In many fungi, reproductive spores are remarkably aerodynamic

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The reproductive spores of many species of fungi have evolved remarkably drag-minimizing shapes, according to new research by mycologists and applied mathematicians at Harvard University.

In many cases, the scientists report this week in the *Proceedings of the National Academy of Sciences*, the drag experienced by these fungal spores is within one percent of the absolute minimum possible drag for their size. But these sleek shapes are seen only among spores distributed by air flow, not those which are borne by animals.

"We set out to answer a very simple question: Why do fungal spores have the shapes that they do?" says co-author Marcus Roper, who contributed to the research as an applied mathematics graduate student in Harvard's School of Engineering and Applied Sciences. "It turns out that for forcibly ejected spores, the shape can be explained by simple physical principles: The spores need to have a close to minimum possible air resistance for their size. As projectiles, they are close to perfect."

Roper is now a postdoctoral researcher at the University of California, Berkeley.

Together with colleagues at Harvard, Roper studied the airborne spores of more than 100 species of ascomycetes, the largest phylum of fungi. These fungi enter the sexual phase of their life cycle when they deplete nutrients in the deposits of feces or decaying matter where they reside.

In these species, spores are held in fluid-filled sacs where pressure builds until they eventually explode, ejecting the spores into the surrounding air. An optimal drag-minimizing shape ensures that the spores can traverse several millimeters of still air surrounding the fungus' fruiting body; once past that point, the 10-micron spores are light enough to be propelled by even the gentlest breeze.

While Roper and his colleagues found that ascomycetes eject spores at an unexpectedly forceful 1.24 meters per second, the spores decelerate very rapidly, heightening the importance of aerodynamics in reproductive success.

Spores transported by animals lack the drag-minimizing shapes seen among airborne spores, says co-author Anne Pringle, a mycologist.

"A well known ascomycete, the truffle, spreads its spores when it is eaten and egested by animals," says Pringle, assistant professor of organismic and evolutionary biology in Harvard's Faculty of Arts and Sciences. "Other ascomycetes encase their spores in a goo which is then spread by insects. These animal-dispersed spores do not exhibit particularly drag-minimizing shapes."

"We can see the signature of natural selection in this very simple principle that cuts across a range of species," Pringle says. "It is a real leap forward in our understanding of the biology of a mega-diverse group of microorganisms, showing how they manipulate and respond to their environment."

The unusual marriage of mycology and applied mathematics was fostered at Harvard by the physical proximity of disparate facilities such as high-speed cameras Roper used to photograph spore release and the 130-year-old Farlow Library, which ranks among the world's strongest mycological and botanical collections.

"This collaboration represents exactly the type of opportunity that is unique and special about Harvard," says co-author Michael P. Brenner, Glover Professor of Applied Mathematics and Applied Physics in Harvard's School of Engineering and Applied Sciences. "The work combines diverse fields -- mycology and applied mathematics -- in synergistic and truly collaborative ways, with a critical contribution coming from Harvard's remarkable collections."

Source: Harvard University