

# Protist of the Year 2021

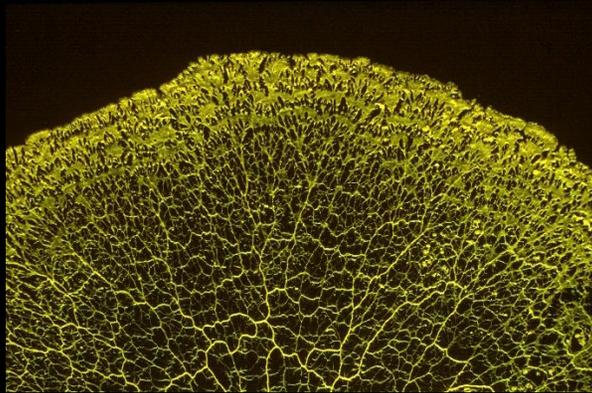


Fig. 1: Part of the yellow plasmodium of *Physarum polycephalum* with system of veins and migration front.

## *Physarum polycephalum* - The slime mold

Deutsche Gesellschaft für Protozoologie (DGP)  
German Society for Protozoology



[www.protozoologie.de](http://www.protozoologie.de)

### Overview

*Physarum polycephalum* is the most well-known and in the laboratories of cell biologists most cultivated representative of the slime molds (myxomycetes), of which there are about 900 species. Slime molds combine characteristics of fungi (the formation of fruiting bodies) and animals (possession of motile sex cells), but are not directly related to either of them. Instead, they systematically belong to the Amoebozoa, which usually contain tiny, single-celled amoebae. The macroscopically visible life form of *Physarum* represents a gigantic amoeba, i.e. a single cell. This life form, known as plasmodium, contains a large number of nuclei and forms a network of veins (Figs. 1-3). With the help of fluid cell plasma flowing rhythmically in the veins, the plasmodium slowly moves. In contrast to this one giant cell, other slime molds such as *Dictyostelium discoideum* (Protist of the Year 2011) form large stages by aggregation of many small amoeboid cells.



Fig. 2: Branched vein system of a plasmodium.

### Life cycle

The life cycle of *Physarum* can be roughly divided into three phases: plasmodium, fruiting body and spores. The large, network-shaped plasmodia contain numerous nuclei with a double (= diploid) set of chromosomes, which divide synchronously when the cell grows. For growth, the plasmodia need to take up food such as protists, bacteria, fungi, lichens, plant and animal remains. In the laboratory, the plasmodia can be easily fed with oatmeal.



Fig. 3: Two approximately palm-sized slime molds in their natural habitat, here on the rotting branch of a fallen tree in Grunewald, Berlin.

Under favorable conditions, such plasmodia achieve an almost unlimited lifetime. However, if the humidity of the environment drops below a minimum or it is getting too cold, drought-resistant permanent stages with a thick cell wall, so-called sclerotia or macrocysts, are quickly produced. These can remain germinable for months or years. In case of food

shortage, climate change or brightness, fruiting bodies are formed, which are shaped species-specifically and consist of a stem and one or more heads (Fig. 4). The nuclei in the head undergo a reduction division (meiosis), so that the resulting spores have a simple (haploid) chromosome set.

The resistant spores, which can germinate for several years, are spread by wind, water and animals. In humid environments, up to four sex cells (gametes) hatch from them. Depending on the water content of the environment, the cells can occur as myxamoebae creeping in a thin water film or myxoflagellates swimming in little water bodies. They multiply by division, transform into each other, take up food (bacteria, dissolved substances) or form microcysts. If two haploid myxamoebae fuse to become a diploid zygote, the latter grows into a plasmodium – the life cycle has closed.

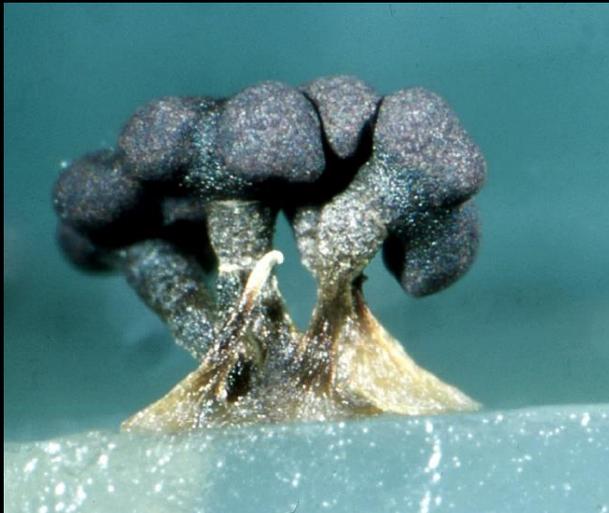


Fig. 4: Fruiting bodies with several spore heads (*polycephalum* = multi-headed).

## The largest protist in the world

*Physarum polycephalum* has earned a place in the Guinness World Records as the largest protist in the world (Fig. 5). The ability of its myxamoebae and plasmodia to merge enabled the breeding of a 5.54 m<sup>2</sup> specimen in the laboratory. For the retirement of the well-known *Physarum* researcher Karl-Ernst Wohlfarth-Bottermann in 1987, the slime mold was grown at the University of Bonn in the shape of a "W".

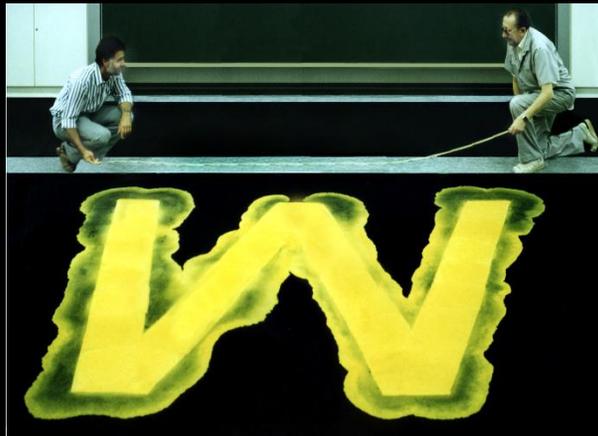


Fig. 5: Gigantic slime mold (Photo: F. Achenbach, Bonn).

## Research

Today, in addition to molecular studies on its phylogeny, the scientific focus is on the pursuit of cell biological questions (e.g., motility, cell cycle, differentiation), and its complex behavior such as decision-making, efficient foraging, and memory. The giant plasmodial cell with thousands of identical nuclei and large quantities of motility proteins is an excellent model organism due to its size and easy way of cultivation.

## Specifics

The networks of slime molds are capable of special achievements, in particular the ability to find 'intelligent' solutions for optimal path-finding, such as bypassing obstacles, finding a food source in the shortest possible way or avoiding danger. The algorithms developed from these experiments even provide clues for technical solutions, e.g. for integrated circuit design or traffic planning in road and rail networks. For teaching purposes, there are purchasable slime mold sets for experiments on chemical-controlled behavior in labyrinths and other phenomena. For those who like it: grilled or fried plasmodia of the related species *Fuligo septica* (scrambled egg slime, or flowers of tan) are consumed in Mexico as "caca de luna" (moon poo) as a delicacy.

## Further reading

Alvarado C.R., Stevenson S.L. (2017): *Myxomycetes: Biology, Systematics, Biogeography and Ecology*. Academic Press, Elsevier, London

Neubert H., Nowotny W., Baumann K., Marx H. (1993-2000): *Die Myxomyceten Deutschlands und des angrenzenden Alpenraumes unter besonderer Berücksichtigung Österreichs*. Band 1-3. Karlheinz Baumann Verlag, Gomariningen.

Oberösterreichisches Landesmuseum (Hrsg.) (2000). *Wolfsblut und Lohblüte – Lebensformen zwischen Tier und Pflanze*. Stapfia 73. [https://www.zobodat.at/publikation\\_volumes.php?id=143](https://www.zobodat.at/publikation_volumes.php?id=143)

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