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First record of *Badhamia polycephala* (Physaraceae, Physarales) on bacterial films in a sewage pipe

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Abstract: We report the first observation of the plasmodium of *Badhamia polycephala* on bacterial films from a kitchen sink trap. After placing fragments of bacterial films with the plasmodium present into a moist chamber, we obtained fully matured sporocarps. We confirmed the species identification using light and scanning electron microscopy.

Keywords: aquatic habitat, ecology, morphology, SEM, urbanization.

Introduction

Myxomycetes are widespread and are found worldwide. Their trophic stage is mostly associated with moist places with numerous bacteria suitable for their nutrition. At the same time, myxomycetes can adapt to harsh conditions. Many species are well adapted to life in deserts, and others live at circumpolar latitudes (Novozhilov et al. 2022). In most cases, myxomycetes are found in natural habitats; however, sometimes myxomycetes can live alongside humans. For example, the formation of large plasmodia has been reported by aquarists (Kappel 1992). Myxomycete plasmodia can damage the fruiting bodies of cultivated fungi (Golenia and Rebendel 1970; Madelin et al. 1975; Li and Li 1992; Dai et al. 2023). In some cases, the mass development of sporocarps on cultivated plants can lead to slowing down of photosynthesis processes and a deterioration of their marketable properties (Zhang et al. 2024). Well-formed sporocarps of myxomycetes have been found on substrates of anthropogenic origin in abandoned buildings (Degawa et al. 2006).

Badhamia polycephala (Schwein.) J.M. García-Martín, J.C. Zamora & Lado (≡*Physarum polycephalum* Schwein.) is a widespread species characteristic of tropical (Farr 1976) and warm climates (Lister 1924). Its sporocarps form on rotten wood, bark, fruiting bodies of aphyllophoroid fungi (Martin and Alexopoulos 1969), and on nearby plants. Apparently, it can grow on a wide variety of decaying substrates of plant origin. In 2012, sporocarps of this species were obtained in a moist chamber during

incubation of tuber fragments of rotten potato purchased from a grocery store (Gmoshinskiy 2013). The plasmodium of this species can be cultured relatively easily in laboratory conditions. Therefore, it is an important model object for various investigations (Oettemeier et al., 2022).

In December 2021, we sampled bacterial films with visible plasmodium traces when cleaning a sink trap in Klin-9 town, Moscow region. Cultivating them in moist chambers allowed us to obtain sporocarps that were identified as *Badhamia polycephala* based on morphology.

Materials and methods

Moist chamber culture

Fragments of thick bacterial film were collected from inside the sink trap at a distance of more than one meter from the drain, near the junction of the pipe and the riser (Fig. 1). The film was covered with yellow strands of a plasmodium.

The bacterial film was placed onto a piece of filter paper in a sealed container and covered with a small amount of water. Small fragments of oat flakes were placed on the surface of the paper. After the plasmodium moved from the bacterial film to the filter paper, the film was removed from the chamber. After 67 days, sporocarps formed in the chamber and were dried at room temperature, mounted onto a U-shaped paper substrate, frozen twice in a household refrigerator at −18 °C, and stored in the herbarium.

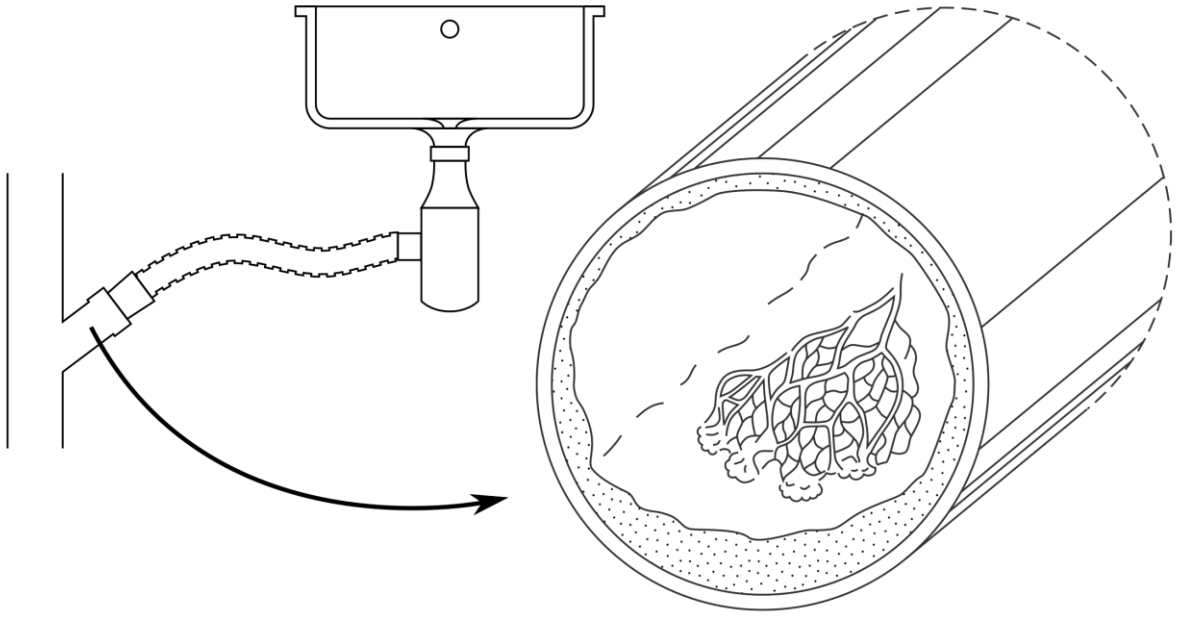

Figure 1. Plasmodium of *Badhamia polycephala* in the sewage pipe. Author of illustration: A. V. Matveev.

Morphological studies

Photographs depicting morphology of sporocarps were taken with a Micromed 3 var. 3LED light microscope equipped with a E3CMOS06300 digital camera and epi-illumination. A series of pictures was taken in different optical sections and processed using Helicon Focus ver. 6.0.18. Light microscopy (LM) of sporocarps and spores was carried out with a Micromed 3 var. 3LED light microscope equipped with a E3CMOS06300 digital camera. Samples of sporocarps for LM were mounted in 4% KOH. The dimensions of spores, capillitium, and sporocarps were calculated using ImageJ ver. 1.52a (free software). Spore sizes were recorded after the highest measurement, including surface warts, with an oil immersion lens. Spore surface and capillitial structure were studied using Jeol JSM-6380 LA (Jeol, Japan) scanning electron microscope. Specimens for SEM were mounted on copper stubs covered with nail polish and sputter-coated with gold-palladium.

The specimens described below are deposited in the MYX Herbarium (Department of Mycology and Algology, Faculty of Biology, M.V. Lomonosov Moscow State University, Moscow, Russia).

Specimen examined: — RUSSIA, Moscow region, Klin-9. Plasmodium collected on December 10, 2021, mature sporophores collected on February 16, 2022. Coll. Matveev A.V., MYX 24309.

Results

Badhamia polycephala (Schwein.) J.M. García-Martín, J.C. Zamora & Lado, Persoonia 51:113 (2023). (Fig. 2).

Sporocarps – stalked sporangia, gregarious, sometimes with adhered stalks, up to 2.1 mm high, white (Fig. 2A, B). Sporotheca curved, helvelloid, gyrose, umbilicate below and above (Fig. 2A–C), 0.6–0.8 mm in diameter, flattened, 0.4–0.5 mm thick. Peridium single-layered, thin, fragile, membranous, ashy, with weak yellow or golden reflection, with white rounded calcareous plaques at the site of attachment of the capillitium (Fig. 2G). Dehiscence irregular. Hypothallus membranous, dark-reddish brown or almost black at the stalk base, individual or common to the group of sporocarps. Stalks straight or slightly nodding, deep-wrinkled, reddish-brown, thick (about 0.3 mm in diameter) and long (up to 1.5 mm high) (Fig. 2A, B). Columella absent. Capillitium present as a dense elastic net of branching and anastomosing delicate hyaline threads with large spike-like or fusiform nodes (Fig. 2E, F), some of them attached to peridium (Fig. 2G). Spores in mass dark-brown; light-violet-brown in transmitted light, globose, with uniformly thick wall, (7.1–) 7.7–8.7 (–9.3) μm in diameter (Mean = 8.21, SD = 0.53, n = 30), minutely warted with 2–3 groups of large warts on hemisphere (Fig. 2D). Under SEM spores baculate (according to Rammeloo, 1975) with irregularly distributed bacula (Fig. 2 H, I). Plasmodium yellow.

Discussion

Badhamia polycephala is a rare species in the Moscow region. In addition to the abovementioned specimen isolated from decaying potato tubers, another specimen was reported from the Zvenigorod Biological Station of the Moscow State University (Barsukova et al. 2012). However, a revision of the referenced specimen MYX 1975 confirmed its affinity to *Physarum compressum* Alb. & Schwein. Thus, in the Moscow region, *Badhamia polycephala* has been reliably recorded only on substrates associated with human activity.

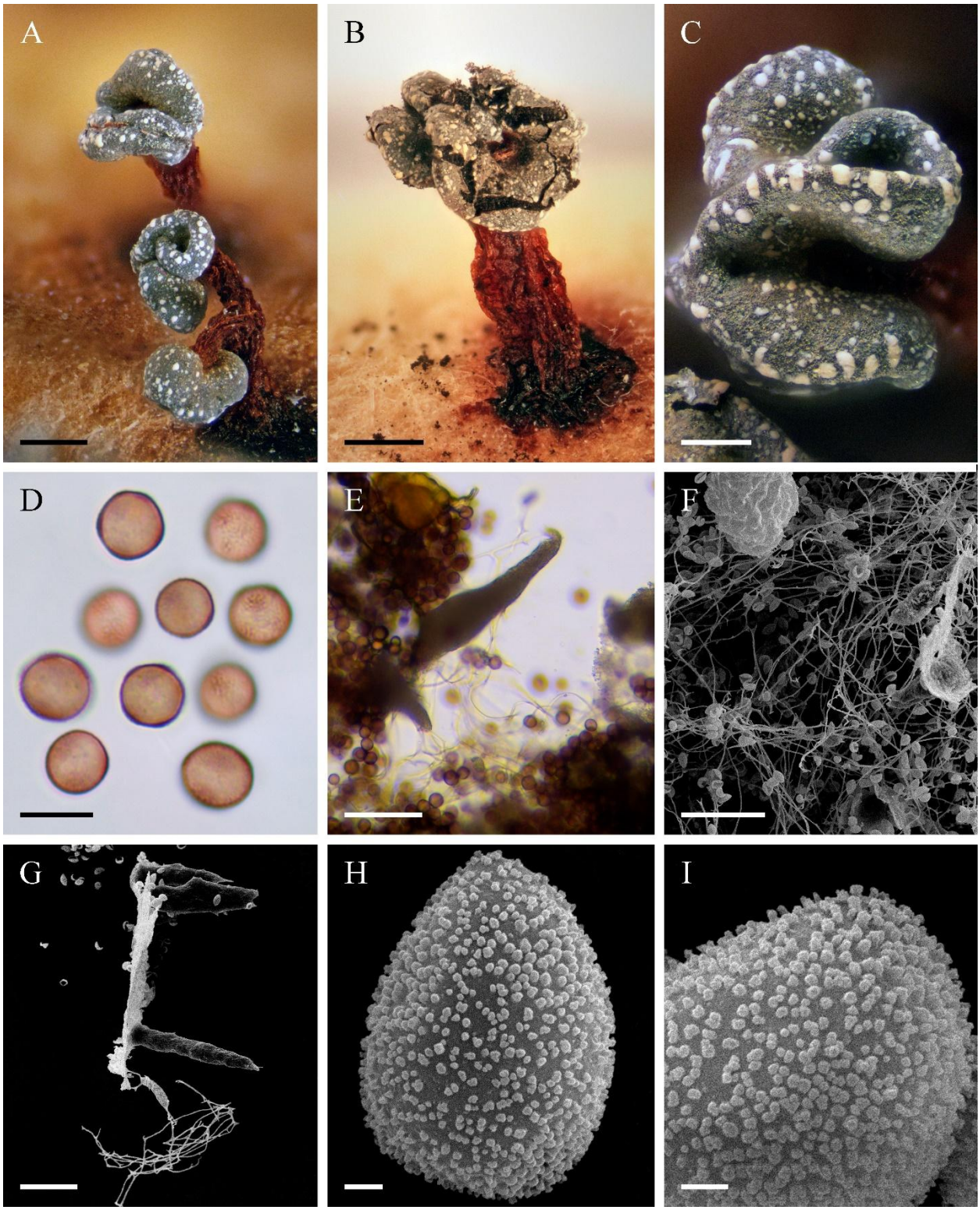

Figure 2. *Badhamia polycephala* (MYX 24309): A–C – sporocarp morphology, D – spores, transmitted light (TL), E – capillitium nodes and spores, TL, F – capillitium and spores, scanning electron microscope (SEM), G – capillitium nodes attached to the peridium, SEM, H, I – spores, SEM. Scale bars: A, B – 500 µm, C – 200 µm, D – 10 µm, E, F, G – 50 µm, H, I – 1 µm. Authors of photographs: A–C — N. I. Kireeva; D–I — V. I. Gmoshinskiy.

We are not aware of other reports of myxomycetes from sewage systems. However, such findings are expected because many species of myxomycetes are well adapted for survival in aquatic environments and can be isolated from aquatic habitats (Lindley et al. 2007; Bodyagin and Barsukova 2009). Moreover, some species of *Didymium* (Gottsberger and Nannenga-Bremekamp 1971; Kappel 1992; Müller et al. 2008), *Diderma* (Tamayama and Keller 2013), *Physarum* (Ward 1886; Parker 1946), and *Fuligo* (Parker 1946) are able to complete the entire life cycle in aquatic habitats, including sporocarp formation. It is likely that the survival of plasmodium in the sink drain was also facilitated by the fact that, in this case, the homeowners avoided the use of surfactants for dishwashing as much as possible.

Thus, it can be hypothesized that myxomycetes can successfully adapt to anthropogenic habitats. This may apply both to urban environments (Ing 1998; Hosokawa et al. 2019; Kireeva and Gmoshinskiy 2024 etc.) and buildings and utility systems themselves.

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