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### Mycelium Unknown

Mushrooms predate humanity by millions of years, yet they share a common ancestor with us (Stamets "How Mushrooms" 154). While many many think of mushrooms as being similar to plants, mushrooms are actually classified under a different taxonomic kingdom than chlorophyll-producing plants and have very different properties. Plants are classified under kingdom Plantae, while mushrooms are classified under kingdom Fungi. Like humans, mushrooms gather energy from their environments instead of directly from the sun. Like humans, mushrooms are deeply interconnected with each other and unable to sustain themselves without a network of support.

Paul Stamets, one of the world's foremost mycologists, gave an interview to *Explore* on the subject of how mushrooms can save the world, wherein he asserts that there are vast untapped or unknown benefits that lie within fungi. As a mycologist for over 40 years, Stamets has been on the leading edge of research into medicinal and practical uses of fungi. In the following paragraphs, I will be affirming the details of some of his various points from the interview and then taking a further look at their implications.

In the interview, Stamets discusses the longstanding archaic relationship between humans and mushrooms. Mushrooms play a major role in the ecosystem, enriching the soil and providing

a foundation for biodiversity. In doing so, the antibacterial action of fungi in the ecosystem functions in an analogous manner to the human immune system, creating an environment in which many species can flourish.

Mushroom-based medications and vaccines have the potential to treat a variety of ailments, including smallpox and other viruses (Savitz “A mycological” 5). In addition, mushrooms embody sustainability by behaving so as to benefit their network long after they are dead. Certain fungal strains have been demonstrated to be effective at denaturing toxic waste and allowing decomposition to begin (ibid. 9). To Stamets, it is important that the use of these mushrooms must be done in a reciprocal manner with the environment without exploitation of either humans or other living beings (ibid. 11).

Stamets speaks to both the heart and the brain of the reader, making an impassioned plea for humans to care about mushrooms and long-term sustainability while backing up his claims with specific examples. Though some of his claims about nature being conscious or intelligent may be controversial, his research seems to fit into that model of interpretation. Reading this interview may result in a sudden urge to go out and find mushrooms. The article is structured as a typical interview, with a series of short prompts by the interviewer Bonnie Horrigan each followed by a response from Stamets. Despite the technical jargon and latin included in Stamets’ responses, the interview maintains a casual conversational tone, as if one were talking to Stamets over a cup of coffee, though at times a section might require multiple scans in order for the reader to fully understand a concept. I found myself occasionally Googling phrases that I did not fully grasp. Unfortunately, the article includes no references except a mention of Stamets’ book *Mycelium Running: How Mushrooms Can Save the World*, and it is from that that I assume the

article derives its title. The book includes much of the information mentioned in the interview in much greater detail and references hundreds of other works (“Mycelium Running” 311). I suspect that this interview was done at least in part as a promotion for this book. From this analysis I conclude that Stamets’ claims are indeed backed up by substantial empirical evidence.

Due to my newfound personal interest in mushrooms, the amount of empirical evidence backing Stamets’ claims, and my lack of expertise in the field of mycology to a degree that would allow me to construct an educated oppositional thesis, I cannot help but agree with the overall argument that Stamets is making. If controlled experiments show that a certain fungal strain can treat a certain ailment, I cannot claim otherwise with academic integrity given my limited experience.

I can, however, investigate the more controversial claims about natural intelligence, as these speculations lie more in the realm of philosophy than science. Intelligence itself is not a well defined concept, and it is not obvious what entities can and cannot be called intelligent (Savitz “The Future” 2). I will delve into the details of Stamets’ well-substantiated claims about the medical properties, ecological benefits, and structural sophistication of mushrooms. This last item will lead into a discussion of the potential philosophical implications.

Species from the kingdom *fungi* may have substantially more medical potential than is currently understood. Mushrooms have been used for medicinal purposes since archaic times, though very little record remains (Stamets “Mycelium Running” 35). There is a record of mushrooms being used in ancient Western medicine. The first known manual of medicinal herbs published in 65 AD, *Materia Medica*, documents the medical uses of a variety of mushrooms.

Agarikon, known today as *Laricifomes officinalis*, is described as being a suitable treatment for “indigestion, hernias, and falls from on high,” among other conditions (Dioscorides 363).

Recent research indicates that this mushroom can act as an insulin sensitizer and can “reduce hypoglycemia” (Lindequist) and extracts of this mushroom have been shown to have anticancer effects (Durgo et al.) Methanol extracts *Hypsizigus marmoreus*, commonly known as the white beech mushroom, have also been shown to have anticancer and anticarcinogenic properties (Chang). In a study of patients with hepatitis B, a 12-week regimen of *Ganoderma lucidum* extracts, also known as Reishi, resulted in 13% being completely cured at the point of a 6-month follow up (Lindequist).

There also appears to be a substantial potential for the treatment of mental health conditions using the psilocybin-containing psychedelic mushrooms of the *Psilocybe* genus when administered in an appropriate clinical setting, however the research into this area is far from conclusive (Savitz “The Mystery”). Clearly, Stamets is no charlatan when it comes to touting the medicinal potential of mushrooms. I could continue this paragraph for a very long time, given that there is substantial research into the medicinal benefits of mushrooms. There are even entire journals dedicated to the topic such as the *International Journal of Medicinal Mushrooms*.

While mushrooms have the potential for substantial positive effect on the micro ecological system that is the human body, they also play a major role in macro ecological sustainability. Stamets claims that that mushrooms can restore the environment in a process that he calls “mycorestoration.” This is the primary topic of his previously referenced book (Stamets “Can Mushrooms” 158). He calls fungi the “immune system” of habitats and cites a 1998 study by Roy Watling as a demonstration of the potential for mushrooms to restore a devastated

ecological environment after a natural disaster (Stamets “Mycelium Running” 55). A 2014 study found that certain mushroom species are effective at detoxifying human-made toxic waste by targeting and denaturing certain pollutants specific to the specie of mushroom (Kulshreshtha). Stamets considers mycorestoration to be in its infancy but this is a promising start to an exciting area of sustainability research (Stamets “Mycelium Running” 57).

The structure and behavior of mycelial networks themselves are intriguing. By the manner in which they decompose organisms and create soil, mushrooms create a food source for both themselves and future organisms that can live and die to later be decomposed by and feed the descendants of those mushrooms. They behave as if they are planning for the future of their network long after their death. According to Stamets, this is a natural example of a Native American concept which is essential that one should always be “thinking seven generations ahead” (Stamets “Can Mushrooms” 158).

Humans can learn from the structural sophistication and sustainable behavior exhibited by mushrooms. As Stamets puts in in *Mycelium Running*, “The architecture of mycelium resembles patterns predicted in string theory” (9). This structure, which he calls the mycelial archetype, may be similar to the theoretically most efficient way, to arrange matter and energy, as a network of “threads” (ibid. 9). Humans have essentially begun to replicate this structure by creating the internet, a network of information-sharing nodes arranged so as to minimize points of failure and pool computing power (ibid. 10). Over time, the internet is continuously developing into this archetypal form, becoming more decentralized and efficient as the technology improves. A mycelial web manages to maintain a shocking level of integrity despite each strand being a single cell thick. Stamets believes that this archetype is also manifest as the

human brain (ibid 10). Given that mycelial structure is a manifestation of the same archetype, and that this structure developed in fungi before humans, perhaps the human brain is simply a portable version of the mycelial web optimized for mammalian survival. If true, this implies that the mechanism by which human intelligence capabilities arise, being a construct of our neural structure, are a copy of an a mechanism that predates humans. He also believes that greater understanding of mycelial information structure will lead to a breakthrough in human computational capability (ibid. 10). A greater understanding of both neural structure and network optimization imply substantial advances in the efficiency and efficacy of neural networks, which are networks of computing nodes designed to learn from their environment by mimicking the structure of the human brain. These networks are a fundamental component of machine learning, which is one of the biggest domains of artificial intelligence.

As mentioned above, intelligence, let alone artificial intelligence, is a difficult concept to define. One dictionary defines it as “capacity for learning, reasoning, understanding, and similar forms of mental activity; aptitude in grasping truths, relationships, facts, meanings, etc. [sic]” (“Intelligence”). Artificial intelligence depends and builds upon this definition, yet if intelligence is not well defined nor easily observable, neither is artificial intelligence (Savitz “The Future” 2). Despite this, it is generally agreed upon that, at minimum, humans exhibit intelligent behavior. Stamets holds that there is an intelligence nature and that humans are not the only intelligent species. In another interview, he cites a Japanese study that demonstrated intelligence on a cellular level (Rogan 21:30). While it can be argued that this apparent intelligence is simply the result of evolutionary pressures shaping mushroom behavior towards sustainability-seeking, I would counter that the same can be argued about the development of intelligent human behavior,

including morality. I do not mean to reduce morality to an evolutionary construct, but further discussion of this topic is beyond the scope of this paper.

Mushrooms and humans that did not behave so as to sustain both themselves and the system which contain themselves would have had a lower chance of survival and reproduction than those who did. As such, intelligent behavior appears to be an emergent property of sustainable organic structures, but there is no reason to assume that being organic is an essential property of these structures. Assuming that life is an emergent property of natural processes, then so are humans and so is intelligence, and if these processes shaped human behavior, and human behavior shapes mechanical behavior, then an argument can be made that the distinction between natural and artificial intelligence is arbitrary and irrelevant. If intelligence can be generalized to non-human entities, and a machine can be made to act as an intelligent entity — i.e. mimicking organic sustainable behavior exhibited by both humans and mushrooms — then I can safely conclude that “artificial intelligence”<sup>1</sup> is not only possible, but highly probable and possible inevitable given a long enough span of time. Life as we know it took four-and-a-half billion years to emerge on this planet since its beginning, so a “long enough span of time” is certainly a matter of relative scale, and I would recommend that those eager for the dawn of artificial intelligence prepare to exercise extreme patience. By the time that this truly superhuman-level artificial intelligence emerges, it is very possible that all those alive at the time that I write this paper will have been dead for quite a long time.

But will one’s subjective experience continue after one’s body has ceased to live? This question has started humanity in the face since we gained the ability to model the future. A

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<sup>1</sup>As explained by Tegmark and Bostrom (Savitz “The Future” 2).

definitive conclusion is far beyond the scope of this paper and possibly beyond the scope of the human experience, but I can pose some highly speculative conclusions based on several moderately speculative operating assumptions. If one were to assume that consciousness is an emergent property of neural structure, and the archetype that is manifest as this structure predates human beings, the consciousness cannot be unique to humanity. At a minimum, this would imply a conscious experience emerging from complex networks that manifest the mycelial archetype, but it is not clear whether there would be an absolute threshold of complexity and optimization for the emergence of consciousness, whether the degree to which an entity is conscious is a function of its complexity and optimization, or whether there is a conscious element that transcends all individual entities. Consciousness, with this generalization, cannot be limited to mere subjective human experience, yet it is difficult if not impossible to grasp what a nonhuman subjective experience would entail.

But if consciousness emerges from an underlying network, and if the network from which consciousness emerges is itself an emergent property of a complex and optimized network, then it would follow that some type of consciousness can emerge from this underlying network. It is not a great leap to then conclude that the consciousness that emerges from the primary network is related to if not an aspect of the consciousness of its underlying network. Upon the termination and dissolution of a network, it could likely be that the network's emergent consciousness returns to the consciousness of its underlying network, especially if the conscious network of the primary network is an aspect of the consciousness of the underlying network. With this conclusion, the question yet remains as to how an emergent consciousness acts following the termination of its underlying consciousness. Perhaps the entire structure is a manifestation of a



single thing as multiple aspects or segments, rather than as distinct entities, implying that consciousness, and an element of every conscious being, has an essential transcendent nature. As this specifically relates to humans, my conclusions imply that given the substantial underlying assumptions as stated above, conscious awareness does not cease after death, but rather changes its form or manifestation, returning to whence it came or shifting into something new. All of this is of course highly speculative, but the implications of Stamets' conclusions seem to indicate potential in this line of reasoning. In another interview, he claims that "reality is not limited to the perception we have traditionally used," which seems to be in alignment with the idea that there exists realms of subjectivity beyond the limitations of the human instrument (Rogan 2:12:30).

As an example of alternative human conscious experience, Stamets describes an experience where he had a lucid dream while on psilocybin mushrooms of hundreds of dead cattle, and a week later, he saw this exact scene. To explain this, he states, "I entered, I think, into the multiverse" (Rogan 2:08:30). Stamets has several more examples of seemingly unexplainable phenomena occurring as a result of psilocybin mushroom ingestion. A friend of his, Bill Webb, had a hearing problem that required a hearing aid. While on a five gram dose of psilocybin, he experienced a spontaneous and substantial recovery in hearing ability that lasted for several days. According to Stamets, this is due to neurogenesis that occurs due to the influence of the psilocybin experience (ibid. 1:07:30). Stamets personally experienced a spontaneous and permanent elimination of his stuttering problem after a powerful psilocybin trip of approximately twenty grams of dried mushrooms (ibid. 37:00). The potential for neurogenesis as a result of psychedelic experience is currently one of the frontiers of modern research. This

phenomenon may be a major factor may contribute to the “great possibility for psilocybin in particular and psychedelic drugs in general to be used for therapeutic applications in a clinical setting” (Savitz “The Mystery” 10). Unfortunately, these mushrooms are considered to be dangerous and addictive by the United States federal government, and as such are put in the same category as heroin, despite neither of those things being true (ibid. 11).

The potential that lies within mushrooms is so potentially disruptive to the societal status quo that many governments have made some of them illegal. As Stamets rightly points out, mushrooms have the potential to change the world. From medicinal uses to ecological remediation, and even the potential to combat colony collapse disorder — the name given to the now-worldwide phenomenon of worker bees abandoning their hives and disappearing<sup>2</sup> there is a vast range of known uses for fungi, and far more unknown uses. The practical claims made by Stamets are well-backed by empirical evidence. The more speculative conclusions implied by his findings further imply a reality of experience and possibility far beyond human comprehension that requires much greater research. The general public should be far more educated about fungi; the common association of mushrooms with hallucinogenic “magic” mushrooms does more harm than good in this regard. Perhaps one day, mycelium may no longer be unknown.

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<sup>2</sup> Colony collapse disorder is the name given to the now-worldwide phenomenon of worker bees abandoning their hives and disappearing. While in a semi-dream state, Stamets conceived an idea to treat this disorder using fungi (Rogan 1:25:30).

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