Individual and collective swimming of plant pathogens zoospores in microfluidic devices

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Phytophthora diseases cause big threats to agriculture and eco-systems. Spreading is based on rapid dispersion of biflagellate swimming zoospores that once having reached a host initiate plant infection. Understanding their swimming mechanism and their interactions against gradients and surrounding environments becomes important. In this study, we develop a microfluidic system to investigate collective and individual motions of Phytophthora parasitica zoospores, a species that infects a broad range of host plants. Our system can generate a chemical gradient diffusing to a group of swimming zoospores and observe their swimming motions as well as the changes of the gradient at the same time. Our results show that a group of P. parasitica react differently against different doses of potassium chloride gradients: Low concentration of potassium reduces their speed and lures them away or initiates auto-aggregation, while high concentration (>3mM) causes them to change their swimming pattern to circulating around or stop moving.

Moreover, observing a single zoospore swimming in water, we achieved the characteristics of its beating flagella. The correlation between zoospore velocity and its flagella motions helps us explain their reactions against the potassium gradients. Our findings suggest that the zoospore generates speed mainly due to the mastigonemes attached front-flagellum while the whiplash back-flagellum acting as a paddle for steering. The spontaneous rotation of the cell body contributes to the long and straight swimming trajectories, which helps the zoospores spread faster and penetrate to the plant root more easily. Moreover, we find that the zoospores randomly change direction by "complete stop and turn." The turning angle is varied from 45 up to 180 degree.

[1] E. Galiana, C. Cohen, P. Thomen, C. Mura and X. Noblin. Guidance of zoospores by potassium gradient sensing mediates aggregation. Accepted to Journal of the Royal Society Interface (2019).
[2] Swimming of individual Phytophthora parasitica zoospores in water. Q. D. Tran, E. Galiana, P. Thomen, C. Cohen, F. Orange, F. Peruani and X. Noblin. To be submitted.

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