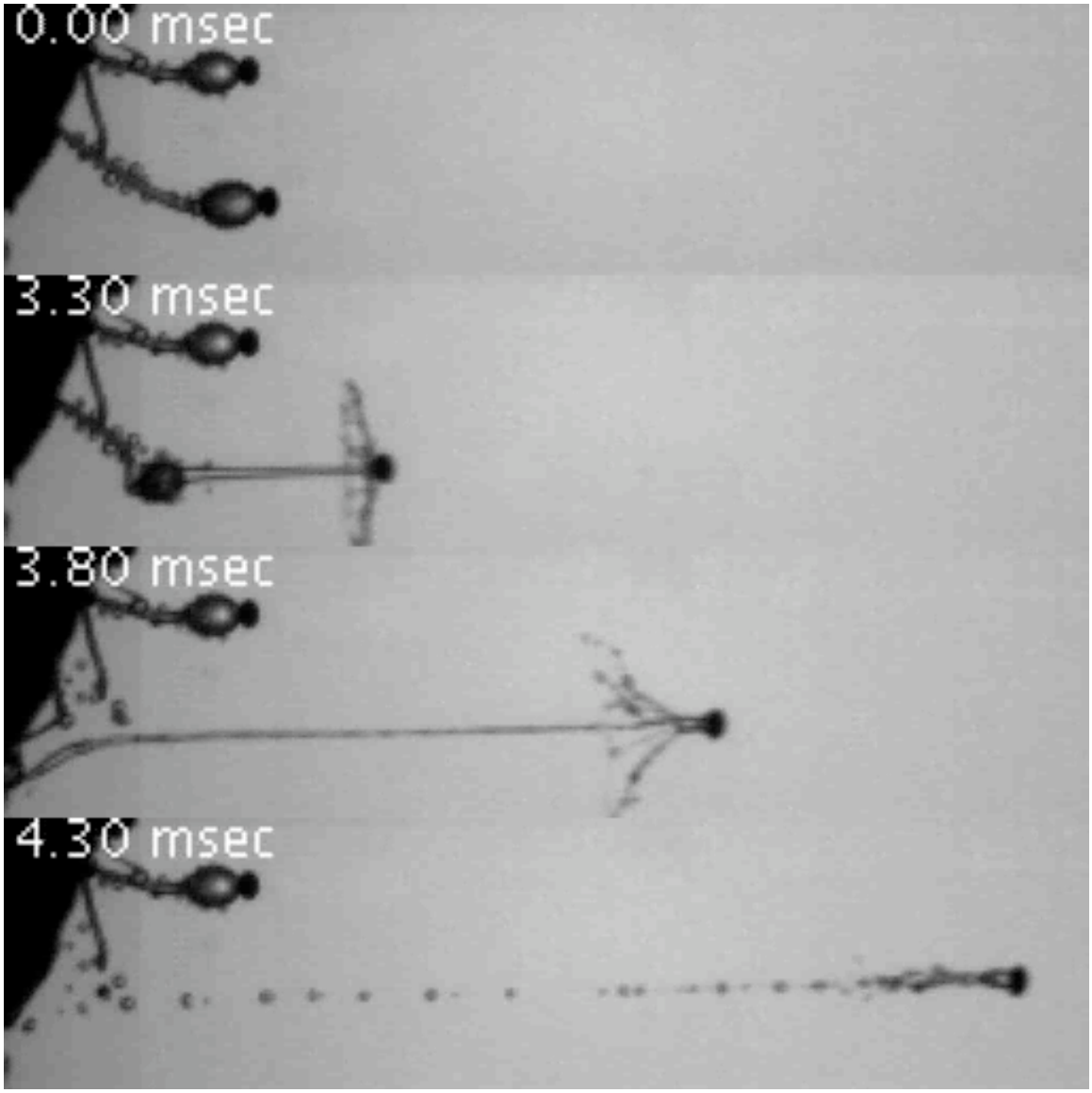
SC/BPHS 2020 Assignment One (31 September 2010)
KEY



QUESTION ONE: Explain the mechanism that causes spore discharge with an astonishing impulse force of 100,000 – 200,000 X g[1]. Please ensure that your explanation is clear and lucid, so that a non-Physicist like Dr. Lew can understand it. Diagrams help him, as does clarity with respect to the use of units.

HINT: Three researchers have worked on aspects of fungal spore discharge: Nick Money, Frances Trail and Steven Vogel. You may wish to refer to their published work to discover the explanation

Ground Rules: I expect that students may (or may not) wish to work with each other on the assignment (depending on personal preference), and may certainly come to me for help. But, please ensure that the work you hand in is your own.

[1] Levi Yafetto, Loran Carroll, Yunluan Cui, Diana J. Davis, Mark W. F. Fischer, Andrew C. Henterly, Jordan D. Kessler, Hayley A. Kilroy, Jacob B. Shidler, Jessica L. Stolze-Rybczynski, Zachary Sugawara, Nicholas P. Money (2009) The Fastest Flights in Nature: High-Speed Spore Discharge Mechanisms among Fungi. PloS ONE doi:10.1371/journal.pone.0003237

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As might be imagined, this was a very open-ended assignment. Students identified a number of different propulsive mechanisms that occur in major clades of the Fungal Kingdom.

In Basidiomycota, release of spores from the hymenium involves the formation of an external liquid droplet (known as the Buller drop) that absorbs moisture from the surrounding air (condensation) due to the presence of osmotica (mannitol and hexoses[2]) excreted from the basidiospore. As the droplet increases in size, it migrates to the supporting stalk (sterigma), causing the spore to be released (due to breakage of the connection between the spore and sterigma). The details of the mechanism —from a physics viewpoint— were described by Turner and Webster (1991)[3].

In Ascomycota, the ascospores are released from an ascus sac that surrounds multiple spores (often eight) and/or through a pore in a perithecium containing many ascii. In both instances, the driving force is turgor (hydrostatic pressure). Frances Trail (2007)[4] provides an excellent biological explanation of the mechanism; Steven Vogel (2005)[5] provides a physical viewpoint.

In Zygomycota (exemplified by the so-called coprophilous —dung-eating— fungi), the spores are ejected by a structure subtending the spore cluster at the tip of the spore-bearing zygosporangium[6]. The physicist Max Delbruck worked on many aspects of sensory physiology of zygosporanagia (in the model organism *Pilobolus*). He won a Nobel Prize for his work in molecular genetics, and is one of the founders of the academic discipline of Biophysics.

Assignment Scoring: Because of the variety of potential systems, mechanisms and sources, scoring was based on effort, clarity of explanation, effective use of sources, the use of diagrams, etc.

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[2] Webster J, Davey RA, Smirnoff N, Fricke W, Hinde P, Tomos D, and Turner JCR (1994) Mannitol and hexoses are components of Buller's drop. Mycological Research 99:833–838.
[3] Turner JCR and Webster J (1991) Mass and momentum transfer on the small scale: How do mushrooms shed their spore? Checmial and Engineering Science 46:1145–1149.
[4] Trail F (2007) Fungal cannons: explosive spore discharge in the Ascomycota. FEMS Microbiology Letters 276:12–18.
[5] Vogel S (2003) Living in a physical world III. Getting up to speed. Journal of Bioscience 30:303–312.
[6] [6] Levi Yafetto, Loran Carroll, Yunluan Cui, Diana J. Davis, Mark W. F. Fischer, Andrew C. Henterly, Jordan D. Kessler, Hayley A. Kilroy, Jacob B. Shidler, Jessica L. Stolze-Rybczynski, Zachary Sugawara, Nicholas P. Money (2009) The Fastest Flights in Nature: High-Speed Spore Discharge Mechanisms among Fungi. PloS ONE doi:10.1371/journal.pone.0003237