The physarum experiments

This portfolio presents a body of work created with a classic model organism - the slime mould *Physarum polycephalum*. Within a studio setting, the slime mould is staged within novel environments and its growth trajectories captured as it navigates: calculating routes, making decisions, and responding to encounters. Through the representation of emergent growth trajectories and behavioural responses to given interventions the work aims to 'draw out' fundamental processes of life as a relational exercise. Imaging technologies – specifically macro and time-lapse photography – mediate between spatiotemporal subjectivities, amplifying slime mould behaviour to human scale.

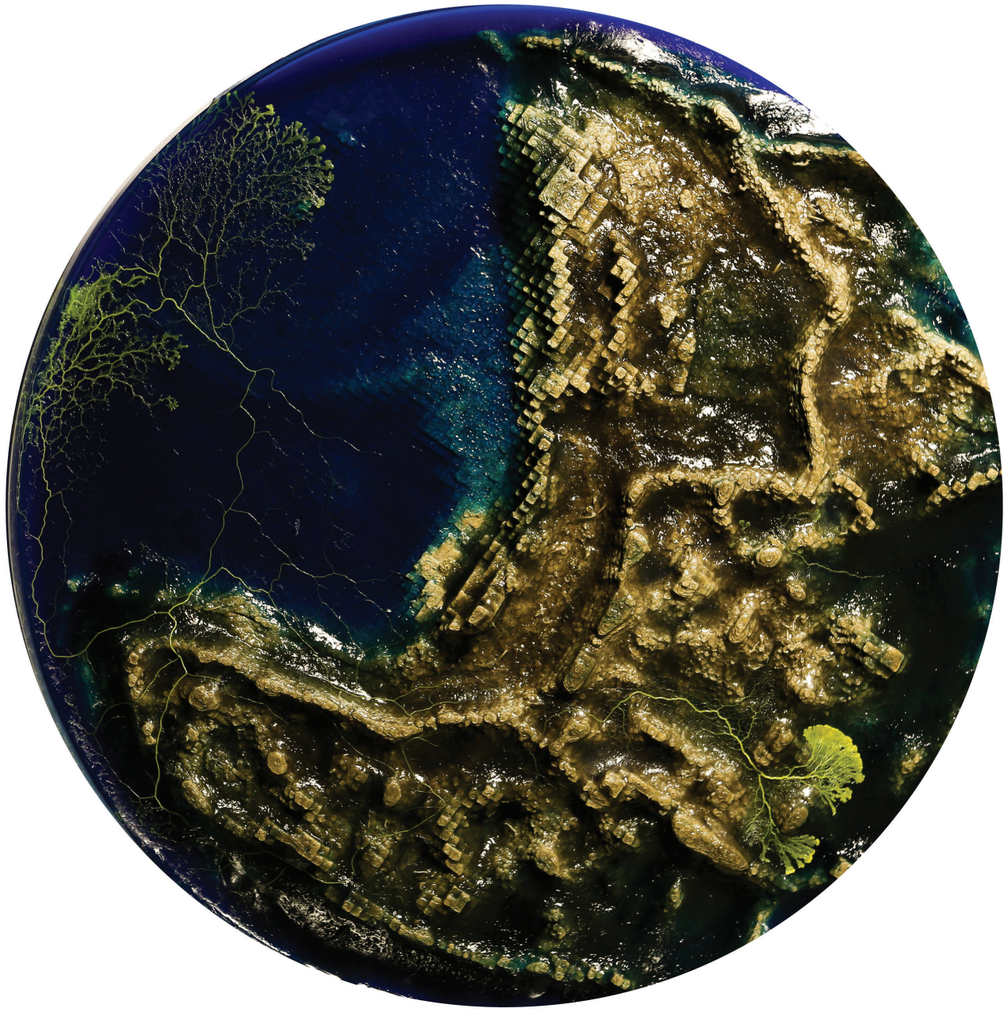
text and images: **Heather Barnett**

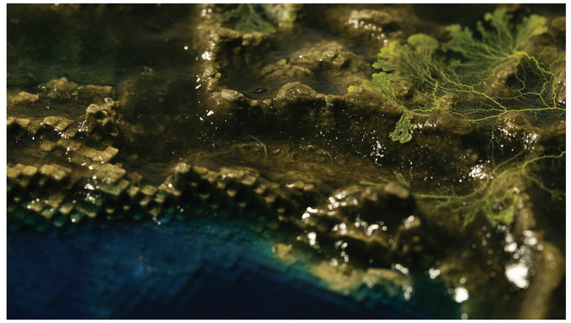
Physarum polycephalum offers us something like the degree zero of sentience and of decision-making. Its mode of thinking doesn't involve concepts, representations, intentional objects, self-awareness, or even an underlying unity of experience; it leaves out most of the things that philosophers have traditionally considered to be necessary or intrinsic to thought. And yet, it feels, and ponders, and decides.[1]
Steven Shaviro, *Discognition*, 2016

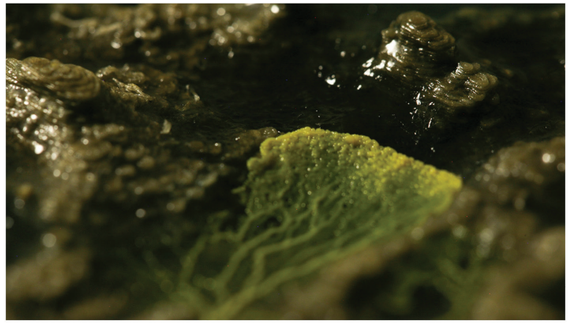
Since 2009, I have been working with the true slime mould, *Physarum polycephalum*, as material, model, and metaphor, generating speculative artworks reflecting on the relationships between human and nonhuman agents. This 'collaboration' with a single-celled organism has evolved along diverse yet interconnected trajectories, involving the creation of films, installations, encounters, and participatory experiments.[2] Grouped together under the umbrella of *The Physarum Experiments,* this interdisciplinary artistic research brings human and slime mould intelligence together in a process of interspecies co-enquiry – a sympoietic practice.[3]

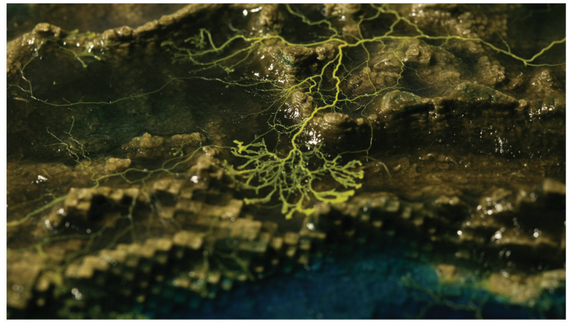
This portfolio centres on films produced working directly with the organism – a process involving the construction of novel environments, within which the slime mould navigates, responding to my interventions. Through a series of invitations and interruptions, utilizing known attractants and repellents, a performative stimulus/response emerges, captured using macro and time-lapse photography. The imaging technologies employed mediate between two different species-specific 'umwelts', defined by naturalist Jacob von Uexküll as the subjective sensorial experience of any living organism within its environment.[4] Here, time-lapse photography amplifies the biological world of the slime mould, pushing it towards human spatiotemporal scale. The intention of the work is to reveal the underlying mechanisms at play within this fascinating and beautiful organism and, through the aesthetic and technical devices employed, to elicit a relational encounter.

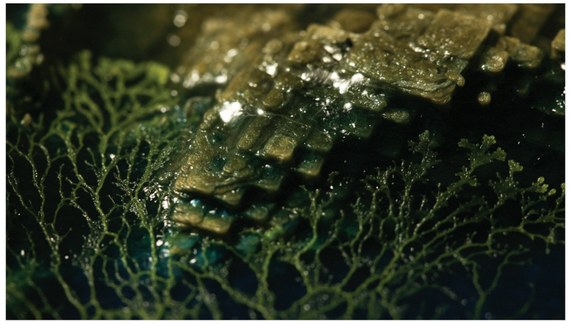
The organism at the heart of this inquiry is a nomadic amoeboid, *Physarum polycephalum,* one of over 900 known species of slime mould to be found creeping around temperate woodlands feasting on rotting vegetation. Comprising thousands, often millions, of individual nuclei, the slime mould operates as a collective entity, highly coordinated with a demonstrable 'primitive intelligence'.[5] Without any central nervous system and without a brain, it has many noted achievements, including high-level network optimization,[6] spatial and temporal memory,[7] and the ability to learn from its environment and to pass that learning

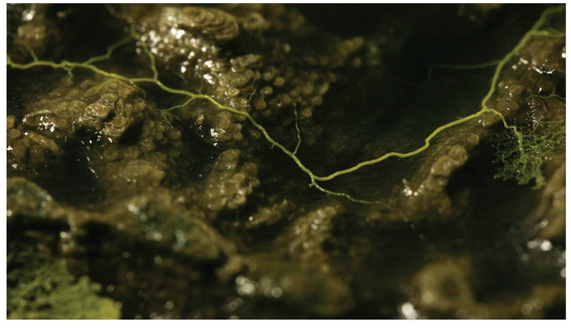


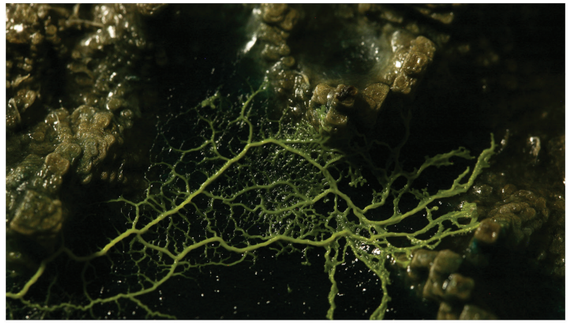


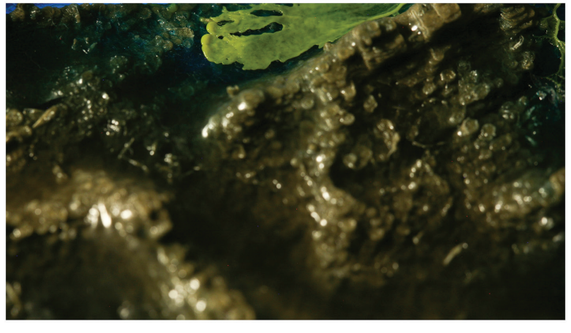












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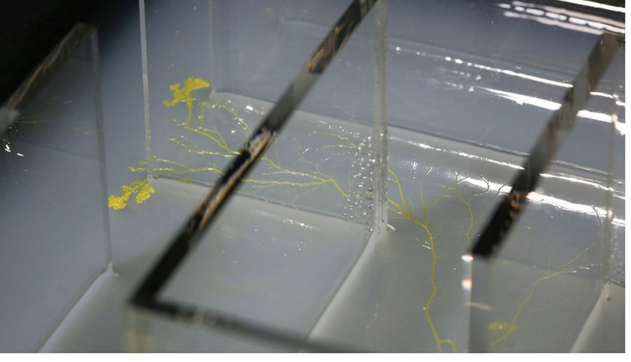
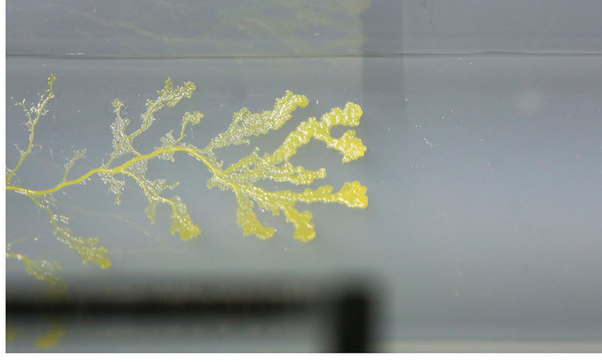
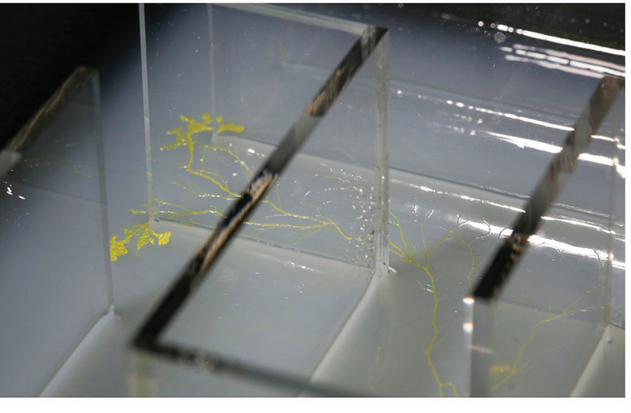
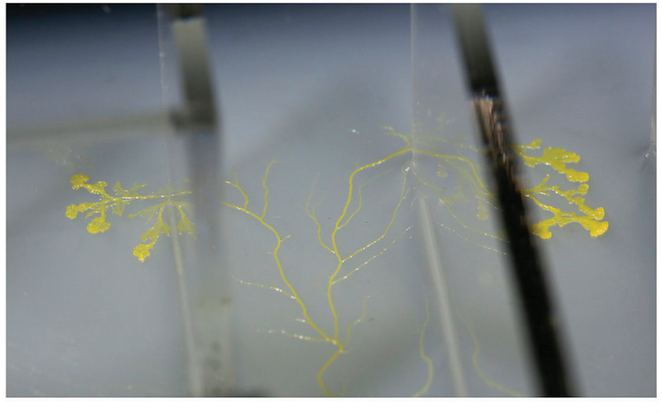
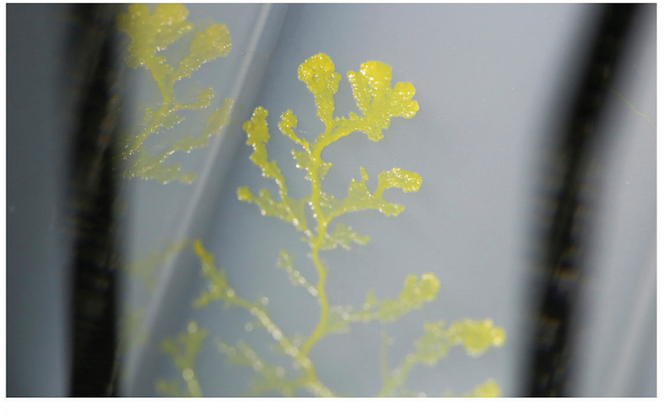
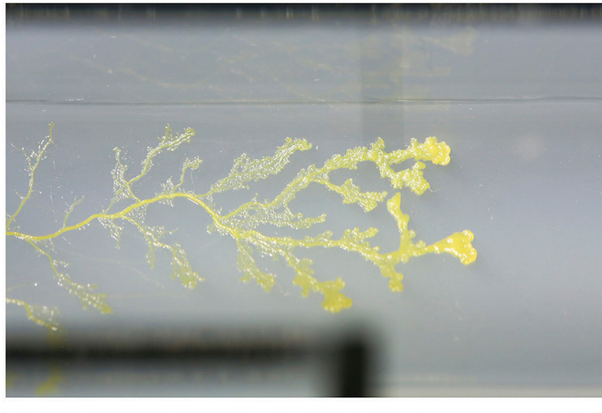
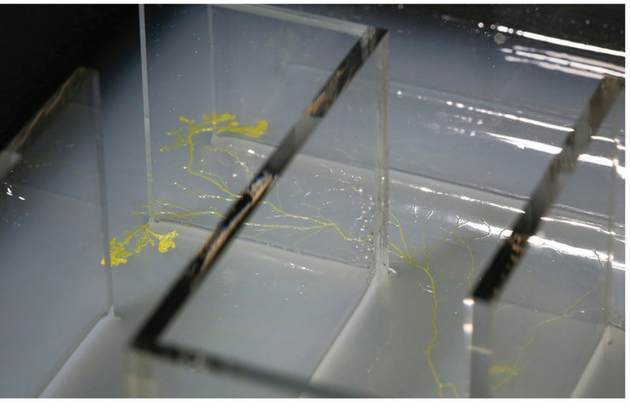
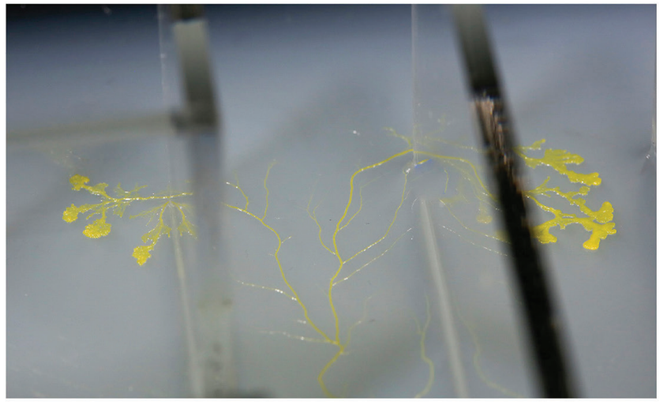
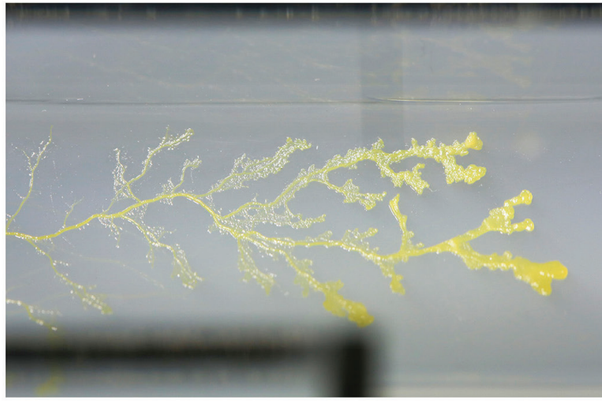
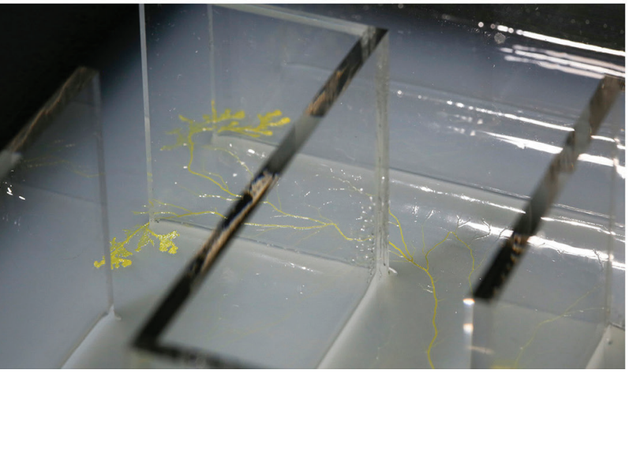
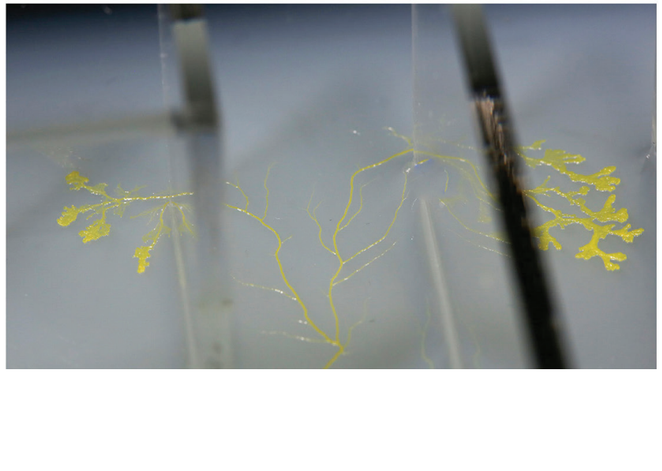
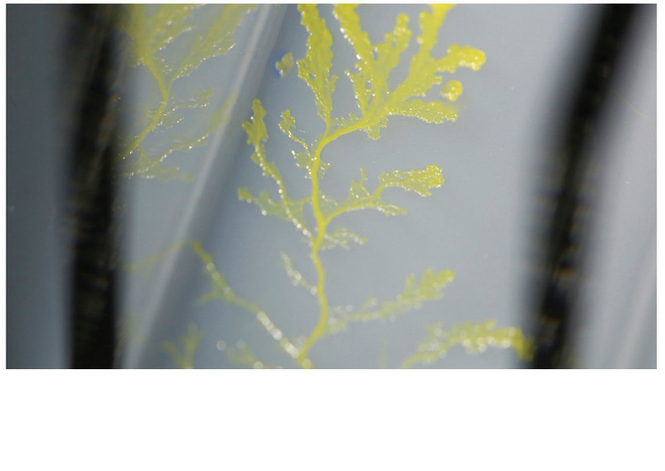
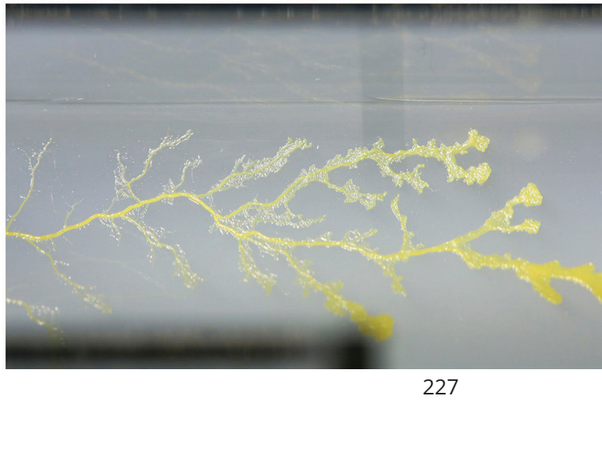
Resilient Topographies #1: the peninsula of Paljassaare
Film stills from HD video
Made in collaboration with ecoLogicStudio for BioTallinn, Tallinn ArchetecturaL Bienalle 2017 © Heather Barnett

Pages 226-227: Film stills from HD video © Heather Barnett
The slime mould navigates a scaled up replica of the maze used in the experiment led by Toshiyuki Nakagaki which demonstrated 'primitive intelligence'



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The Physarum Experiments, Study No.022: Starvation Fireworks

Film stills from HD video (duration 01:35)

When food is removed from the environment the slime mould performs a dramatic display

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The Physarum Experiments, Study No.026: Intraspecies Fusion

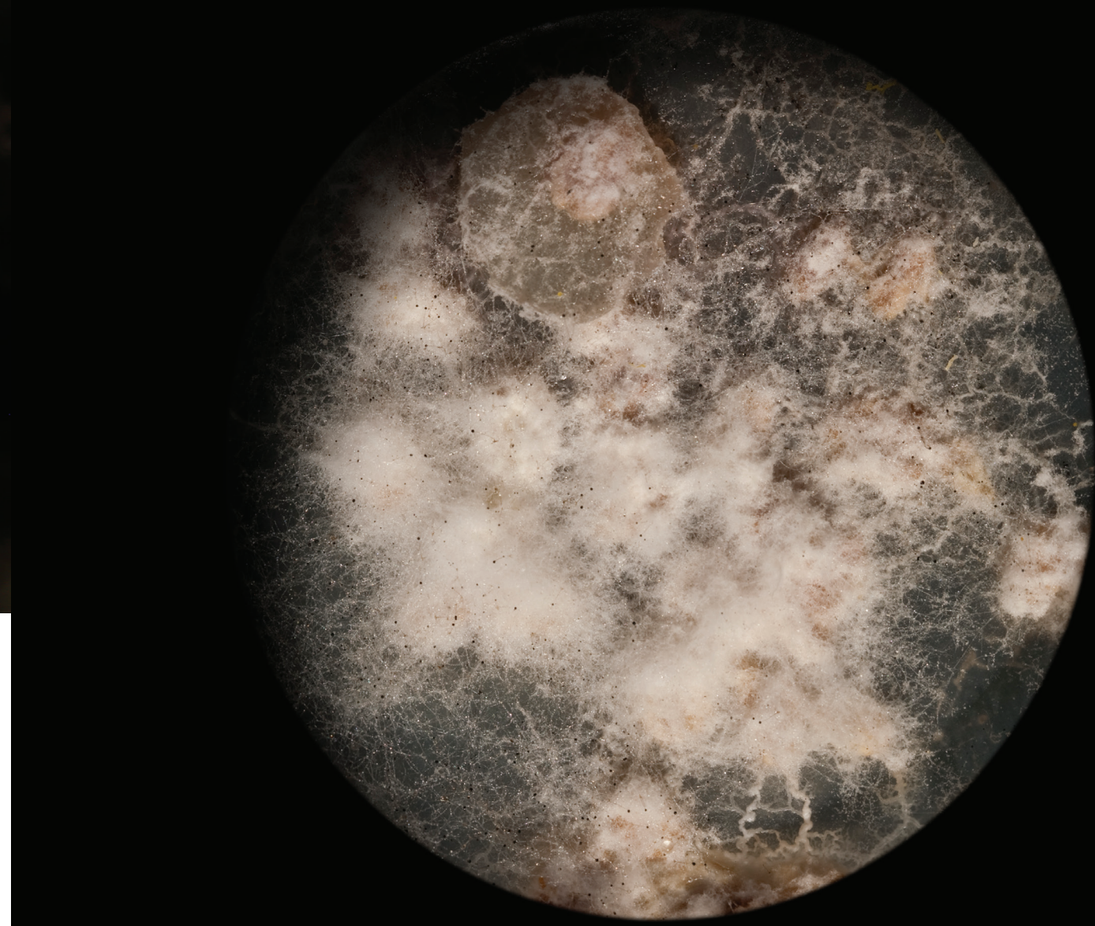
Film stills from HD video (duration 02:47)

Two genetically identical slime moulds meet and fuse, exchanging information and experience © Heather Barnett

onto other slime moulds.[8] It is therefore little surprise that, outside of its natural habitat, the slime mould has become a valuable model organism, serving diverse fields of enquiry: from biophysics to computer science, from urban planning to philosophy, and from material science to music and art.[9] In laboratories and studios across the globe researchers are asking myriad questions about the slime mould, seeking to better understand how such a simple organism can achieve such complex tasks.

The slime mould navigates its world through a process of chemical sensing. As the organism roams it interprets the signals it discerns, homing in on food sources, avoiding toxic repellents, and recognizing its own extracellular trail left behind in earlier journeys. Signals are distributed through a process of protoplasmic streaming, a rhythmic flow of nutrients and chemical information shuttling back and forth inside a dynamic network of interconnected veins. Its form is that of a shapeshifting 'body without organs', the 'glacial reality where the alluvions, sedimentations, coagulations, foldings, and recoilings that compose an organism—and also a signification and a subject—occur'.[10] It is ever fluid, constantly adapting in response to its encounters. It is an exploratory environmental barometer, highly sensitive to changes in temperature, humidity, and chemical composition.

In the films I create, I aim to connect the conceptual, biological and aesthetic properties of 'slime mouldness' through the staging of the organism and the capturing of its biological actions and reactions through time-lapse photography. Here, time is manipulated outside of the confines of any species-specific 'moment



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The Physarum Experiments: remnants of a process #3

Archive digital print (16 x 20")

The remnants of experiments, as environmental moulds take over and cover the traces of slime mould journeys

© Heather Barnett 2009

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The Physarum Experiments: traces of a journey

Archive digital print (20 x 16")

Traces of extracellular slime deposited by the slime mould as it journeys, leaving a map of where it's been © Heather Barnett

sign',[11] which Uexküll defines as the subjective passing of time experienced uniquely by an organism, and enters an intermediary space between human and slime mould rhythm and flow. This filmic *staging* brings different elements to the fore: sometimes directly referencing the scientific studies which have demonstrated memory or learning,[12] sometimes revealing the global dynamics of collective decision-making as the organism is exposed to novel situations and environments.[13] Different species are introduced[14] and genetically identical slime mould kin are re-introduced.[15] Our definitions of intelligence are called into question.

The films do not follow traditional conventions of scientific or natural history filmmaking and they do not present any fixed narrative. By maintaining ambiguity of scale or time, the visual tropes of time-lapse photography allow the organism to stage itself. Through its oscillatory rhythmic flow of protoplasmic streaming, through the constant pushing and pulling of internal forces, the slime mould reveals the 'cognitive' activity of a chemically sensing body, mediated by the interventions of a curious human. My artistic inquiry *with* slime mould is a form of dialogue between empirical, intuitive, and explicit knowledge systems, as a means to *draw out* the inherent characteristics of the organism.[16] To *draw out* is to entice, to lure something out, to tease into being. A process of gradual extraction, *drawing out* is to prolong, to lengthen time, a pulling of threads. In human terms it can mean to induce someone to speak openly, to reveal true feelings. In slime mould terms it means to amplify processes of life that lie beyond our perceptual grasp and to scale up the organism (literally and metaphorically) to create a relational space between two radically different spatiotemporal worlds.

The slime mould, simultaneously one and many, offers a rich philosophical 'discourse object',[17] inviting us to speculate... on the nature of self and other, on the identity of the individual and the collective and on the fundamental building blocks of intelligence. Through looking *at* and looking *with* other life forms, I suggest that we might shift our ontological assumptions, allowing us to 'observe the mechanisms of thought in something like their primordial form'[18] - a mode of thought that is distributed and dynamic, and highly attuned to ever-changing environmental conditions.

Endnotes

[1] Steven Shaviro, 'Thinking Like a Slime Mold', in Discognition (London: Repeater Books, 2016), 213.
[2] Heather Barnett, 'Many-Headed: Co-Creating with the Collective', in Slime Mould in Arts and Architecture ed. Andrew Adamatzky (Denmark: River Publishers, 2019), 13–37; and Heather Barnett, 'The Physarum Experiments'. Accessed September 10, 2021. http://heatherbarnett.co.uk/work/the-physarum-experiments/.
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[4] Jacob von Uexküll, A stroll through the worlds of animals and men: A picture book of invisible worlds. (1934) Accessed October 10, 2021. doi:10.1515/semi.1992.89.4.319.
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[11] Uexküll, A stroll through the worlds of animals and men: A picture book of invisible worlds. 340.
[12] Heather Barnett, The Physarum Experiments: Study No. 019: The Maze. Time-lapse HD video, 2013. Accessed September 10, 2021. https://youtu.be/SdvJ20g4Cbs.
[13] Heather Barnett, The Physarum Experiments, Study No.016: Establishing likes and dislikes. Time-lapse video, 2011. Accessed September 10, 2021. https://youtu.be/-aet4Jnl5Tk.
[14] Heather Barnett, The Physarum Experiments, Study No.024: Interspecies Encounter. Time-lapse video, 2016. Accessed September 10, 2021. https://youtu.be/cbEirySHYXc.
[15] Heather Barnett, The Physarum Experiments, Study No.026: Intraspecies Fusion. Time-lapse video, 2018. Accessed September 10, 2021. https://youtu.be/wSCZSBcZNDA.
[16] Heather Barnett, 'Drawing Out the Superorganism: Artistic Intervention and the Amplification of Processes of Life', in Drawing Processes of Life: Cells, Molecules, Organisms, ed. Gemma Anderson, John Dupré, and James Wakefield (Intellect Books, 2023). 193-218.
[17] Hans-Jörg Rheinberger, Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube. (Writing Science. Stanford, Calif: Stanford University Press, 1997).
[18] Shaviro, Discognition, 212.

Heather Barnett is a British artist, researcher, and educator working with natural phenomena and emergent systems. Employing living organisms, imaging technologies, and playful pedagogies, her work explores how we observe, influence, and understand multi-species ecosystems. Recent work centres around nonhuman intelligence, collective behaviour, and experimental systems for co-enquiry, working with humans, ants and slime moulds. Heather is Pathway Leader on the MA Art and Science, and co-director of the Living Systems Lab at Central Saint Martins (University of the Arts London), a Visiting Associate Professor at Tokyo Institute of Technology, and founding member of The Slime Mould Collective.