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The fastest flights in nature: High-speed spore discharge mechanisms among fungi

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Microscopic coprophilous or dung-loving fungi help make our planet habitable by degrading the billions of tons of feces produced by herbivores. But the fungi have a problem: survival depends upon the consumption of their spores by herbivores and few animals will graze on grass next to their own dung. Evolution has overcome this obstacle by producing an array of mechanisms of spore discharge whose elegance transforms a cow pie into a circus of microscopic catapults, trampolines, and squirt guns.

A new paper from Nik Money's lab at Miami University in Oxford, Ohio, in collaboration with Diana Davis and Mark Fischer at the College of Mount St. Joseph in Cincinnati, is published in the open-access journal *PLoS ONE* and solves the operation of squirt guns that fire spores over distances of more than 2 meters.

The researchers used high speed cameras running at up to 250,000 frames per second to capture these blisteringly fast movements. Spores are launched at maximum speeds of 25 meters per second–impressive for a microscopic cell–corresponding to accelerations of 180,000 g. In terms of acceleration, these are the fastest flights in nature.

The paper is significant for a number of reasons. This is the first study utilizing ultra-high-speed video cameras to capture the events of spore discharge in ascomycete and zygomycete fungi. Previous investigators relied upon models to predict ballistic parameters and produced erroneous estimates of velocities and accelerations. These estimates were then used to suggest that pressures within the spore guns were very high. Fungal cells generate pressure by osmosis and, in the *PLoS ONE* study, the authors used a combination of spectroscopic methods to identify the chemical compounds responsible for driving water influx into the guns.

These experiments showed that the discharge mechanisms in fungi are powered by the same levels of pressure that are characteristic of the cells that make up the feeding colonies of fungi. Therefore, the long flights enjoyed by spores result not from unusually high pressure, but from the way in which explosive pressure loss is linked to the propulsion of the spores. There appear to be some similarities between the escape of the spores and the expulsion of ink droplets through nozzles on inkjet printers.

Another important aspect of the new work is the way that it has allowed the researchers to test different models for the effect of viscous drag on microscopic particles and identify limitations in previous approaches to modeling. This information is very important for future biophysical studies on spore and pollen movement, which have implications for the fields of plant disease control, terrestrial ecology, indoor air quality, atmospheric sciences, veterinary medicine, and biomimetics.

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