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The Hidden Importance Of Fungi

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Humans and the world as we know it would not exist without fungi. Unfortunately, this is not a widely known fact. The kingdom of fungi is very understudied and underappreciated compared to the other kingdoms in biology. Regardless, it has been found that these ancient organisms have played a vital role for humanity from the moment they appeared on the Earth and will continue to do so.

To fully understand the impact of fungi in the past, present, and future, it is important to take a scientific approach. About a billion years ago, fungi created the oxygen-rich atmosphere that life needs to survive by helping plants undergo photosynthesis. As civilization advanced, scientists found that fungi currently have other important uses, such as food crops benefiting from fungi by receiving nutrients and fungi being an effective way to clean oil spills due to their ability to break down almost anything. Additionally, knowing fungi were a key factor for life on Earth, NASA researchers have begun to search for a way to use fungi for space travel and to create a livable environment on other planets in order to put humanity one step closer to space colonization.

Fungi are multicellular eukaryotic organisms that are excellent at obtaining nutrients by producing enzymes that enable this process. These enzymes do not only allow fungi to survive but they also help the surrounding environment since fungi only need a small amount of the nutrients obtained. Any nutrients left are transferred to things like soil and plants.

Fungi are not only great decomposers, they are opportunists and very resistant, which allows them to adapt to many different environments, like space. According to the source “How

Fungi Can Support Life in Space" by authors Allison Lucht and Will Broussard, fungi can survive extreme conditions such as low temperatures and some are even resistant to radiation. Additionally, fungi can actually flourish without gravity since spores, microscopical biological particles released by fungi to reproduce, can travel and spread without limits since there is no friction without gravity.

It is commonly taught that plants are responsible for the oxygen-rich atmosphere of Earth by performing photosynthesis. While that is partially true, a billion years ago plants and soil did not work the same way they currently do. The source "How Fungi Helped Create Life As We Know It" by the University of Leeds, explains that plants in ancient Earth did not have roots, and were non-vascular, meaning they could not hold water. The soil plants came into contact with lacked the organic matter that was needed to help plants grow. In order to explain how plants were able to grow and undergo photosynthesis if the bridge between plants and soil was broken, scientists from the University of Leeds performed an experiment in which the atmosphere of ancient Earth was simulated in computer models. The results revealed that fungi were essential organisms for the creation of an oxygen-rich atmosphere since they were responsible for transferring minerals to plants by a process called biological weathering that consists of fungi extracting and transferring phosphorus from rocks which helped the plants grow and fuel photosynthesis. Without the aid of fungi, plants would have never been able to begin creating the atmosphere which would later support more advanced life like animals and humans.

While these organisms played a huge role in ancient Earth, currently, they are still very important for humanity and Earth's ecosystem by solving or potentially solving important environmental issues. According to the article "Benefits of Arbuscular Mycorrhizal Fungi in Sustainable Crop Production" by M. Vosatka and J. Albrechtova, soil in the last century has

deteriorated on a global level. Due to the increasing world population chemical fertilizers are used to keep up with the demand; unfortunately, these chemicals can not sustain the long term health of soil and plants. This problem does not only affect agriculture, it also affects the increasing world population, since the demand for needs such as food and livable environments are also increasing. A way to solve this issue is with the help of Arbuscular Mycorrhizal (AM) fungi. These fungi are efficient biofertilizers and very beneficial in forming relationships with the majority of crop plants. They are responsible for the health and effectiveness of soil in environments due to their ability to inhabit ecosystems and acquire nutrients. AM fungi helps the growth of plants by reducing phosphate and nitrate requirements, enhancing seedling growth, and it can build the resistance of plants against soil-borne pathogens. With the help of AM fungi, farmers would be able to maximize crop productivity, reduce soil pollution, and contribute healthier food to society.

Fungi also play an important role in healing other ecosystems damaged by humans. The article “Bioremediations for Oil Spills by Utilizing Microbes” discusses the various methods of bioremediation used to break down pollutants, such as oil spills, that can negatively affect marine ecosystems. One of those ways is Mycoremediation, a method that uses fungi for the degradation of environmental toxicants. Since fungi are powerful decomposers due to their production of enzymes, fungi have the ability to break down harsh toxins from oil spills without negatively affecting the existing ecosystem. An example of a fungus that can be used to clean up oil spills is Penicillium Chrysogenum. Companies that are responsible for damaging the environment release xenobiotics, like phenol, that can be dangerous to life. Penicillium Chrysogenum, has been demonstrated to break down xenobiotic chemicals into less dangerous substances towards the living organisms in the affected environment. Using fungi, like Penicillium Chrysogenum, is not

only beneficial because it can help heal the environment, it is also an effective method of cleaning up as it is less damaging, more cost effective, and time saving.

Just like the past and the present, the future still involves the use of fungi. An article published from NASA by author Frank Tavares, "Could Future Homes on the Moon and Mars Be Made of Fungi?" discusses the possibility of using fungi to help humanity establish itself on other planets. The Myco-architecture project in NASA's Ames Research Center in California Silicon Valley is working towards creating technology that would use fungi to create the environment to sustain human life on the moon and Mars. The idea is to create a lightweight compact habitat that astronauts can carry containing dormant fungi. Upon arrival to their destination, astronauts would add water to the fungi and let it grow to create a livable environment for humans. The mycelium, a root-like structure of a fungus, would be responsible for creating a home and could also be used to create other things, like furniture, as mycelium can be coaxed into making structures. Since mycelium is important in accomplishing this goal, researchers know it is important to have a way to sustain it. Like other living organisms mycelium breathe and eat, that is why cyanobacteria will be used. Cyanobacteria use energy they collect from the sun to convert water and carbon dioxide into oxygen and fungus food. While there is still a lot of work to be done, researchers are always experimenting with new ideas to use fungi to create a sustainable environment for humans on the moon and Mars.

Fungi would not only be important for living on other planets, they would be essential for Earth-independent missions. The article "Fungal Biotechnology in Space: Why and How?" introduces the idea of using fungi to allow astronauts to make their resources instead of having to resupply. The International Space Station is currently resupplied by supply missions from Earth. However, with the plan of traveling further away from the Earth to explore other planets,

it is imperative astronauts are no longer dependent on the supply mission and instead are able to make their own resources according to their needs. These resources are also known as production compounds which include food, materials, and pharmaceuticals. To accomplish this goal, it is proposed to use the fungus A. niger, an efficient production system often used in biotechnology. A. niger has a multipurpose cell factory that can produce a diverse range of organic acids, enzymes, proteins, and natural products on Earth which sets it apart from other fungi as the efficiency of A. niger can not be matched. This fungus is also a great candidate for space missions due to its ability to be cultivated in a wide range of conditions such as low temperatures, lack of nutrients, and under low gravity. Using these organisms would not only help astronauts survive and travel further distances, it would actually be a more practical and less expensive solution than bringing all of the supplies astronauts would need.

An uncertainty many might have regarding using fungi for agriculture, especially farmers, is why don't fungi play a primary role in agriculture despite the benefits fungi have on plants. Unfortunately, it is not because there is no proof, it is because of the lack of awareness and education about fungi. Most people are usually misinformed and think of fungi in a negative manner, like mold or infections. Unfortunately, this causes disinterest or mistrust among people, like farmers, who could benefit from using fungi. To fix this, it is important that sustainable soil management begins to be taken seriously not only by farmers but the government as well so proper education and training about using fungi for agriculture can be provided.

Using fungi for space travel and space colonization has its limitations. After all, the research has just begun. Important projects like these take years before any working technology is developed. Concerns about the survival of fungi in space stations are valid; however, the first hint of the ability of fungi to survive in space stations was in 1988. According to the previous

article “How Fungi Can Support Life in Space”, in 1988 the Russian space station, Mir, was “attacked” by fungi. The astronauts found that fungi were rapidly spreading throughout the station, gradually eating it away. Since fungi are very adaptable, they were most likely able to survive by feeding off the dead skin cells that astronauts inevitably shed during their travels. Not to mention, some fungi, like yeast, are resistant to radiation making them very valuable for space travel. This proves that fungi will find a way to survive anywhere by themselves. So if they can already do so much by themselves, using technology to further advance their benefits is only a matter of time.

Another big concern would be the health of the astronauts. An unplanned “attack” of fungi, like the Russian space station suffered, can be risky for human health in indoor-closed environments. Fortunately, with research, proper preparation, and well designed technology, the risk will be lowered. For example, creating an artificial atmosphere in which astronauts can control the moisture and temperature will limit the risk fungi have on the health of astronauts. This would allow for fungi to be able to contribute to the sustainability of long term missions instead of causing problems.

While fungi can be very helpful organisms, their benefits are useless if society does not take the steps towards understanding and taking care of them. In the instance of using AM fungi to improve the soil of crops, it is not only important that farmers are educated about the benefits that fungi can have on their crops. It is also important to educate them about the appropriate management practices that will help farmers use fungi and their benefits to the fullest potential. For example, it is important that farmers know that when using AM fungi, they should reduce the use of agrochemicals, like pesticides, use appropriate tillage practices and more, otherwise the hard work fungi performs to help crops will be wasted and no improvements will be made.

It is also imperative that society pays more attention to fungi because like any other organism, climate change can negatively affect them, which in turn could have a negative effect on not only agriculture but on human health as well. According to the article "Climate Change And The Emergence of Fungal Pathogens" by Nnaemeka Emmauel Nnadi and Dee A. Carter, climate change could create environmental pressures that lead to diseases caused by fungi. Unfortunately, since mainly viral and bacterial pathogens receive the most attention and research, a fungal pathogen outbreak would be more deadly. The world has already witnessed how deadly an outbreak of a viral pathogen can be with Covid-19, even with scientists being more knowledgeable about viruses. If a fungal pathogen were to spread like Covid-19 due to climate change, it would be more deadly since fungi are very understudied and there is currently no vaccine to treat a fungal pathogen.

Not only must society learn more about fungi for agricultural and health purposes but also because they are the future. Perfecting using fungi for space colonization and traveling will take years. That's why it is important to educate younger generations as well, because if the younger generations do not know about the benefits of fungi, important projects, like space colonization, will not be able to move forward as current scientists will begin to grow older. If that happens no growth or improvements will be made towards a life changing project.

The importance of fungi is undeniable: however, in order for society to utilize their benefits it is important for society to change its view and grow its knowledge regarding fungi. A start would be in the education system. As stated before, most students are taught that plants are responsible for the oxygen-rich atmosphere, but no one mentions how fungi were the organisms that helped plants achieve photosynthesis. This not only takes the credit away from fungi but it also withholds helpful and important knowledge from students who could actually become

interested in fungi if they were taught more. Additionally, when the kingdom of fungi is taught in schools, it is done so with a negative stigma as usually infections or mold are the main point. If the importance and benefits of fungi were pushed more in education, more research and interest would be shown towards these organisms and with that fungi and humans would be able to better work together towards the future of human civilization.

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