SCIENTIFIC AMERICAN

http://www.scientificamerican.com/article.cfm?id=radiation-helps-fungi-grow

Do Fungi Feast on Radiation?

Apparently, but only if they contain melanin, the chemical that serves as skin pigment in humans

By David Biello | Tuesday, May 22, 2007

RADIATION EATERS: New research may show that fungi with melanin—the protective pigment in human skin—thrive in the presence of ionizing radiation.

Like plants that grow toward the sun, dark fungi, blackened by the skin pigment melanin, gravitate toward radiation in contaminated soil. Scientists have observed the organisms—somewhere between plants and animals—blackening the land around the Chernobyl Nuclear Power Plant in Ukraine in the years since its 1986 meltdown. "Organisms that make melanin have a growth advantage in this soil," says microbiologist Arturo Casadevall of the Albert Einstein College of Medicine in New York City. "In many commercial nuclear reactors, the radioactive water becomes contaminated with melanotic organisms. Nobody really knows what the hell they are doing there."

Casadevall and his colleagues, however, have a theory. Based on experiments with three different types of fungi, they believe the melanin-containing breeds absorb the high levels of energy in ionizing radiation and somehow turn it into a biologically useful (and benign) form, akin to a dark and dangerous version of photosynthesis. "We were able to see significant growth of the black ones relative to the white ones in a radiation field," he says. "That is the observation. How you interpret it … is where the interesting speculations come in."

In a paper published online in PLoS One, Casadevall and his colleagues report that ionizing radiation changes the electron structure of the melanin molecule and that fungi with a natural melanin shell (the soil-dwelling Cladosporium sphaerospermum and yeastlike Wangiella dermatitidis varieties), which were deprived of other nutrients, grew better in the presence of radiation. They also report that fungi induced to produce a melanin shell (the human pathogenCryptococcocus neoformans) grew well in such levels of radiation, unlike those sans pigment. Further, an albino mutant strain of W. dermatitidis failed to thrive as well as its black cousin when exposed to 500 times the normal amount of ionizing radiation (still well below the level of radiation necessary to kill tough fungal forms).

"The presumption has always been that we don't know why truffles and other fungi are black," Casadevall says. "If they have some primitive capacity to harvest sunlight or to harvest some kind of background radiation a lot of them would be using it."

Melanin drinks in ultraviolet rays, acting as a natural sunblock for human skin. "Melanin is very good at absorbing energy and then dissipating it as quickly as possible," says Jennifer Riesz, a biophysicist at the University of Queensland in Brisbane, Australia. "It does this by very efficiently changing the energy into heat."

But Casadevall and his colleague Ekaterina Dadachova, a nuclear chemist at Einstein, speculate that the melanin in this case acts like a step-down electric transformer, weakening the energy until it is useable by the fungi. "The energy becomes … low [at] a certain point where it can already be used by a fungus as chemical energy," Dadachova argues. "Protection doesn't play a role here. It is real energy conversion."

Mycologists and biophysicists find the notion both intriguing and potentially plausible. "Since melanin is used commonly by fungi—and other organisms—to protect themselves against UV radiation, it is perhaps not surprising that melanin would be affected by ionizing radiation,'' says Albert Torzilli, a mycologist at George Mason University in Virginia, adding that "the subsequent enhancement of growth, if true, is a novel response."

Riesz, for one, is skeptical. "It does not surprise me that fungi protected with higher levels of melanin might grow better when exposed to [ionizing radiation], since the nonprotected fungi are more likely to be harmed by the radiation," she says. "However, I find the claim that melanin is involved in energy capture and utilization to be unlikely."

More study is needed to confirm whether fungi will be able to add the ability to grow by harvesting radiation to their list of seeming superpowers, but it does raise the question of whether edible fungi—like mushrooms—have been harboring this function undiscovered for years. If true, melanin could be genetically engineered into photosynthetic plants to boost their productivity or melanin-bearing fungi could be used in clothing to shield workers from radiation or even farmed in space as astronaut food. The group plans further tests to see if fungi with melanin are converting other wavelengths of the electromagnetic spectrum into energy, as well.

"[Melanin] doesn't reflect any light; it's all going into it. Is it all disappearing into a black pigment and has no use whatsoever? Biology is incredibly inventive," Casadevall argues. After all, extremophile microbes thrive in the heat and acid of hydrothermal vents below the sea or live off the radiation of decaying radioactive rocks deep inside Earth's crust. "It's not that outlandish," Casadevall says, for fungi to harvest the energy in ionizing radiation with the help of melanin. But it is unexpected and strange.