Optimizing Transport in the Vein Network of *Physarum polycephalum*

by

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Abstract:

Foraging organisms such as fungi and the slime mold *Physarum polycephalum* grow as remarkably large networks to explore their environment and find scarce and spatially disjunct resources. The mechanisms used by these organisms to integrate disparate sources of information and regulate growth remain unknown.

We study the cytoplasmic shuttle flow within the vein networks of *P. polycephalum* as a mechanism to coordinate behavior through transport. We find that the cytoplasmic flow is driven by radial contractions of the veins that are correlated in a wave of contractions, like in classical peristalsis. We show how to extend the concept of peristalsis to a random network of contracting veins. Theoretical and numerical analysis predict that transport is maximized within the network when the wavelength of the peristaltic wave is of the order of the size of the network. We demonstrate that contraction patterns derived from the theoretical model on actual *P. polycephalum* network architectures agree with the experimentally observed phase distribution and correlations. Thus, *P. polycephalum* seems to coordinate its foraging behavior by optimizing transport within its network veins, with the result that resource get distributed isotropically.

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