

Quantitative comparison of plasmodial networks of different slime molds

Christian Westendorf
Institute of Plant Sciences
University of Graz

Holteigasse 6, A-8010, Graz, Austria.
+43 3163805756
christian.westendorf@uni-graz.at

Christian Josef Gruber
Institute of Plant Sciences
University of Graz

Holteigasse 6, A-8010, Graz, Austria.
+43 3163805756
c.gruber@uni-graz.at

Martin Grube
Institute of Plant Sciences
University of Graz

Holteigasse 6, A-8010, Graz, Austria.
+43 3163805655
martin.grube@uni-graz.at

ABSTRACT

We have compared *Physarum polycephalum* to other plasmodial slime molds, based on several properties of their respective phaneroplasmodia, as well as their chemotactic responses. This work was presented at PhysNet 2015.

Categories and Subject Descriptors

J.3 [Life and Medical Sciences]: Biology and genetics.

Keywords

Myxogastria, Chemotaxis, Image processing, Phylogeny.

INTRODUCTION

Physarum polycephalum is a unicellular but spatially extended organism, which gathered large interest of biologists and physicists. During its life cycle stage as a Phaneroplasmodium it develops sophisticated networks of connected veins. Via oscillating plasmodial streams it distributes nutrients as well as signaling factors. These properties have rendered it a model organism to investigate network-, biological fluid-dynamics and food foraging behavior. It is often found in moderate temperate and humid environments, usually in forests on dead wood. Due to the fact it is potentially covering a large area it has to integrate a number of different stimuli, ranging from food sources to photo-avoidance. Early studies on the chemotactic behavior defined positive and negative chemotaxis of *Physarum polycephalum* towards different sugars and amino acids [1]. More recent studies have shown its capability to distinguish qualitative aspects of various different simultaneous inputs, e.g. food sources [2]. Phenotypic changes of the plasmodial network in response to such stimuli are observable as a variation of oscillating stream frequency and network structure. However, the diverse group of the Myxogastria contains more than 800 species. Many of these are known to form a phaneroplasmodium during its life cycle. So far only a few studies have compared the chemotactic properties and capabilities as well as the network architecture among different other plasmodial slime molds [5].

METHODOLOGY AND RESULTS

In this study we have isolated other phaneroplasmodia-forming slime molds. Two collected species proved to be sustainable under laboratory conditions with slight modifications of the standard laboratory protocols for *Physarum polycephalum*. Identification was carried out by partially sequencing 18S and 26S rRNA genes. Alignments were performed with sequence data derived from strains of known identity as well as with publicly deposited sequences. Phylogenetic analysis with RAxML [4] unambiguously identified these respective strains as *Badhamia utricularis* (Fig.1B) and *Fuligo septica* (Fig.1C), which are members of the Physaraceae family as well. Preliminary phylogenetic results suggest a close relationship of *Badhamia utricularis* and *Physarum polycephalum*, whereas *Fuligo septica* is more distantly related. In previous literature it was disputed whether the genera of *Badhamia* and *Physarum* should be merged into one [3].

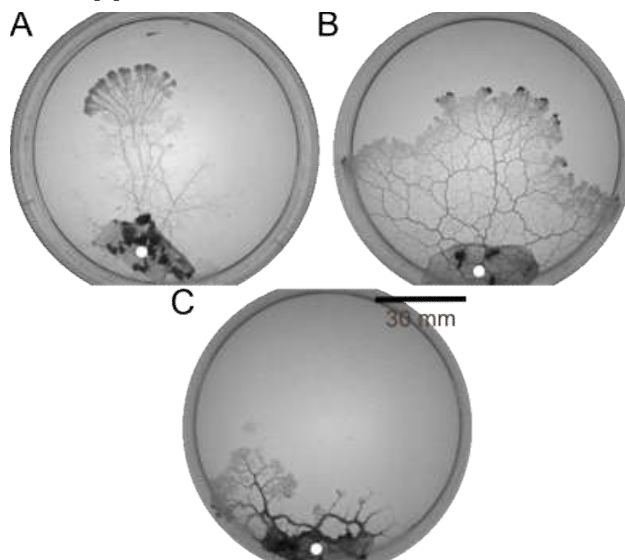


Figure 1: Exemplary images of the plasmodial networks formed by the different slime molds investigated in this study. (A) *Physarum polycephalum*. (B) *Badhamia utricularis*. (C) *Fuligo septica*. All slime molds grew from a freshly transferred culture (marked by white dot) on 1.2% water agar without additional food sources. Images were illuminated by an array of green LEDs from below and the transmitted light was recorded. The images represent different individual time points after the culture was transferred.

Custom made optical setups were used to conduct chemotaxis and growth experiments. Initially, we recorded the slime molds' response to stationary sources of various sugars previously identified to be chemoattractive or repellent towards *Physarum polycephalum*. To quantitatively describe and compare the chemotaxis among the slime molds we derived a chemotactic index adapted to the variation of the network size over time. In a more comprehensive approach to understand and compare network properties and rearrangements, we recorded the plasmodium in detail in the presence or absence of selected, significant chemoattractants or repellants. The dispersion of the respective substrate is triggered by network growth itself, as it reaches a defined region of interest. The comparison discerns several properties such as the network extension velocity, its covered area and vein thickness oscillations. Comparison of different phaneroplasmodial networks will allow deducing generalized rules for network extension and architecture.

REFERENCES

- [1] Chet, I.; Naveh, A. and Henis, Y. Chemotaxis of *Physarum polycephalum* towards Carbohydrates, Amino Acids and Nucleotides. *J General Microbiology*, 102 (1), 2015.
- [2] Dussutour, A. Latty, T., Beekman, M. and Simpson, S. J. Amoeboid organism solves complex nutritional challenges. *PNAS*, 107 (10), 2010.
- [3] Nandipati, Satish C. R., Haugli, K., Coucheron, D. H.; Haskins, E. F. and Johansen, S. D. Polyphyletic origin of the genus *Physarum* (Physarales, Myxomycetes) revealed by nuclear rDNA mini-chromosome analysis and group I intron synapomorphy. *BMC Evolutionary Biology*, 12, 2012.
- [4] Stamatakis, A. RAxML version 8: a tool for phylogenetic analysis and post-analysis of large phylogenies. *Bioinformatics*, 30 (9), 2014.
- [5] Yip, V., Beekman, M. and Latty, T. Foraging strategies of the acellular slime moulds *Didymium iridis* and *Didymium bahiense*. *Fungal Ecology*, 11, 2014.