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Ethics and the Extraterrestrial Environment

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ABSTRACT *After a brief review of environmental ethics this paper examines how terrestrial environmental values can be developed into policies to protect extraterrestrial environments. Shallow environmentalism, deep environmentalism and the libertarian extension of rights are compared and then applied to the environmental protection of extraterrestrial bodies. Some scientific background is given. The planet Mars is used as a test case from which an ethical argument emerges for the protection of environments beyond Earth. The argument is based on the necessity to recognise the intrinsic value of all living species and natural environments. At present, the treatment of extraterrestrial environments by makers of space policy is ethically undernourished. This paper explains why such an attitude endangers those environments and calls for the policy-makers to incorporate non-anthropocentric ethics into extraterrestrial environmental policy.*

Terrestrial Environmental Ethics

A US goal for the early twenty-first century is to land humans on Mars. Beyond that one of the long term objectives of the US Office of Technology Assessment is 'to spread life in a responsible fashion throughout the solar system' [1]. If such a serious commitment to exploring and colonising the solar system is planned without recourse to ethical and environmental considerations then, as Hargrove [2] states, industrial and commercial projects for space may simply produce a new environmental crisis that dwarfs our current one.

It has taken industrialised humanity about three centuries to inflict an environmental catastrophe on Earth unparalleled for sixty-five million years. In the next few centuries this degradation may be extended to other planets in the Solar System, perhaps with biocidal consequences. How can the environmental ethics we already have be used to stave off such disasters? Can it serve for Mars if for Antarctica?

In the past twenty years we have been attempting to extend ethical boundaries beyond human affairs to embrace all living and non-living components of the environment on Earth. There are three general reasons for this: Libertarian extension, Ecologic extension and Conservation ethics.

Libertarian extension involves the widening of rights to previously unconsidered members of the living and non-living community. One can trace in human history an evolution of such an ethical extension which aims at promoting human rights for every individual. In the realms of environmentalism Libertarian extension is most manifest in the works of animal rights activists who believe that animals (generally those with an advanced central nervous system) hold the same rights and should be valued at parity with humans. Such ethical extension tends to emphasise the importance of individuals. If one carries

Libertarian extension beyond just the narrow scope of animal rights it must find application to all organismal entities.

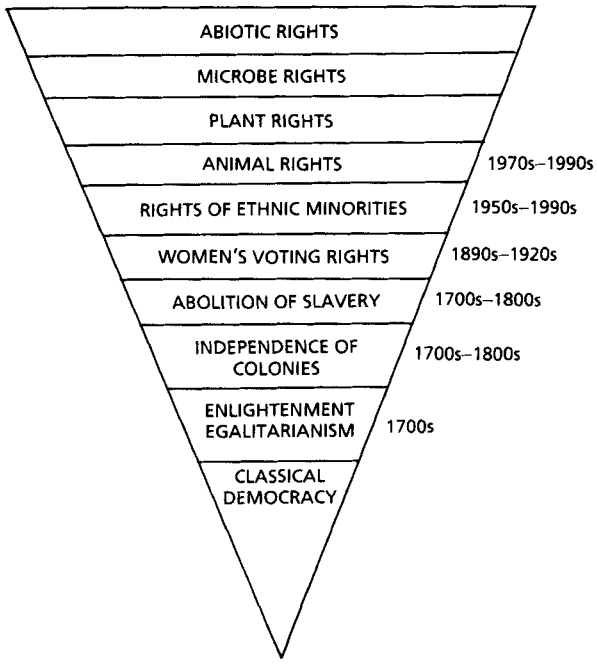


Fig. 1 The evolution of Libertarian Extension (Adapted from Nash [3]).

Ecologic extension has evolved from the science of ecology and from deep environmentalism which tells us how all the components of a living ecosystem, along with the abiotic components, are interrelated and dependent on the well-being of one another. Such an approach emphasises the value of species, communities, ecosystems and ultimately the biosphere of planet Earth more than the rights of individual organisms. Ecologic extension considers each species important not only because it contributes to the overall ecosystem but because diversity in the biosphere is intrinsically valuable.

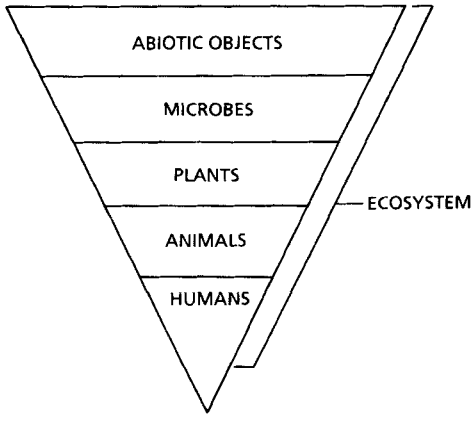
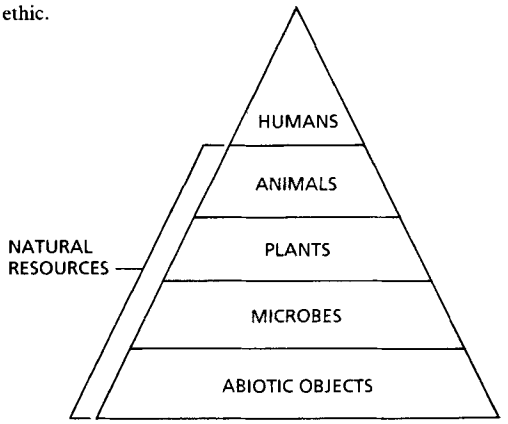


Fig. 2 Ecologic Extension.

The Conservation ethic does not recognise any intrinsic value or rights in the various components of the environment but sees their value purely in terms of their being natural resources which have a use or potential use for humanity. The Conservation ethic parallels the view known as shallow environmentalism [4, 5] within environmental philosophy. It is anthropocentric. Such an ethic recognises we must conserve and manage environmental resources primarily to ensure a continued high standard of living.

Fig. 3 The Conservation ethic.



Extraterrestrial Environmental Policy According to the Conservation Ethic

The anthropocentric nature of the Conservation ethic currently governs the implementation of policies designed to protect extraterrestrial environments. In respect of scientific investigation it would be prudent to minimise environmental destruction of extraterrestrial bodies owing to the desire to study natural environments in their original state without their having been degraded by human influence. Scientists studying the earth or celestial objects from earth orbit would also suffer if the orbital space of scientific satellites were cluttered with debris from other space missions.

From a commercial point of view the implementation of a conservation ethic can be supported, since telecommunications and resource-mapping satellites may suffer the same problems of orbital pollution as scientific satellites. The pollution of Earth orbits is such that it has become an acknowledged threat to the long term future of space activities [6]. Naturally, because of the possible effect on human space exploration and space commerce, orbital pollution has received a great deal of attention. In view of the exploitation of planets, moons, asteroids etc, the instigation of conservation management policies for economic reasons will have to take place since consideration must be given to the needs of future generations, including their resource needs. However, the view that extraterrestrial resources are an infinite bounty will probably blind consumers of space resources to any need for conservation of those resources. As on earth, such an ethic will only permeate economic theory when the supply of resources approaches zero.

Along with scientific and economic reasons for conserving extraterrestrial environments there are aesthetic reasons. The natural beauty of planetary rings, Martian volcanoes or lunar moonscapes is a human-imposed value which must be considered if exploitation of the solar system becomes widespread. On a lunar mining site or near a colonial Marsbase the scars inflicted on the landscape due to human exploitation or pollution may create

spots of unnatural ugliness out of sites of natural beauty, though some would claim that they make artificial beauty out of natural ugliness.

Some environmentalists will consider the scientific, economic and aesthetic reasons for extraterrestrial environmental protection as the guiding philosophy for implementing environmental policies, but we must ask if the same environments deserve protection only if they satisfy the human characteristics of curiosity, utility and beauty. Science, economics and aesthetics may evoke needs for environmental protection but they are all human concerns that evade the intrinsic value of natural environments. Many environmentalists, however, are resigned to the idea that anthropocentric conservation ethics must be employed in order that policies which by chance protect the intrinsic value of natural objects or the integrity of ecosystems may be put into effect.

Extraterrestrial Environmental Policy According to Ecologic and Libertarian Extension

In discussing what ecologic and libertarian extension of ethics have to say about extraterrestrial environmental policy formulation I shall be concentrating on the planet Mars. There is a terrestrial analogue to Mars. The Antarctic continent, like Mars, possesses an extremely inhospitable environment and is viewed as a frontier to human advance. We can study how policies are implemented and what philosophical reasons there are for the protection of the Antarctic environment and seek to apply them to Mars. Antarctica is the least populated and contains the least diverse terrestrial ecosystem of all the continents but it is still replete with life. It has many indigenous species of animals and plants in its coastal zones, although most of the Antarctic landscape is devoid of life. Devoid, that is, except for microbes.

How do we go about formulating ethics and implementing policies for Antarctic environments? From a popularist point of view there exist variable levels of concern regarding what species are more valuable than others. When we are considering the plight of Weddel seal pups or Emperor penguins, sympathy can be easily attracted in support of environmental protection policies. With polar insects, moss or colourless flowering plants it is somewhat more difficult to raise concern. With microbes, which are the only inhabitants of vast tracts of inland Antarctica, it is even more difficult. Such a scale of differential concern for living species is referred to as the 'cuddly quotient' by Michael Ohrbach [7]. It is abundantly clear what effect exploitation of resources would have on coastal Antarctic mammals and birds even if it were limited to the inland areas of Antarctica; support services, such as seaports, airports, pipelines etc, would ultimately adversely affect bird and seal colonies, perhaps causing local extinction. But would we care if the whole of Antarctica were inhabited only by microscopic organisms? Here we come to Mars, an environment not too dissimilar, with respect to the prospects for living ecosystems, to the dry valleys of the Antarctic interior. To extract resources in Antarctica will not be economical, if we allow it, for many years yet. Resource-extraction on Mars may not be economical for hundreds of years, but if there are microbes on Mars, will environmental ethics be developed enough for us to consider their interests?

At the moment some conservation ethics governs the treatment of extraterrestrial environments and there is even some legal backup in the form of international treaties. However, Byerly [8] acknowledges that writings on space law, although having occasion-

ally dealt with the space environment, are typically legalistic in nature and devoid of ethical considerations [9].

Much of the thinking about extraterrestrial conservation revolves around the subject of preventing the contamination of the Earth by extraterrestrial lifeforms (back-contamination) but it also extends to protecting bodies of the solar system from being contaminated by Earth organisms (forward-contamination). The main purpose of this is to discourage the interference of contaminant lifeforms in the conduction of life-detection experiments. Such conservation necessities were realised early in space exploration when in 1959 COSPAR (the Committee On Space Research) set up guidelines for spacecraft decontamination procedures to be implemented on interplanetary missions. Sometimes the commitment to these decontamination policies has been dubious. The Galileo spacecraft, launched in the late 1980s, will insert unsterilised probes into Jupiter's atmosphere. Right now, bacterial spores may be awaiting to infiltrate and germinate in the warm layers of the Jovian atmosphere and pursue a planetary conquest to the detriment of native lifeforms. Similarly the Zond 2 probe, which crashed on Mars in the early 1960s, and the two Viking Orbiter spacecraft, which may yet crash on Mars, were not sterilised before launch.

Is there life on Mars? This is obviously an important question, since the formulation of an environmental policy for Mars depends on the answer [10]. While some scientists believe that life on Mars is still a distinct possibility, many biologists in the post-Viking era doubt the ability of the Martian environment to support extant life. Although a widespread microflora is absent there exist various possible life-supporting environments on modern Mars: for example

1) sub-regolithic life (life below the soil)
2) polar life (life in the icecaps)
3) endolithic life (life inside rocks)
4) life associated with hydrothermal or volcanic areas.

Such life is common in the Antarctic inland regions.

An endemic Martian biota may be intensely susceptible to invasion by humanity and its pollutants. The two Viking Lander spacecraft, which tested for life on Mars in 1976, were sterilised such that the chances of a terrestrial microbe reaching the Martian surface were exceedingly small. However, Boston [11] starkly declares that we must accept the reality and inevitability of forward contamination that coincides with future exploration plans. The potential for an Earth microbe to live through spaceflight conditions and survive the extreme environment of Mars may be unlikely (though some studies suggest that it is not [12]), but if a microbe does survive it may:

A) attack and kill indigenous microbes
B) alter the environment so that this kills indigenous microbes.

Biological processes that could contribute to A) include:

antibiosis (the production of substances by one microbe that are toxic to another),
phagocytosis (the eating of one microbe by another to obtain its carbon, water etc),
infection (the intracellular invasion of one microbe by another to facilitate reproduction).

While infection may be unlikely, as it relies on the specificity of a host-parasite relationship arrived at through a co-evolutionary heritage, the other processes pose real threats. That such processes will remain localised at the point of contamination cannot be assumed. Bacterial spores may be carried thousands of kilometres by the episodic Martian duststorms. The chances of contamination would increase along with the increasing duration and area covered by manned missions. With permanent bases, contamination of Mars would be assured. And the dissemination of contaminants would be furthered by widespread prospecting and resource-extraction, especially if polluting activities prevailed which might work synergistically to enhance microbial invasion. On the most Mars-like environment on Earth, the dry inland valleys of Antarctica, introduced microbes from scientific personnel and bases have commonly grown and reproduced more rapidly and at lower temperatures than the indigenous Antarctic microflora [13]. It is possible that biological or chemical pollution on Mars may enhance a native microbial ecosystem so that it speedily colonises the whole planet and moves into previously unsuitable areas. If several Mars species exist then the balance of one to another may be affected so that one microbial species could be enhanced to the detriment of others. Alternatively an indigenous microbial species enhanced by human activities may alter its environment so as to make that environment unsuitable for its own existence. We could be responsible for a Martian microbial species' poisoning itself to death.

The potential disturbances outlined above should encourage the policy of exploring Mars with sterilised unmanned probes extensively before embarking on a series of manned missions. It would be shameful to discover life on Mars and then cause its extinction. The situation would be akin to that of an exploratory entomologist who discovers a small group of unidentified butterflies and promptly fixes them into a collection only to find out later that an entire species has been exterminated in the name of science.

To some the probability of either 1) there being life on Mars or 2) that earth microbes could survive and affect Mars microbes, is deemed to be so remote as not to justify concern [14]. However, there are two points that must be considered here. Firstly, it is questionable whether or not we have enough knowledge (of Mars, and of the nature of life) to assume that the probability of life on Mars is as low as some suggest. Secondly, how can we weigh up the likelihood that there is no life on Mars against the possibility of exterminating an extraterrestrial race? Boston states: 'as unlikely as it seems now that life exists on Mars presently the unparalleled importance of finding other life dictates that we err on the side of excessive caution rather than jeopardise the precious opportunity to study it' [15]. While Boston reflects the anthropocentric desire to use the situation to advance scientific knowledge she considers that careful exploration should precede the first exploitation. From the above analysis a familiar theme in the formulation of environmental policy emerges, which exemplifies the need for a philosophical analysis. Science can play a role in assessing the probability of there being life on Mars and the risk of such life's being destroyed by terrestrial invaders but it cannot evaluate whether the risk is justified or not. Holdgate [16] addresses this issue in relation to Antarctica: 'the process of risk estimation, which is the definition of the probability of a particular change following a particular action, can be objective (although hedged about with uncertainty) but the process of risk evaluation, which answers the queston "is it worth it?" must inevitably be subjective'.

If a policy is implemented which restricts the exploration of Mars to sterilised unmanned missions in order to preserve any possible life, we will soon find ourselves asking the question: when do we finally decide there is no life on Mars and allow human

exploration? After ten years of unmanned exploration? After one thousand years? The trouble is that an unexplored environment can always be thought of as harbouring undiscovered life. Even after breaking open a million Martian rocks we can never be totally sure that Mars is devoid of living organisms. After just two immobile lander missions, however, it would be foolish to believe that we have enough information to rule out a 'life on Mars' hypothesis and risk the extinction of extraterrestrial species.

If we do find life on Mars before or soon after manned exploration, what should we do? From the point of view of ecologic extension we should let Mars be: plan no more manned missions and place a ban on exploitation. Mars could become a 'World Park', in similar vein to that hoped for in the Antarctic case. Science, of course, is permitted in Antarctica and it should be permitted on Mars, but only with decontaminated robotic probes. However, direct human contact, as in Antarctica, would be out of the question. Only perhaps after a millenium of study, when we know how a microbial ecosystem on Mars will react to human invasion, should planning of a manned mission be permitted. As Sagan [17] admits 'Mars belongs to the Martians'. How can we trespass, knowing that to do so may mean speciecide?

A Mars microbiota will be valuable for scientific reasons, and this to some extent will ensure preservationist policies. But more than that, Martian life is intrinsically valuable. That life on Mars may possess a scientific use for humans is not necessarily the prime consideration. For Martians have no duty to contribute to the knowledge of humanity. Some would protest that the intrinsic value of extraterrestrial species is a human value, like that of aesthetics. But intrinsic values are not imposed by human beings; they merely involve human recognition of value. It may be hard for us to accept responsibility for 'mere' microbes, but we may ponder the situation, which has become a familiar theme in science fiction, in which an extraterrestrial species from an alien planet may look upon Earth as an interesting or resourceful looking place and decide we were not worthy of consideration because we were mere humans.

The ethic of libertarian extension would place value on each Martian microbe. The ethic of ecologic extension would value each Martian species, along with the environment in which it lives. Even the conservation ethic would place value on Martian microbes because of their use for science. If we adhere to the libertarian extension of ethics in advocating the protection of indigenous planetary organisms then a conflict of interests may result. A libertarian may feel the need to halt space exploration for fear that it may kill a living organism on Mars. However, libertarians may not wish to violate the right of terrestrial organisms to explore. It can be argued, though, that since it is the aim of libertarian extension to give equal rights to all organisms regardless to which species they belong, a microbe has the right to live on its own land free from invasion and domination by others — a right asserted by human beings on their own behalf. The conflict of interests associated with the libertarian extension of rights may indicate that ecologic extension (which evades such a conflict because the right of one organism to explore is not valid compared to the survival of a species) may be better able to protect extraterrestrial environments.

Baird-Callicot [18] tries to use an amalgamation of environmental ethics to devalue Martian microbial life. Baird-Callicot does not believe that the Leopold land ethic [19] is applicable to microbial life on Mars since Leopold emphasises that we should value organisms which exhibit interactions and interdependency with the natural environment (i.e. possess an ecology) and have a co-evolutionary history (i.e. possess a common heritage) with humans. This may apply to every species on Earth but Baird-Callicot

believes it does not apply to Martian species. However, Martian microbes interact and depend on the environment, as all organisms must, and so they do possess an ecology (albeit a simple one). If we consider cosmic and stellar evolution we can also find an affinity with Martian microbes and fulfil Leopold's concept of common heritage.

If Mars, or any other planetary body, is devoid of life it does not follow that it is devoid of value beyond any resources it may have that are useful to humans. An extension of human ethics to animals and thence to other organisms if taken to the next step would include an extension of ethics to abiotic objects (be they rocks, rivers or ringed planets) even if they do not contribute to a living ecosystem. It must be remembered that nature is not static in abiotic worlds. Myriads of dynamic physical, chemical and geological phenomena permeate lifeless planets. The turbulent atmosphere of Neptune, the volcanic activity on Jupiter's moon Io and the chemical reactions of the surface-atmosphere interface of Venus could fulfil many definitions of what it is to be 'alive'. Rolston [20] declares rightly that abiotic planets have value regardless of being acted upon by living organisms or intelligent beings.

Consider Mars again. Although it might seem to be a great useless hunk of red rock to us, humans could, in the view of martian rocks, be merely living organisms who are yet to attain the blissful state of satori only afforded to non-living entities. Rolston believes we should learn to appreciate alien worlds for what they are in themselves and refrain from depreciating them because they have failed to furnish life. In reality they have not 'failed' to be anything; they have achieved being what they are. We must not consider Mars or any other celestial body to be unlucky just because it does not support life. Indeed, even in the absence of an indigenous lifeform, Mars possesses its own uniqueness and diversity which are worthy of respect. Briggs, a planetary scientist, comments that he has come to like Mars very much as a beautiful red planet with a stunning, dynamic geology[21]. It is evident that geologists can admire and wish to preserve the pristine nature of geological structures, just as a biologist would wish to preserve a living forest or coral reef. Even if a planet appears undynamic or dead it may preserve in its rocks and minerals things which represent millions, or even billions of years of past dynamic processes. It may also preserve past histories of life in the form of fossils.

The intrinsic value of an uninhabited planet may not be considered to be as great as that of a planet with an indigenous biota, but we should enforce strict contamination-prevention policies all the same in order to preserve its natural state. If human exploration and exploitation were to occur on Mars it would be prudent to retain a representative proportion of the planet's surface, especially areas of unique geology, for ethical as well as scientific reasons. Only those people deficient in any ability to see beyond the concerns of humanity would advocate laissez-faire mining of Mars. Some suggest that, if Mars is found to be lifeless, a policy should be implemented to preserve only selected areas of scientific interest. However, such SSSI's (Sites of Special Scientific Interest) have been implemented in Antarctica but have been known to have been ignored or even repositioned if they happen to conflict with human interests [22], suggesting the inadequacy of conservation measures governed by anthropocentric environmental policies.

Summary and conclusion

Environmental considerations should inform planning for the exploration and colonisation of the solar system, just as they should be prominent on Earth.

According to Hartmann [23] we need extraterrestrial exploration and development as

an insurance policy, to provide new options for humanity to survive terrestrial environmental crises. This mentality of a disposable planet is ethically dubious and anthropocentric. We should learn to deal with the problems we have created for the Earth's environment before packing up, moving house and creating problems somewhere else. Some 'shallow' environmentalists will decide that humans should exploit the resources of the solar system to the full in order to bring resource shortages on Earth close to an end as soon as possible, but others will say that this is simply a continuation of improper environmental policies that are taking place on this planet and an avoidance of the real causes of the environmental problems on Earth. We must be courageous and admit that we should not need to go to space to extract resources and must realise that to advocate the scientific exploration of space in order to exploit boundless resources is arrogant and ethically vacuous. In the end, the decision about what is an acceptable environmental policy for extraterrestrial situations and what is not is not likely to be the same for everyone. The whole planet 'World Park' scheme will ultimately invite criticism of being a needless block to human progress. But human progress is not the only important thing in the universe and it should not sacrifice the intrinsic value of extraterrestrial life or landscape. As a guide to formulating extraterrestrial environmental policies the arguments presented in this paper would advocate: 1) that a planet with an indigenous biota should be left alone (with exploration only via sterilised automated spacecraft) and 2) that a planet devoid of life should have a representative proportion of its physical environment preserved. This second policy guide raises the point that to preserve a representative proportion of the physical environment of many planets may be difficult without what amounts to an observance of the first policy guide. For instance it would be impossible to preserve a representative proportion of much of the physical environment of the Jovian planets since the products of a microbial invasion or pollution would be spread throughout the planet by atmospheric processes. Human pollutants and invasive microbial populations may alter the chemical environment of a planet's atmosphere irrevocably.

Some may say that seeking to preserve extraterrestrial environments on the basis of philosophical arguments reeks of sentimentalism. Rolston [24] answers such criticism by saying something like 'humans who belittle concern for other species, for ecosystems and for landscapes need pity, for they cannot see beyond the narrow limits of their own affairs.' Applying environmental ethics to extraterrestrial situations is certainly an interesting way to test humanity's commitment to environmentalism on Earth. It is sometimes argued that extraterrestrial preservation schemes for, say, Mars microbes and landscapes might bolster the desire to protect terrestrial species and environments. It is evident, however, that lack of interest in terrestrial environmental ethics makes the idea that humans will be ethically inclined to protect microbes on Mars seem rather remote. Even the committed environmentalist James Lovelock advocates a rapacious exploitation of extraterrestrial bodies by extolling the virtue of a terraformed Mars [25]. But as environmental philosophy grows to be a potent intellectual, and then a social, force more people may express concern for the lives of Martian microbes.

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NOTES

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