Module 1 Writing Assignment

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Homo sapiens. Beings who by use of technology have elevated themselves past the limits of evolutionary constraint, becoming dictators of their own fate, along with the fate of the Earth. Their success has led to a population explosion now numbering about 7 billion individuals. However, in doing so, they have begun to resemble a cancer that is consuming and destroying Earth's regulatory systems. The Earth thus currently sits at a crucial turning point that will determine the fate of its future. Within itself, rests two key players in its transformation: one whose metabolic engines have been driving its change for eons, and one who's recent emergence as an environmental force has been so large that it surpasses much of the natural order before it. Microbes, with steady evolution moulding Earth's elemental equilibriums to the point where abundant oxygen for aerobic respiration, and elemental sequestration that constitutes the building blocks of organic matter, have been the custodians of this planet for billions of years, are now being overthrown by the species claiming dominion over all. In this essay, I will present a defence of the notion that microbial life existed easily without human intervention from the dawn of the Archean (Nisbet & Sleep, 2001), whilst promoting the notion that humans rely on microbes for key processes that are essential for sustaining life, and as we continue to exert large change on our environment, that we risk disrupting the delicate balance created by microbes that enables the survival of the human species. This disruption of complex elemental cycling is ultimately insurmountable even by the vast capacity of human innovation, thus dooming us to extinction should we carelessly venture past the boundaries of ecological provision.

The reasons for why this is true branch into three main chains of thought that I will elaborate upon through the course of this essay: 1) Microbial engines that have existed without the need for human intervention drive the world at a magnitude and complexity impossible for humans to replicate. 2) Even if we could in the future replicate these processes, the result of such intervention would more likely than not be extremely harmful towards microbes and ourselves. 3) There is a fundamental human weakness at addressing problems of this nature, which lies in the social and psychological impetus for change at a global scale.

The very existence of microbial metabolism throughout evolutionary time also presents evidence towards the independence of microbes from human intervention (Nisbet & Sleep, 2001). The nitrogen and oxygen cycles represent key drivers for life on earth and are especially relevant towards the survival of the human species (Falkowski, Fenchel & Delong, 2008). The oxygen cycle links in with the nitrogen cycle and is obvious in its utility of allowing for aerobic respiration, of which humans obligately rely on. Nitrogen cycling however, is of large relevance towards the question of how we feed ourselves (Canfield, Glazer & Falkowski, 2010). Since the start of the industrial age we have relied on the Haber process to sequester N_2 into NH_4. The magnitude of our reliance is such that global Haber-Bosch processes contribute 120 million tons of NH_4 sequestration annually, constituting 40% total nitrogen sequestration on earth (RockstrÖm et al., 2009, Canfield, Glazer & Falkowski, 2010). In contrast, microbes are responsible for the remaining 60%, as well as for all the counter reactions of denitrification that equal the magnitude of nitrogen fixation globally. We know little about how long it took for localized metabolic activity to begin altering the Earth on a global scale. In addition, we also know little about how the coevolution of metabolic pathways gave rise to complete elemental cycles resembling the ones essential to sustain life. These processes likely came about through complex horizontal gene transfer mechanisms between species which humans have not yet been able to replicate (Falkowski, Fenchel & Delong, 2008). This gives us pause when we would suggest that the feasibility of synthesizing a technologically driven nitrogen cycle. For one, consider the magnitude of production that has gone into providing the fertile ground for human crop cultivation. Microbes have already been shown to contribute the majority of reduction from, N_2 to NH_4 and all denitrification/annamox reactions balancing them. Replacement of just this step of the cycle by humans would require an engineering solution equal to the magnitude of our global efforts at fertilization, whilst increasing global nitrogen fixation through the Haber process by 2.5 times. Therefore, it is reasonably difficult that humans would not survive. We do not currently have an industrial process mirroring denitrification for our benefit. Therefore, we must keep in mind that any efforts to do so would be solely for ensuring our continued survival through maintenance of the nitrogen cycle. In doing so, we can expect significant strain on our capacity to feed ourselves without microbes. To justify the capacity of microbes not requiring human intervention, one need only consider the scenario of humanity disappearing. The realistic expectation of what follows would be a return of equilibrium to a steady state after a bloom of denitrifying bacteria and archaea (Falkowski, Fenchel & Delong, 2008).

If we took the opposing arguments target the possibility of synthetic life or large-scale geoengineering to counter the loss of microbes at their best, we would consider that our grasp of technology to be superior to our circumstances. Solutions would then come in the way of genetically modified organism, and energy production could be handled through solar powered plants (Achenbach, J. 2012). What has not been considered here is the fact that humanity fails in its application of technology in two major ways: first in ecological/environmental damage that could jeopardize our survival as a species, and the second is through the creation of anthropologically driven climate change (Achenbach, J. 2012). Our technology is not as robust as we often think it is. Examples such as the Fukushima Nuclear Plant incident, along with the BP oil spills show how even with a host of systems in place to guard against catastrophic failure, that these events still occur (Griffin D., 2015, World Nuclear Association, 2018). Humans are also responsible for creating imbalances within the Earth's geochemical cycles. Although humans were responsible for developing the Haber process in the 20th century, the process was only 40% efficient at delivering reduced nitrogen to crops (Canfield, D., Glazer, A., & Falkowski, P. 2010). This had 2 effects, the first of which is that fertilization of crops became an expensive endeavor, and the second was that large amounts of NH_4 made its way into waterways, inducing large zones of eutrophication and hypoxia. Continued use of nitrogen-based fertilizers in this manner will lead to a new balance in the nitrogen cycle, permanently altering the viability of marine life (Canfield, D., Glazer, A., & Falkowski, P. 2010, RockstrÖm, J. 2009). This in turn decreases the availability of fish for us to each, ironically limiting our food supply further. Historically, humans have mismanaged the resources available to them even when they were relatively abundant. An example of this is can be found in the American Southwest, where overgrazing caused the erosion of grassland to ever more worthless grasses, shrubs and weeds (Leopold, 1995). It is reasonable to expect that even with the technological capacity to overcome the limitations that a lack of microbes brings, that humans would resort to methods that are less than ideal to do so. In the process, we can extrapolate that further devastation of the Earth's biosphere would result, such that most life on Earth would eventually perish. If humans, driven by the prospect of short term gains fail to adequately manage what little chance they have in the absence of microbes, they would, despite having the technological capacity to do so, fail in their own survival through this mechanism (Leopold, 1995). In fact, our current struggle to mitigate and manage the onset of climate change gives indication to the likelihood that given the circumstances of having no choice but to have to replace the nutrient cycling functions that microbes provide, even with the theoretical inevitability that technology would allow us to someday do so, we would fail, or in doing so, create an uninhabitable planet from which we must also protect ourselves.

This leads into my final contention, which addresses the psychosocial factors in addressing the need for change. An event as significant as the loss of all microbial life from Earth would require a level of international cooperation that has yet to materialize (Achenbach, J. 2012). Because of a lack of political willpower to do so, and humans often motivated more strongly by short term gains than by long term consequences, we are already unlikely to meet climate change goals set forth as guard rails to secure humanity's safety (Raftery, Zimmer, Frierson, Startz & Liu, 2017). One could argue that eventual economic forces would incentivize humanity to make drastic shifts towards responsible change, but these reactionary movements fail in their adequacy to address the problem sufficiently, despite having the technology and the rationale for doing so. Therefore, humans present a unique challenge to their own survival because of their own psychological motivations in doing so. In our laziness, the responsibility of the tasks essential to our survival but providing no immediate benefit often get passed on to the government, in the assumption that it would be taken care of. In return, as we have seen through the example of climate change and in the field of conservation, that this results in a dynamic of minimization of the problem. Humanity thus intentionally ignores these sources of existential crisis to itself, failing to fully grasp the gravity of the situation, and even when it does, not acting in severe enough magnitude to stop it (Leopold, A. 1995). Our current economic and educational landscape are divergent from the requirement that mankind develop a strong land ethic as described by Leopold (1995) to ensure that what we currently have lasts many generations to come. Therefore, even with the technology, premise and resources to do so, and even with the luck to succeed without mishap, we as humans could fail because we lack the motivation to do so.

In conclusion, the inability of humankind to mitigate the effects that a loss of all microbial life brings boils down to three factors: the first being our inability to do so, the second being our rate of failure even in doing so, and third in our lack of motivation to do so. Because of these three factors, and their underlying mechanisms described above, it is thus unlikely if possible that humans could survive without microbes, while at the same time, based on maintaining the evolutionary equilibrium sustained for many millions of years, microbes would simply return the earth to its stable state without the presence of human activity. This problem closely mirrors the existential threat that we currently face: climate change and raises key questions as to how we should proceed. The solution to these issue is proposed not just in the form of greater volume of education, but in greater quality of education (Leopold, A. 1995). It highlights the problem as not just a technological struggle to control the world around us, but also a psychological need to do so. Perhaps it would serve us better to see ourselves as microbes have taken upon themselves to have done for billions of years, which is to now take on that responsibility of the custodians of this planet, even as we wrestle with our ever-growing power as the species that surpassed evolution.

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