The secret of mushroom colors

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The fly agaric with its red hat is perhaps the most evocative of the diverse and variously colored mushroom species. Hitherto, the purpose of these colors was shrouded in mystery. Researchers at the Technical University of Munich (TUM), in collaboration with the Bavarian Forest National Park, have now put together the first pieces of this puzzle.

In nature, specific colors and patterns normally serve a purpose: The eye-catching patterns of the fire salamander convey to its enemies that it is poisonous. Red cherries presumably attract birds that eat them and thus disperse their seed. Other animals such as chameleons use camouflage coloring to protect themselves from discovery by predators.

But climate also plays a role in coloration: Especially insects and reptiles tend to be darker in colder climates. Cold-blooded animals rely on the ambient temperature to regulate their body temperature. Dark coloration allows them to absorb heat faster. The same mechanism could also play a role in fungi, as the research team of Franz Krah, who wrote his doctoral thesis on the topic at TUM and Dr. Claus Bässler, mycologist at the TUM and coworker in the Bavarian Forest National Park suspect. Mushrooms might benefit from solar energy to improve their reproduction, as well.

Distribution of 3054 fungus species studied

To test their theory, the researchers combed through vast volumes of data. They investigated the distribution of 3054 species of fungi throughout Europe. In the process, they analyzed the lightness of their coloration and the prevailing climatic conditions in the respective habitats. The results showed a clear correlation: Fungal communities have darker mushrooms in cold climates. The scientists also accounted for seasonal changes. They discovered that fungal communities that decompose dead plant constituents are darker in spring and autumn than in summer.

"Of course, this is just the beginning," explains Krah. "It will take much more research before we develop a comprehensive understanding of mushroom colors." For example, further seasonal coloring effects cannot be detected in fungi that live in symbiosis with trees. "Here, other coloration functions, such as camouflage, also play a role." The

researchers also need to study the degree to which dark coloration influences the reproductive rate of fungi.

More information: Franz-Sebastian Krah et al, European mushroom assemblages are darker in cold climates, *Nature Communications* (2019). DOI: 10.1038/s41467-019-10767-z

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