealth by a few to the disadvantage of the least advantaged. Current welfare programs, for example, tend to focus on redistribution programs which tax or otherwise take money from the wealthy to support social programs for the poor. Rawls suggests that another method would be to pre-distribute property. This would spread property ownership more evenly prior to that property being used to generate wealth.

"According to Rawls, while income *re*distribution creates dependency, property *pre*distribution empowers" (emphasis as in the original) (Barnes 2006, 105-109; Dalton 2010). But rather than confiscate existing property from the wealthy for such a program (which would be just another form of redistribution), Barnes suggests that the Earth's commons be *propertized*, that nature is treated as property, that it is ownable. Rather than ownable in a traditional property sense, ownership would be through shared interests. He continues, "By propertizing (without privatizing) some of that wealth, we can make everyone a property owner." The example Barnes provides is propertizing the air (2001). As he describes, with the air owned by all rather than by no one, air-polluting industries would pay for the privilege, thus internalizing the costs of their pollution. Commons become less exploitable. Such a scheme may be particularly applicable to outer space. Mars, again our example, could be "propertized" with ownership awarded, in part, to a trust. The trust would manage the fees collected for use of the "commons." This would, in part, fulfill obligations established under the Common Heritage of Life concept.

Recommendation:

- Consider the creation of Extraterrestrial Exclusive Economic Zones (EEEZ) that would be managed (but not owned) by individual states (Sattler 2005). This would seem an appropriate action for those states actively engaged in space exploration. However, EEEZ could also be awarded to non-spacefaring states. How those states choose to use their Zone within the parameters set by the UN or similar organization would be their decision. If, for example, a non-spacefaring state wished to exploit their Zone, they could negotiate such a concession with a spacefaring state or private venture.

Any single treaty such as the UNCLOS, AT or the Outer Space Treaty is benefitted by its simplicity and the ability to clearly state broad goals and agreements. Treaties and policies are weakened when they attempt to be overly detailed. With any adaptive management program changes are to be expected, and re-opening original agreements to enable amendment provides opportunities to dismantle its core or significantly modify its original intent.[273] Rather, ATS and UNCLOS provide examples of organic treaties that encourage tiered, later-in-time sub-treaties, conventions and other such accords that support the original without potentially destroying it. In addition, such a series decreases the relative importance of each. This should encourage cooperation in negotiation.

9.3.4 Forward contamination

Far more pressing than the theoretical aspects of bioethical relationships and approaches to profit sharing, the potential for forward contamination remains as an overarching issue. Its potential for its near-term impacts on ETBE is profound. Forward contamination is commonly defined to include contamination by Earth organisms and organic matter associated with cells or cell components. It is "a significant threat to interpretation of results of *in situ* experiments specifically designed to search for evidence of extant or fossil Martian microorganisms" (NRC 1992). This pragmatic definition ignores possible impacts on the goals of the search, Martian microorganisms themselves. It excludes ethical consideration and is notable in its limitation to microorganisms. Other forms of life that may be encountered but are outside our ken are omitted. This demonstrates a lack of openness to novelty. Regardless, forward contamination may represent the highest potential for adverse impacts on ETBE. Foreseeable physical actions on a planet, such as mining or construction related to research, housing, or launching facilities would

[273] For example, the US Endangered Species Act is required to be reauthorized by Congress every five years. The last reauthorization expired in 1992. It has been supported over the past 20 years through a series of annual continuing resolutions and funding. A prominent reason for avoiding formal reauthorization is that neither conservatives nor liberals wish to reconsider the ESA for fear of its being modified in ways unproductive to their respective causes and because any votes on such reauthorization have significant political consequence for campaigning Members of Congress.

require considerable planning and preparation. That period would also include ETBE investigations which would increase our knowledge of their potential presence, range and nature.

Significant physical impacts, such as an extended human presence, are not likely any time soon. The forward contamination of Mars, however, has already begun, well prior to our knowing if ETBE exist or how they may be affected (NASA 2003; McKay 2009; Walsh 2009; David 2011). The Phoenix lander, Spirit and Opportunity all carried microbial loads.

While many maintain that Earth's life cannot tolerate the Martian environment and that such forward contamination will have only temporary impacts, each claim has its limitations:

- Claim: Earth life could not exist if exposed to the radiation on the surface of the planet. Exposure to solar radiation on the surface of Mars would kill any Earth microorganism "within minutes" (McKay 2009).
  However:
  -If the organism was shielded from direct radiation (for example by the metal walls of the spacecraft itself) it may continue to exist in a dormant state for hundreds of thousands of years before finally succumbing to more penetrating cosmic radiation.
  -If the organism fell or was blown into a deep recess or crevasse it would not be exposed to lethal levels of radiation (Kramer 2009).
- Claim: Earth life may survive the surface temperatures, but would not reproduce under those conditions.
  However:
  -As above, if the organism fell into a deep crevasse it may survive and we do not know what temperatures may be afforded by deeper strata.
- Claim: The surface of Mars is too dry for Earth's life to replicate.
  However:
  -Earth microorganisms can survive living inside salt rock in the Atacama Desert, the driest known habitat on Earth. Other life (e.g., some seeds) can survive desiccation for centuries.
  -We have proof that water ice exists just a few centimeters below the Martian surface -- there may be pockets of liquid water at greater depths.

It has been demonstrated *in vitro* that the two common forward contaminating organisms (*Escherichia coli* and *Serratia liquefaciens*) could survive the cold, radiation, low pressures, and high salt content of Martian soils for 7 days (Berry, Jenkins et al. 2010). This provides evidence that NASA's position that such organisms would die "within minutes" is in error. If bacteria did find an environment suitable for reproduction (e.g., at a deeper and possibly warmer geologic stratum and with the presence of water) it is also possible that they may evolve to better adapt to Martian conditions. We cannot assume that the exact form of the microbe that we send to Mars or any other location in space will be genetically static. If it reproduces, one would expect high mutation rates in response to ambient radiation. Mutations may assist the organism in adapting to survive higher radiation environments, such as those found on Mars.[274]

The most significant concern regards drilling. As demonstrated at Lake Vostok in Antarctica, special care must be taken to guard against contaminating lower depths, especially if liquid water may be encountered. It would likely be extremely difficult to reverse such contamination with foreseeable technology.

The Outer Space Treaty addresses forward contamination, but only regarding research activities; much hangs on interpretations of the word "studies:" "States Parties to the treaty shall pursue studies of outer space . . . so as to avoid their harmful contamination and also adverse changes in the environment of the Earth…." The intent appears to have been to prevent contamination that would influence research results. It is silent on issues involving, for example, industrial uses of space which would present much more likely opportunities for contamination.

In addition to spacecraft and machinery sources of forward contamination, if/when humans are on the planet there would be an abundance of contamination should they leave the confines of a sealed vessel or other habitat. Space suits (current designs) vent water and other gases, carrying bacteria. As bluntly stated by the National Research Council (1992), "Missions carrying humans to Mars *will* contaminate the planet" (emphasis added). It continues by recommending "that every attempt be made to obtain evidence of past and/or present life on Mars well before these missions occur." However, that "every attempt be made" is a nearly impossible standard; proof of a negative. Taken literally, every potential environment would have to be tested, surface as well as subsurface (and to what depth is unknown), and the investigation would have to be done by robotics and similar probes or by remote sensing, all without forward contamination. Given that Mars has a surface area of approximately 145 million square kilometers (56 million square miles), about one-quarter of Earth's surface area, it is a very restrictive recommendation.

It seems there is clear intent among space-faring nations that if the technology exists and if there is funding to send a crew to Mars, a crew will be sent. As stated previously, this becomes especially assured as private enterprise competes for the honor of placing humans on the planet. It seems doubtful that NRC's recommended surveys will be accomplished before piloted missions there.

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[274] Specific areas aboard unpiloted spacecraft are kept warmed above ambient during long transit missions, such as a 9-month flight to Mars, to allow for proper functioning of computers, small motors, and communications equipment. Bacteria may not only grow at these warmed sites but would be exposed to radiation, likely increasing their rate of mutation and possible adaptation to the space environment. While spacecraft have no free liquid water to support microbial life, other areas of contamination, such as hydraulic fluids and lubricants, may. It would be interesting to know if the bacterial load of a spacecraft on liftoff (e.g., microbes per square or cubic centimeter) increases during flights.

Recommendations:

- Sterilize all parts of craft destined to planets or moons that are designed to land, crash, or have the potential of either, such as satellites to pre-Voyager standards or better regardless of the purpose of their mission.
- Humans on Mars will introduce a suite of forward-contaminating organisms. Claims are made that robotics will never be able to do what humans can – thoughtfully observe, react quickly to nuance and anomaly, and be inquisitive.[275] What is flawed in that argument is that while robots with AI may not be able to accomplish those tasks at present, they may not only be fully capable in the near futures but may exceed human capabilities in many areas. Robots would also be more likely to survive in the Martian environment at a fraction of the cost. They could be sterilized so they would not corrupt the data they seek. The urgency and necessity of placing humans on Mars and elsewhere appears more founded on the need for continued growth, the need for public interest and a degree of hubris rather than scientific accomplishment.

9.3.5 Ethical policy

At a minimum, a set of existing bioethical standards applied to sentient animals in the US and Europe should not cease once we are outside of Earth's atmosphere; space *is* our environment and extends to as far as we can undertake any action that has any effect. Assuming that ETBE likely evolved under conditions significantly different than terrestrial life, we cannot pre-conclude that they exist below some hypothetical, culturally-biased threshold of sentience referenced on Earth. We cannot logically exclude them from any ethical consideration. We should not assume that because they may be small that they do not meet a minimum qualification for consideration. Accordingly, we should proceed with exploration with extreme caution.

- Robotic exploration of planets and moons for the existence of ETBE should be accomplished before piloted flights unless it can be demonstrated that the probability of finding ETBE is extremely low (e.g., the Moon). This process may take decades or a century of concerted effort and a significant investment of funds. But if forward contamination is allowed, the implications could be far reaching.
- Opt for passive observation and remote sensing for signs of possible life as opposed to analyses requiring physical harm. Should the recently-landed Mars Science Laboratory discover living ETBE through a process of purposefully destroying it, we will have set a precedent that will be difficult to reverse. As intriguing as the questions such a discovery may be regarding astrobiology, the immediacy expressed by many to find those answers appears to be based more on exuberance and ego than on any absolute need for the knowledge itself. Because we *can* look for life on Mars does not mean it is a necessity.
- If, however, we do detect ETBE through the destructive analysis methods now employed, cease that portion of the operation immediately. Continue close and

[275] A table of human vs. robot investigations of Mars is provided at The Discovery Channel's website: http://www.racetomars.ca/mars/article_robots.jsp

extended observation coupled with initiation of ethical analysis and open public dialog. Any decision to withhold or limit ethical consideration should be made only after a deliberative process and the rationale for the decision should be fully documented.

9.3.6 Political Policy

- Assemble an international working group to address the issue of bioethical consideration for non-sapient ETBE. Ensure that the group represents a broad sampling of cultures and other traditions and political regimes. Charge them with drafting policies guiding the search for ETBE and protocols for post-detection actions.
- The same or a similar group should be convened to discuss the issue of the ownership of ETBE should it be found, how it would be addressed within the context of intellectual property and how such entities would fit within a category of common heritage of humankind.

9.4 Summary of assumptions

- All life on Earth likely has a common origin. While we are not one organism, we constantly share bits of our genomes making distinctions between organisms less discrete than generally held in Western philosophy and science.
- Recent advances in technology have allowed us to observe that human biological exceptionalism is unfounded. Classes of organisms only recently believed to be incapable of emotional lives are now found to be sapient. Ethical consideration based on degrees of perceived sentience, sapience, or other factors can be, therefore, biased by the sophistication of our technology. With the expectation that our technology will continue to advance it is likely we will continue to be surprised by the "inner lives" of organisms and the interactive complexity of life.
- By extending consideration to all life, very broadly defined, we will approach a more defensible bioethical philosophy. As with the goal of a nonkilling society among humans, a goal of nonkilling by humans of all life, while remote, may be achievable in more distant futures. This would apply to ETBE should they exist.
- Life patents are largely tools that commodify life and remove it from consideration as Common Heritage. While attempts have been made to share derived profits among people through such instruments as the Convention on Biological Diversity and the International Seabed Authority, they have failed. Exploited species and intact ecosystems continue to decline in range and numbers. This appears related to the widening gap between the wealthy and the poor as would be expected under a capitalist system based on continued economic growth. Current economic and political structures that serve to commodify life, such as life patents, will ultimately fail to be deemed ethical.
- Applying the concept of *res nullius* to space diminishes claims that space represents a Common Heritage. As such, it argues that extractive enterprises need not recognize those resources as belonging to anyone other than the extracting industry. Coupled with life patents, there would be little incentive for sharing

profits with "mankind" in a broader sense, much less in conservation of extraterrestrial habitats for the welfare of ETBE. This has been demonstrated before the fact with the reduction of forward contamination standards. The Moon Agreement embraces the Common Heritage approach via *res communis*, that the resources of space are the property of all. That treaty, however, was not ratified by space-faring countries in part due to that provision (Marshall 1995).

- The demand for an aggressive space program is supported by referencing a mythology of capitalism and empire. On closer analysis, however, most economic and social rationales for space exploration and exploitation are groundless. Current space programs, both government and private, exist largely to generate capital to feed businesses on Earth, not to secure rare minerals, discover extraterrestrial life, ignite renewed interest in science, mathematics, engineering and technology or colonize other worlds to relieve population pressures on Earth. Space industries provide another means for continuing the industrial growth provided predominantly by military expansion.
- Space programs have been remiss in not ensuring an extremely high standard of vehicle sterility. NASA states that one of its primary missions is the search for extraterrestrial life yet simultaneously justifies reducing forward contamination prevention standards by stating that (1) contamination is inevitable and has already occurred, (2) cleaning up contamination would be relatively inexpensive, and (3) that contaminating some areas will not affect pristine "no go" areas elsewhere on the planet.
- Extremophile microbes on Earth have proven to be of economic value (Hazen 2007). They are discovered with increasing frequency in habitats long thought to be lethal to life. Being of terrestrial origin, their processes can often be adapted for a variety of industrial, medical and other uses. Yet their habitats are being adversely affected directly and indirectly by some of the same industrial sectors that are supporting the search for ETBE. It appears more desirable to seek new resources in space than husband the ones we already have on Earth.

CHAPTER 10
IN CLOSING

> *If we complete the destruction of nature, we will have succeeded in cutting ourselves off from the source of sanity itself. Hermetically sealed amidst our creations and bereft of those of The Creation, the world then will reflect only the demented image of the mind imprisoned within itself.*
>
> Stephen Kellert and Edward O. Wilson - *The Biophilia Hypothesis* (1993, 437)

The ongoing search for extraterrestrial life on Mars and elsewhere in our solar system provides an ideal opportunity to explore ethical relationships in a fresh context. Using the products of such discussions we can better reconsider definitions of what it means to be human and our concepts of participation as a functioning part of universal life. But we must focus on resolution *prior* to their discovery. Should we leave the questions unaddressed and unanswered, Earth's conflicting and often indefensible bioethical standards will be exported and may become truly universal, representing a forward contamination of a philosophical sort.

While NASA, SETI and others have discussed the potential need for policies and protocols that would guide ethical practices should we be contacted by an extraterrestrial intelligence, the probability of such an occurrence is vanishingly small. There are, however, considered procedures for how to announce to the government, nation, the Vatican and the world that a message has been received. Policies have been published on the bioethical issues associated with backward contamination, the ethical ramifications of using laboratory animals in space, employing astronauts as test subjects and the ethical liabilities of how people here on Earth may be affected by crashes of space vehicles (Pompidou and Audouze 2000; Arnould 2001; Goh and Kazeminejad 2004; Arnould 2012). Regarding potentials for forward contamination, policies are directed predominantly at limiting contamination for the purpose of decreasing the potential that Earth life may influence the validity of our own data coming from tests for extraterrestrial life (National Research Council 1992; Lupisella 2006; National Research Council . Committee on Preventing the Forward Contamination of Mars 2006). There are no policies that address the ethical issues of impacts to the extraterrestrial life we are seeking. While there are many publications regarding our potential to affect extraterrestrial life, only a small percentage speak to ethical issues.

Those in positions knowledgeable about this topic in NASA, ESA and some of the private sector have been mildly curious when asked if they have policies regarding the ethical consideration of the life they seek, but all have essentially inferred that while it is an interesting question that *should* be addressed in a policy context, it isn't.

The current age of space exploration allows us to imagine and plan for ambitious physical structures and architectures, engineering projects in space and on other planets that dwarf anything attempted on Earth, innovation and amazing new knowledge in physics, chemistry, and engineering. But we continue to see ourselves, as *Homo sapiens*, as the only actor. We are entering radically foreign environments, yet we continue largely unchanged in our ways of thinking and our ways of acting. If we initiate exploration followed by colonization and exploitation of other worlds without also rethinking our relationship with the environments we will share and all they offer, biological and physical as well as spiritual, we will have missed a prospect for advancement.

To many, thoughts of providing representation and voice for extraterrestrial biological entities seem a stretch of reason. I hope this dissertation shortens that stretch if only by a hair. Bioethics has progressed to be more inclusive over recent decades and there is little to argue that it won't continue to evolve to be even more comprehensive. Many are responding to that in positive ways.

The current Dalai Lama has suggested, "we have to check our motivation and ensure that (our ethical) foundation is compassion, (that we take) the widest possible perspective, … (and that) in the face of any real ethical challenge, we must respond in a spirit of humility, recognizing not only the limits of our knowledge (both collective and personal) but also our vulnerability to being misguided in the context of such a rapidly changing reality" (Gyatso 2005, 212). As briefly summed in a final scene in the 1937 film *Lost Horizon*, the High Lama advises, "Be kind." It is a standard we should carry with us to the Universe.

In *Social Foundations of Human Space Exploration* (2012, 82), James Dator states, "All traditional ethical systems are based on 'reciprocity.' That is to say, all ethical traditions have some version of what is often called 'The Golden Rule,' which is: '*Do unto others as you would have them do unto you*.' Or stated negatively: '*Do not do to others what you do not want them to do to you*.'" "A better ethical rule now may be: *Do unto others as they would have you do unto them*." That is a remarkable improvement over traditional guidance regarding ethical conduct. But can this be expanded to include all life? Regarding our relationships with ETBE, what if it was rephrased to: Do unto other biological entities as they would have you do unto them. The simplicity seems to cut to the core of ethics in general. It has little to do with expectations of discrete acts of reciprocity in a conventional sense or expectations of some eventual utilitarian benefit. When we can implement such an ethical scheme we will have achieved something of tremendous value. In the context of space voyaging, we have to think beyond Earth if we are going to live beyond Earth.

Donna Haraway was not considering extraterrestrial life of any kind in her 2007 book, *When Species Meet*. Her concerns were the deeper aspects of our personal relationships among us and our companion animals, our pets, and by extension with the other life on this planet. But should the moment of a first encounter happen this month on Mars or after centuries of voyaging to another star system, whatever the entity, we could follow her advice. Allow them their otherness without Othering. Welcome them as a cousin. At our first encounter, when we first see them, they may look back. Meet their gaze.

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