*Bachelor Thesis '21*

# *Pilzbüssli*

*Reaching Mycoliteracy through*
*Collaborating with Fungi*

*Colin Nico Schmid*

*Imprint*
Pilzbüssli: Reaching Mycoliteracy through
Collaboration with Fungi

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## *Abstract*

Human activities, especially during recent centuries, have taken a devastating toll on our natural environments. It is high time we take action and ally with other organisms to reverse the damage we have caused. The Pilzbüssli visits communities and collaborates with humans and a variety of fungal species in Mycological Interventions. This nomadic mycological laboratory is designed to teach mushroom cultivation to people of all demographics, turning them into mycophiles. By co-designing projects such as sustainable mushroom gardens or remediation projects in damaged environments, communities are empowered in working with our powerful fungal allies.


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*Fig. 01: The Pilzbüssli parked in the lush forest at Albisgüetli.*

## *Contents*

### *Chapter Overview*

In this section, I will narrate the structure of my thesis. It will feature a short overview of all the different chapters constituting the text and explain my intentions and thoughts on writing them.

Chapter 1 is a general introduction to the field of mycology. It lays out the field in general terms and explains the various aspects of the scientific field, the culture and the biology of fungi.

In Chapter 2, I take a primarily objective approach to the neglected mega-science that is mycology. In Background and Context, I define mycology, mycoremediation, and radical mycology by drawing up relevant research and popular literature. In Research Questions – Hypothesis, I define just that. The chapter Methodology shows the different design methods and mycological methods that I used for my project. Motivation and Intended Contribution contrasts the beforehand parts by a more subjective style. From the inception of the topic, it shows the germination of an idea into contributions to a vast field and a vibrant global community of fungi enthusiasts.

Chapter 3 defines the concept for my practical work and gives the theoretical, academic angle to it. In related projects, I showcase a selection of influential previous art – in a skeptical manner. Field Research continues to narrate my journey throughout this project. I tell of my gatherings with experts and my first forays into the field. The last section treats the findings I had so far and sets my next steps at this point.

In the last chapter of the main part, I reconstruct the development of my project after the fact. Here I explain how I designed and built my own lab equipment and developed various mycological protocols for mushroom cultivation. All of these achievements foot on the work of the mycological community in the academy and the general public. All I did is iterate on a row of these existing designs in an attempt to make my humble contribution. The last part of this chapter shows how I took this knowledge I compiled and found ways to spread it to a wide range of people. I conducted a series of workshops in differing formats and contents in a variety of communities throughout Switzerland. At this point, I share my findings from these collaborative projects and how they influenced my designs.

*Fig. 02: Armillaria ostoyae in the wild.*

# *1.0 General Introduction*

According to some studies, we have separated from them 1.538 billion years ago. They are neither plant nor animal. They form their very own biological kingdom. Earth's largest organism, Armillaria ostoyae, *(Fig. 02: on page 6)* is one of them. It covers 2,385 acres, or 9.6 square kilometres, of the Malheur National Forest in Oregon, USA. As can be guessed from its nickname, the Humongous Fungus is a fungus. (Schmitt, C. L., et al., 2008)

For as long as humans have walked the earth, we have coexisted with these fascinating organisms. Some cultures, being mycophobic, have feared them for their toxicity and their mythical properties. Other, very much mycophilic peoples have hunted them, ate them, used them in rituals of medicine and magic for thousands of years. (Wasson, 1957)

We have forgotten much of this ancient knowledge. Western cultures mostly fear the mushroom. Thanks to recent progress in research, prolific researchers like Paul Stamets, science, culture and economy are bringing fungi back into humanity's consciousness. For example, recently published studies in chemistry, psychology, neuroscience, medicine and others regarding the psychoactive properties of the long demonised and outlawed genus psilocybe, *(Fig. 04: Fruitbodies of Psilocybe cubensis growing on coconut coir, vermiculite, gypsum substrate. on page 10)* the pejoratively named magic mushrooms.

Nevertheless, mushrooms are way more than just a fun little gimmick, a toy for party folks. These organisms offer a range of practical applications when seen as a material we humans can work with and coexist with in symbiosis.

In his book Mycelium Running (Ten Speed Press, 2005), Stamets lays out various strategies «how mushrooms can help save the world». He explores fields in mycorestauration, such as mycofiltration, mycoforestry, mycoremediation and mycopesticides. For Interaction Designers, these applications offer many possible intervention points. The field offers a plethora of papers and publications that can be taken into the real world using reasonably accessible equipment and knowledge.

Over a year ago, I began my journey into Mycology. I started with a couple of store-bought grow kits with three different species, moved on to producing viable spore prints from these cultures, and collected specimen from the wild. I formulated and started agar cultures, liquid cultures, grain cultures, built lab equipment such as still air boxes and fruiting chambers.

*Fig. 03: Spores perched on the gills of P. cubensis (magnification 80x).*

*Fig. 04: Fruitbodies of Psilocybe cubensis growing on coconut coir, vermiculite, gypsum substrate.*

Now the question remains, in which direction can I take this fascinating material? What applications will benefit humanity the most?

# *2.0 Research Field*

## *2.1 Background and Context*

### *2.1.1 Mycology*

The study of life is a comparatively young scientific discipline. Although biology as we know it is regarded as a relatively young development, it was studied in ancient times as part of philosophy. Magner documents Natural philosophers from as far back as the ancient civilisations of Mesopotamia, Egypt, and today's India and China. (Magner, 2002) Much more recent is the separation of the discipline of mycology from that of botany. It was not until a few decades ago that we recognised the kingdom of fungi to be evolutionarily much closer related to animals than plants. (Hecht, 1993) (Woese, Kandler, & Wheelis, 1990) The fundamental role of fungi in all of Nature and especially as symbionts in the evolution of water-dwelling algae towards plants living on land is another recent discovery that changed our understanding of not only evolution but the core principles of life. (Lutzoni et al., 2018)

In their essay «Fungal HERstory: How Women Shaped Mycology», published in 2016, Mara Penfil and Fern Katz argue for the formation of the study of fungi first to have formed in the womb of women. It was their responsibility to carry the knowledge on foraging and harvesting wild fungi and their use from generation to generation. It was women who possessed the most comprehensive understanding of taxonomy, biology and ecology of the particular local fungal diversity. Only in the last few centuries, the field became dominated by men. The founders of Mycology, Carolus Clusius (1526 – 1609) (Clusius, Pona, & Jules Charles de, 1601) and Franciscus Van Sterbeek (1630 – 1693) (Sterbeeck, 1675) did arguably not gain their knowledge through personal experiences, but from conversations with folk women in the marketplaces of Eastern and Central Europe. The essay describes how these are only a few of the

*Fig. 05: Mycelium of Pleurotus Ostreatus growing on coffee grounds.*

many men seek traditional mycological knowledge and then rebrand it as their own work. (P. McCoy, 2016)

The study of fungi not only concerns itself with the actual organism, however. It includes their interactions within the complex organisational structures of life. The close partnership mycorrhizal species form with plants is only one of these interactions in communities and ecosystems of any kind around the globe. (Leake et al., 2004), (Fricker, 2017) Countless fungi have evolved genetic and biochemical properties that have aroused the interest of humans since the beginning of time. With a mere 120 000 fungal species described so far and an estimated number of total species between 2.2 and 3.8 billion, our neglect of the field is difficult to understand. (David L. Hawksworth & Lücking, 2017) Considering the discoveries of fungi producing toxins, antibiotics and other secondary metabolites, the potential treasures buried in the depths of this young natural science is immense. There are several species known to break down complex organic biomolecules such as lignin chemically. Lignin is the more durable component of wood. Its synthesis arguably leads to the most influential evolutionary trait in the plant world next to photosynthesis – defying gravity using rigid structures to reach up closer to the sun. Lignin, being as durable a molecule, is generally hard to decompose. Fungi, however, with the employment of free radicals, have managed to evolve into the grand decomposers of the world's biomass. Not only plant matter is decomposed and accumulated in fungal organisms. Fungi devour pollutants such as xenobiotics, petroleum and polycyclic aromatic hydrocarbons. By contributing to the transformation of decaying matter into precious humus, fungi inhibit a critical role in the global carbon cycle. Not only do they remediate soil from toxic pollutants, but they function as a bioaccumulator of heavy metals such as arsenic, cadmium, caesium, lead, mercury and copper. It is for these healing properties of not only the human body itself but our environments at large that I regard the potential for collaboration with fungal organisms as a key in our quest to face the current crises that we humans have largely caused. (P. Stamets, 2005)

*Fig. 06: The author standing next to a Mushroom Stone from El Salvador, exhibited at Museum Rietberg, Zürich.*


7
Pitzstein
Stein, skulptiert
El Salvador, Späte Präklassik,
300 v. Chr.–250 n. Chr.
Escultura
de un hombre con personaje
Piedra, esculpida
El Salvador, Preclásico Tardío,
300 a.C.–250 d.C.

*Fig. 07: Cross section of a fresh mushroom, most likely of the genus Morchella subspecies.*

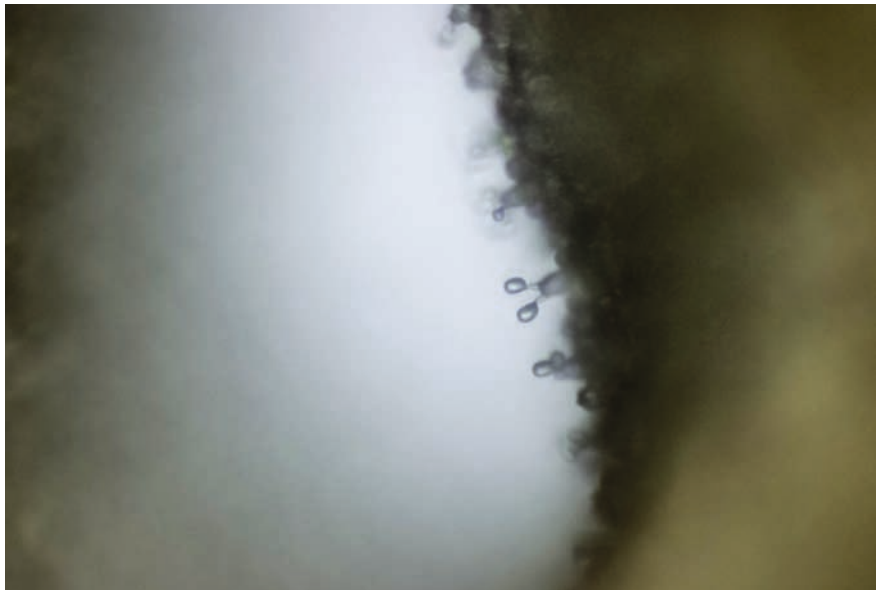
### *2.1.2 Mycoremediation*

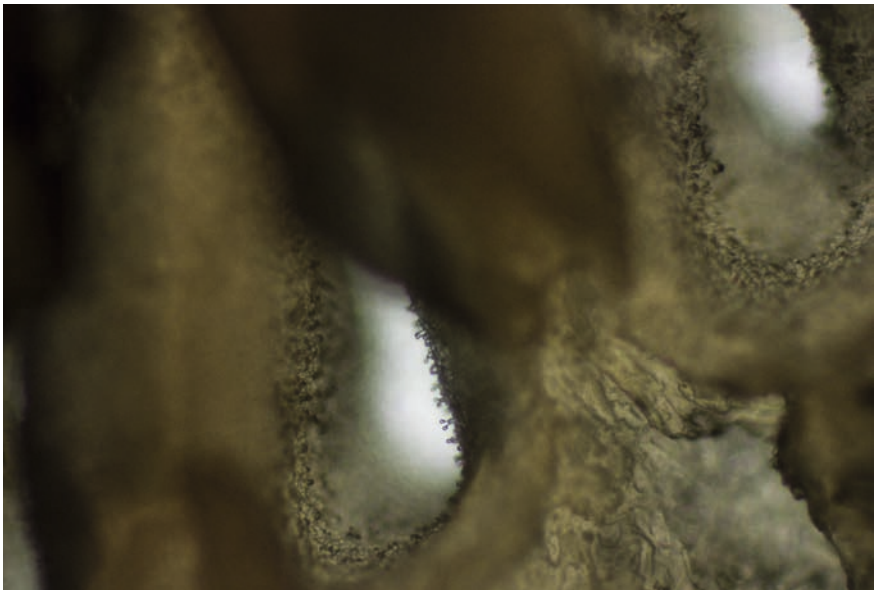
#### *Definition*

Formed from the ancient Greek word for «fungus», *mukēs,* and the suffix -remedium, Latin meaning «restoring balance», mycoremediation is a form of bioremediation in which the environment is decontaminated in collaboration with fungal organisms. The method has proven as cost-effective and environment-friendly in the conversion of toxic pollutants into environmentally benign products through a variety of biological treatments. (Deshmukh, Khardenavis, & Purohit, 2016)

#### *Overview*

Compared to us mammals, fungi have a fundamentally different way to nourish. The evolutionary decision of digesting nutrition externally rather than enveloping it in a digestive sack to do so has evolved in a row of traits that make these organisms powerful partners in bioremediation efforts. With their unique ability to break down lignin, the component in wood that is lending trees their rigidness comes with the capability of digesting structurally similar molecules. Paired with the resilience of pioneering at the edge of life allows fungi to chemically degrade toxic pollutants into more benign compounds, break down plastics, fight off bacteria and virus, accumulate heavy metals and heal



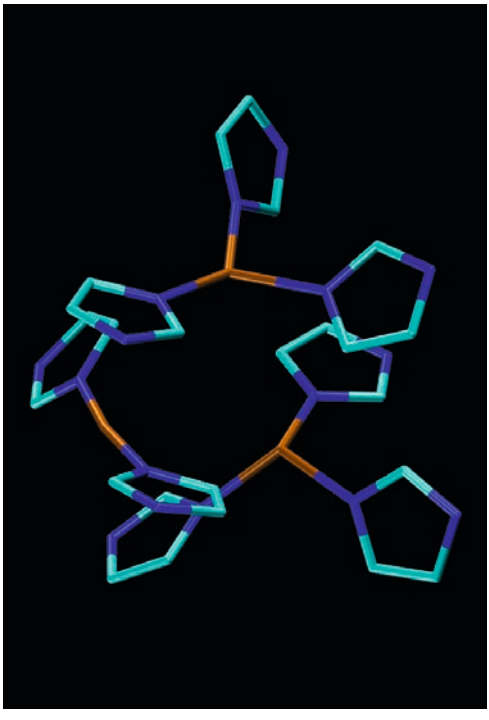


damaged landscapes in turn. Allying with the local species that reduce pollutants allows us to support the communities of plants, beneficial bacteria and the ecosystem as a whole to heal from damage. (Sheldrake, 2021)

## *State of the Art*

In nearly a century of study, hundreds of studies and scientists have contributed to the field. Therefore, it is well established that fungi possess the power to accumulate heavy metals from soil and destroy carcinogens within hours or days. Despite these findings, the large-scale application of the knowledge gained has been dismal. According to Peter McCoy, (P. McCoy, 2016) reasons for the lack of development is owed to limited funding and researchers. Then, looking at recent remediation efforts around the world, the big industries that are often responsible for toxic spills prefer relying on massive, intrusive clean up operations rather than investing in experimental remediation methods. Merlin Sheldrake quotes David Hawksworth in describing mycology as a «neglected mega-science». (D. L. Hawksworth, 2009) It seems that the inaccessibility of the knowledge, with only a few books published on the topic, is a strong factor for this. The books are often quite expensive, and their technical tones may deter a broader audience. How can we change this?

*Fig. 08: At this magnification, the basidia and spores of the fruiting body become recognisable.*



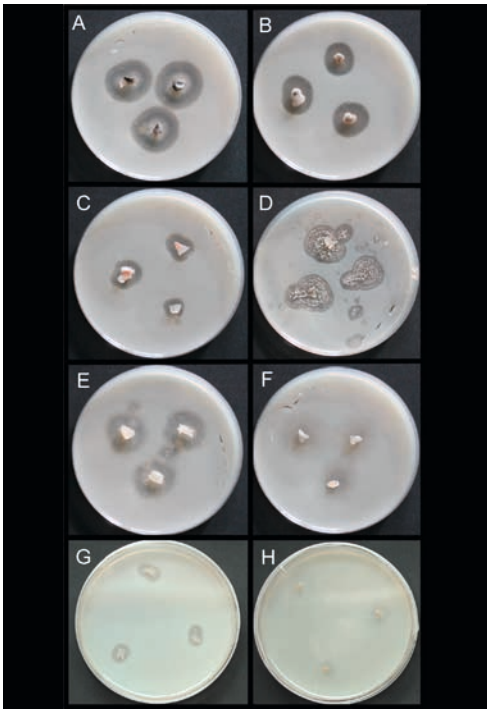



*Fig. 10: The tricopper site found in many laccases, notice that each copper center is bound to the imidazole sidechains of histidine (color code: copper is brown, nitrogen is blue).*

 *Fig. 09: Degradation of polyurethane (PU) in Petri dishes (diameter 9 cm) by fungal inoculi at room temperature.*

*Fig. 11: Petroleum spills are one scenario that is being researched in mycoremediation projects.*

### *Opportunity*

As an interaction designer, I see my role in the field not only in rehashing and mediating scientific findings and mycological knowledge in general. My strong aim is the further development, redesign and democratising of equipment, tools, organisms, and processes and protocols. The great opportunity in this neglected mega-science lies in driving the ideas of Radical Mycology to new spheres and thereby make knowledge and methods approachable for a broader audience. In the words of Peter McCoy: «I envisage teams of Radical Mycologists Without Borders travelling the globe, sharing their skills and discovering new means of working with fungi. Where one Radical Mycologist trains ten, those ten can train a hundred, and from them a thousand — so it is that mycelium spreads.» (Sheldrake, 2021) (P. McCoy, 2016)

## *2.1.3 Radical Mycology*

### *Definition*

A decade ago, the project called Radical Mycology developed in Portland, Oregon. «Its reason is to create a people's mycological movement that is not only versed in the cultivation of fungi and the applications of mycology, but also in how to actively and significantly contribute to the advancement of the science as a whole.» (P. McCoy, 2016) In 2016, a book with the name of the movement was published. Its second edition is being printed as I type. According to Amazon, there are currently 30 copies being sold per month, which makes it a reasonably successful publication in the field. Further, the movement comprises an online mycology school called «MYCOLOGOS». The school aims to enable individuals and organisations to apply mycological knowledge in arts and science by producing educational materials. (MYCOLOGOS, 2021) According to the movements founding father, Peter McCoy, Radical Mycology is a mycocentric and solutions-based approach to tackle the current problems we humans face by collaborating with fungi. It does so by establishing the three major pillars of social change. Radical Mycology educates and builds awareness around important social issues. It resists, slows and

stops ineffective or disastrous social systems. It designs functional and appropriate alternative systems that increase the quality of life. McCoy acknowledges that the fungi can show us how to grow but not change the false paradigms that have steered us off course. Radical Mycologists achieve this by living devoted to and bonded with Nature in an affirming, self-guided way that is resilient against inevitable change. (P. McCoy, 2016)

### *Borrowing from the Idea*

In this thesis and my practical project, I will stand on the shoulders of the mycologists that walked the path before me. The ideas of people such as Paul Stamets, Peter McCoy and Merlin Sheldrake will inform and support my work. I aim to maintain an inquisitive and sceptical curiosity throughout the project.

## *2.2 Research Questions - Hypothesis*

One of the most substantial applications of mycoremediation is microfiltration. The fact that mycelium not only can act as an effective filter for a broad array of toxins but as a live organism actively decompose dangerous molecules into harmless components makes them a compelling subject. I could imagine designing a modular system for growing and applying such filters for a specific use case. The design would also encompass what happens with the organisms after use. The circle could potentially be a closed one, the refuse of one application feeding the growth of new colonies for the next one.

Then there is a large do it yourself mycology scene, especially in the United States but to some extent globally. There are many offers for workshops or grow kits. On YouTube, there is an abundance of video tutorials explaining techniques, teaching mycology or building laboratory equipment from parts you can get at any hardware store. I suspect there is still great potential in that area and that it would be great fun to create something anyone can use to grow mushrooms. At the same time, I feel my contribution to this area would be very immediate and rewarding.

*Fig. 12: The Intruder (ca. 1860) by John Anster Fitzgerald, with a fly agaric centre stage.*

As of recent, research in the use of psilocybin for therapy of psychiatric conditions such as addiction, anxiety, depression and post-traumatic stress disorder has been taken up again in many countries. The US is at the forefront, especially an organisation called MAPS has published many studies in recent times. Switzerland, too, is advancing the research activities with at least a couple of active studies I have found. Here the question to me is how we can essentially rebrand a substance that has been portrayed in the most condemning way possible. Psychotropics such as psilocybin have been demonised for the past two centuries. With some societies waging literal war on them. Only recently have legislatures and public opinion relaxed to the extent of allowing for research to be taken back up. What will be necessary for such a substance to find wide acceptance again in a clinical environment? I think there are many aspects in this that call for the skill set of an interaction designer.

## *2.3 Methodology*

### *2.3.1 Transdisciplinary Approach*

Influenced from my semester abroad with the Transcultural Programme and our daily design practice at ZHdK, the aspect of traversing and the confluence of disciplines played a crucial role in my methodology for this thesis. As an Interaction Design Student, I set out to bring my designer perspective into the realm of hard sciences. At the core, it is a biological topic in theory as well as practice. I did and still do regard my naiveté as an untrained amateur as a superpower. I am not shy to ask stupid questions to seasoned experts, pitch sci-fi-esque ideas for critical and speculative designs and wander off the trodden path in other ways. Sure, my short foray into the Biodesign Challenge (BDC) in 2018 had influence, too. The idea of biohacking and designing with and for different organisms was already known to me. The time and distance lying between my interrupted participation in the BDC allowed me to take a fresh and critical stance on these ideas and methods. Collaborating with other disciplines did not suffice for me. I wanted to deep dive into a field

I had not been as involved with before. Sometimes I felt like Hunter S. Thompson, doing his Gonzo Journalism Jam. It was good stuff.

### *2.3.2 Build Your Own Tools*

Bringing my open-source mindset and DIY attitude into this project meant that I could attempt to build anything. I decided to tackle a couple of hardware projects that I had been dreaming about, sometimes for years. That meant that I could, for one get access to laboratory devices that would otherwise have been plainly out of reach. Furthermore, iterate on community designs for these tools and thereby contribute to the advancement of the biohacking and mycology communities. I would publicise the build plans on instructables.com and serve all the necessary documents such as bill of material, schematics, code and blueprints on github.com.

### *2.3.3 Workshops and Co-design*

The reason for conducting workshops and collaborating with communities on what I call Mycological Interventions is twofold. For one, they are my way of teaching people the means for collaborating with fungi. Participants in the workshops will learn cultivation protocols, see how they can build their own tools and workflows for mycological experiments. These workshops aim to turn potential Mycophobics into Mycophilics by supporting them in reaching Mycoliteracy.

The workshops also embody the user tests for my designs. That encompasses testing the mushroom cultivation protocols that I create and the design of the laboratory equipment. It is a continuous, rolling iterative process towards a fungal future.

## *2.4 Motivation and Intended Contribution*

This bachelor thesis I will devote to the field of mycology. I am convinced of the broad practical uses of fungal organisms in many urgent problems humanity is currently facing. For the two weeks BA Thesis

Concept Seminar, I speculated how I could address mycorrhizal networks and communication. This specific topic is of high value when it comes to propagating the potential of fungi. It seems to help open up a largely mycophobic audience to the reflection on fears and unfamiliarity. The fact that fungi form complex symbioses with other species of the same and the plant kingdom makes them much more relatable. Still, their network life form appears alien to us. There is some research investigating the ways of communication and trade within mycelial networks. Can this knowledge be presented in a scientifically valid way and bring people a bit closer to understanding fungi?

With my thesis, I aim to speak to anyone with interest in Nature and our environment. Primarily established suspect towards fungi in predominantly middle-aged people would be interesting to change. If I can cause reflection and maybe even lay the foundations for mycophilia, such as my mother, that would be a success. I imagine reaching young people, especially children and adolescents who are conscious of environmental topics, will be easy. The end product should be approachable but offer a good amount of depth at the same time.

One outcome for our exhibition I imagine could be described as follows. The «Fungal Organ» *(Fig. 15: on page 25)* consists of several separate self-sustaining vivaria. Three or more glass tanks filled with bioactive soil, a selection of plants, maybe even animals such as insects. In each tank, a living specimen of a mushroom species would be visible. Ideally, the visitor could even make out the mycelial connections underground, the actual symbiotic relationship between fungus and plants. The pedestals on which the tanks stand would have a faceplate offering several audio jack ports. Next to the vivaria, there would be a reasonably sizeable modular synthesiser, also offering a selection of audio ports. The visitors could then use provided patch cables to patch into the ports between vivaria and synthesiser. A sound system would play the patch in real-time. That would allow visitors to explore the communication that happens within the mycorrhizal network. I would certainly aim for the measured voltages to be scientifically representative of actual electrical currents in the organism. If the different currents could even be interpreted to some extent, that would be fantastic. However, even a realistic simulation and interpretation of what is happening could work well.

My overall goal for this installation is not only to present the existence and workings of mycorrhizal networks. However, also to make them

*Fig. 14: Tuber subspecies found by Lily at our Free Flow Seminar, in Gockhausen, Zürich.*

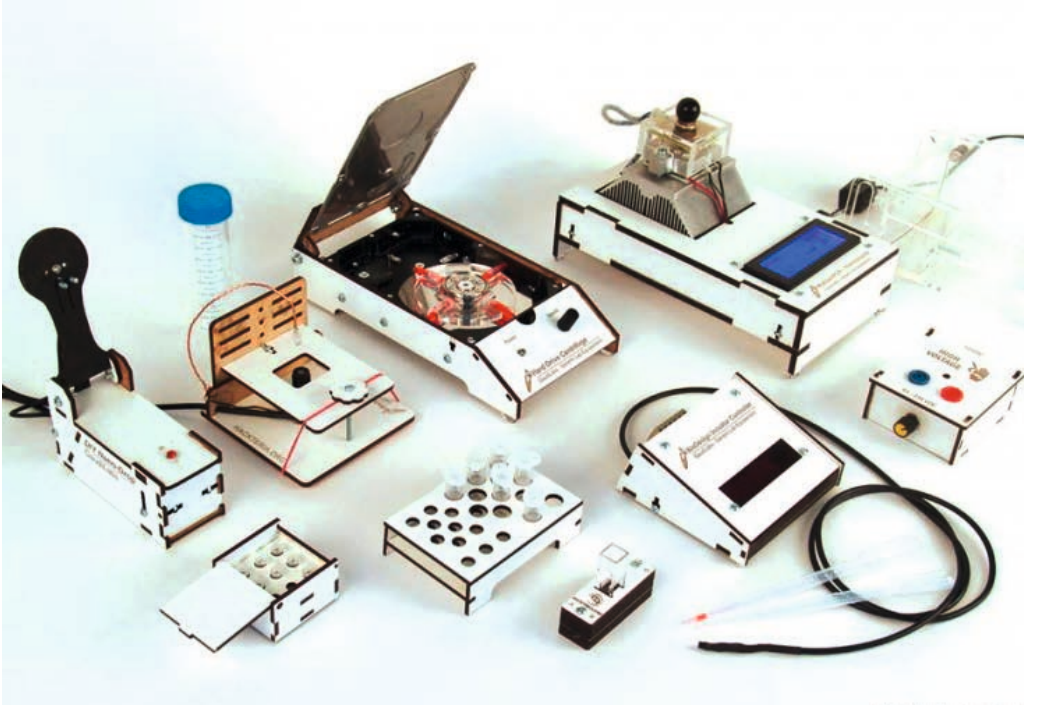


*Fig. 13: Overview of some of our lab tools made using digital manufacturing tools.*

explorable and relatable. I want visitors to think about how fungi experience their surroundings. These organisms are so fundamentally alien to us, the challenge of bringing them closer to us excites me. On a higher level, I see it as my mission to spread the knowledge about the enormous potential fungi have in so many fields. There are applications in nutrition, medicine, psychotherapy, bioremediation, forestry, agriculture, and countless others. Humanity should reflect on the mycophobic sentiments we carry and recognise the deep symbiotic relationship we already form with fungi. If we strengthen and deepen this symbiosis, we and the mushrooms can only gain from it.

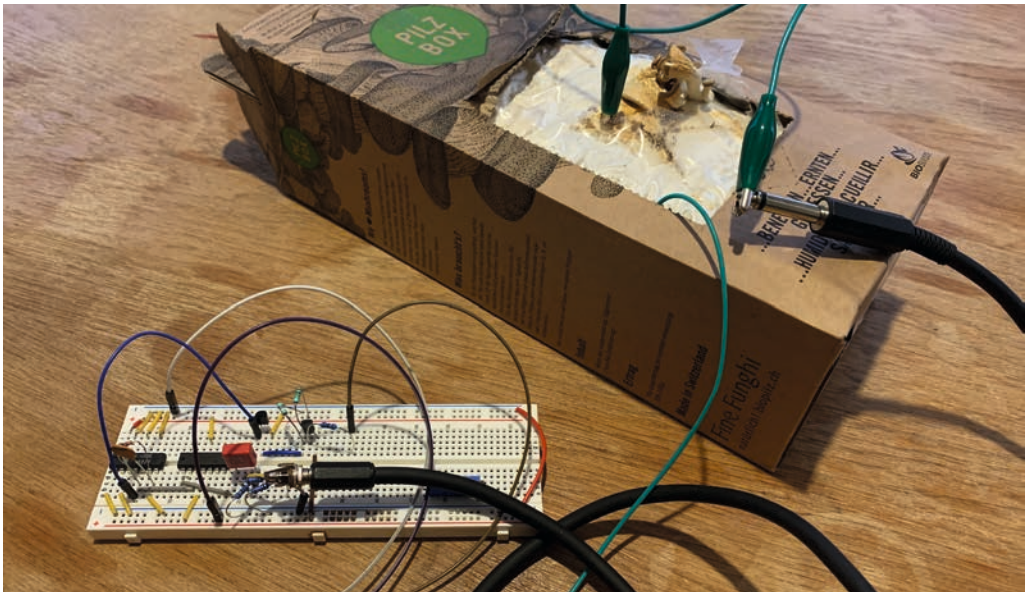



*Fig. 15: The Fungal Organ prototype I built.*

# *3.0 Concept*

## *3.1 Concept and Angle*

Having fallen into the mycology rabbit hole in 2018, it was clear to me that fungi might be influential to my diploma project. Especially reading Paul Stamets work on «how mushrooms can help save the world» (P. Stamets, 2005) was a turning point for me. Performing the «Truffle Hunt Party» *(Fig. 14: on page 24)* at our free flow seminar in September 2019 and then reading Merlin Sheldrake's book «Entangled Life» hit the nail on its head the final time. The fungi had sent me on a mission.

I was fascinated by the undervalued importance of the fungal kingdom in global ecology. Here is this understudied, underfunded and neglected mega-science, with dozens of influential research papers sitting ducks to be funnelled into potentially outstanding design projects.

During my background research, I realised that my scepticism towards popular science's claims for the benefits that fungi offered was justified. Many studies and the data is still insufficiently proven. Some of the claims have been negated along the way and continue to be hard to prove, much less turn into actionable projects. One of the traps I had fallen into was naively imagining remediation projects for heavy metal contaminated soils and chemically polluted water. Upon diving deeper and re-reading the primary science, I quickly realised, my dreams stood on more than shaky assumptions. I had to go back to the drawing board and find a more robust and justifiable way to drive my cause forward.

I decided to get practical and conduct workshops with people on the ground in conclusion of this sobering realisation. I conducted a small series of variable scale mycology workshops that offered invaluable qualitative findings. It was evident that people were more than willing to learn the basic cultivation techniques needed for growing mushrooms. That meant that I could use people's acceptance of mycological teachings as a platform for establishing what I call Mycoliteracy and prime a wide range of demographics. Coming out of these community projects, people said they felt equipped with the practical skills and theoretical knowledge

to take on mycoremediation projects of their own. Some of them may continue a mycological practice and bootstrap other meaningful collaborative Mycological Interventions to further spread the love for these beautiful organisms throughout their communities. Thus I had found the way of the fungus. May the mycelia hyphae spread and prosper.

We live in a largely mycophobic society. (Wasson & Wasson, 1957) Most people are not very familiar with fungi or even mushrooms. We are not necessarily aware of them forming their own kingdom of life. When we buy them for food, we find them in the vegetable aisle in the supermarket. Until a few decades ago, mycology was not recognised as its own field of study. It was botanists who studied fungi. Our phobia towards them seems irrational and primarily emotional. Of course, there are deadly toxic mushrooms. Some tricksters resemble tasty edible species but are, in truth, toxic. Some of them make us feel funny when we consume them. It is that insecurity that comes with not being able to identify fungi and telling the edibles from others that form the basis for our phobia. In literature, the origins of our predominantly western mycophobia is often also drawn back to the prosecution of witches in medieval times. Often the prosecuted individuals possessed excellent knowledge of natural remedies such as plants and mushrooms. Also, in popular literature, they often have a mystical air surrounding them.

This thesis tries to uproot this mycophobia and research how to turn people into mycophiles who are aware of fungi and their benefits and are comfortable handling and cultivating them – it will turn people into mycoliterats.

In an attempt of avoiding anthropocentric and colonial patterns, I think of my work with fungi in non-utilitarian terms. It is not about finding a use for these organisms and applying fungi to our problems. Instead, it is about achieving what I call mycoliteracy, learning to understand the needs of fungi and working together with them. I aim to offer the fungi that I work with as many benefits as I can. I am aware of anthropomorphising the organisms to some degree as a result of this. As of recent, there has been some controversy on anthropomorphism, and I am of the opinion that it can help understand nature and ensure the necessary empathy towards other life forms. Of course, it is necessary to be aware that we are actively shaping other beings' wants and needs towards our own. The fundamental life goal of fungi is arguably self-sustenance and reproduction. In offering the fungus a nutritious substrate

and optimal environmental conditions to sustain and reproduce itself, I act in the organisms' interest. Critical in this mode of thinking is a high sense of awareness of the environment and deep founded respect of all life forms. I try to approach mycology projects with a holistic mindset.

Ecological restoration forms a diversion from the golden age of restorative practices in the late nineties and early two-thousands when the gold standard of restoring ecologies was to revert their state to what it has been prior to being damaged. It takes into consideration that in the face of the Anthropocene, it does not suffice to diminish the damage. Ongoing effects of humanities influence on the global ecology have to be anticipated by restorative designs. What good are projects that help nature find its balance back only to swing out the other end of the scale within the coming years or centuries? Holistic and sustainable practices are necessary. (Higgs, 2003)

With my Pilzbüssli, a minivan converted into a mobile mycological laboratory, and I aim to collaborate with communities in what I call Mycological Interventions in a series of nomadic workshops. I chose the term Mycological Interventions in reference to Oliver Kellhammer's «Botanical Interventions». (Kellhammer, 1993)

*Fig. 16: Lead Down The Garden Path.*

## *3.2 Related Projects*

### *Fantastic Fungi (2019) – Film by Schwartzberg, L., & Larson, B.*

#### *Synopsis*

«A descriptive time-lapse journey about the magical, mysterious and medicinal world of fungi and their power to heal, sustain and contribute to the regeneration of life on Earth that began 3.5 billion years ago.» (Fantastic Fungi, 2021)

#### *Relevance*

This captivating movie is inspiring and motivating for me to pursue my thesis topic. It shows a wide array of relevant topics, from medicinal value to mycorrhizal networks. It does so by letting the most highly regarded experts of the respective fields talk. Although I am somewhat critical of the way early and not yet established research is portrayed in a visually highly appealing way. Doing so may encourage unfounded conclusions in viewers and should be presented in a more distanced way, in my opinion. Still, the way this production is visualising the field of mycology will undoubtedly guide my work.

#### *Topics of Interest*

| | |
|---|---|
| Mycology | Cinematography |
| Animation, 3D | Scientific Visualisation |
| Nature | Environmentalism |

#### *Links*

Fantastic Fungi website:
fantasticfungi.com

Trailer on Vimeo:
vimeo.com/ondemand/fantasticfungi

Rotten Tomatoes on Fantastic Fungi:
rottentomatoes.com/m/fantastic_fungi

## *BeeMushroomed Feeder (2014) Product – by Stamets, P. (Fungi Perfecti LLC, & Taylor, P.*

### *Synopsis*

«Designed by Paul Stamets and Paul Taylor, the patent-pending BeeMushroomed Feeder is a delivery system for mushroom mycelium extract, making this nutritive food readily available to bees to sustain their natural health in this time of crisis. The invention is proclaimed an effective solution for the not fully understood Colony Collapse Disorder (CCD), bees and beekeepers worldwide are currently facing.» (P. F. P. Stamets, & Taylor, P. (n.d.). 2014)

### *Relevance*

Certainly, one of the most prolific projects in mycoremediation is Paul Stamets BeeMushroomed Feeder. It is backed by the latest research and displays the use of the medicinal value that mushrooms offer. One of its most appealing features is how the designers open-sourced the build plans and lifted the patent in developing countries. However, it seems still not to be widely in use after seven years of its inception. More active promotion of the build plans and application scenarios could solve this.

### *Topics of Interest*

| | |
|---|---|
| Antiviral mushrooms | Bees |
| Mycoremediation | Environmentalism |
| Biohacking | Product design |

### *Links*

Why «bee» concerned? – Article on fungi.com
fungi.com/pages/bees

BeeMushroomed Feeder video on YouTube
youtube.com/watch?v=mG5jLJFD7OA

BeeMushroomed on Instagram
instagram.com/beemushroomed

## *Host Defense Mushrooms (2009) – Product by Fungi Perfecti LLC*

### *Synopsis*

«Host Defense builds on Paul Stamets' innovative research into the power and potential of mushrooms, especially mushroom mycelium, the root-like structures found growing below ground. The power of Host Defense comes from the discovery that the mycelium is the immune system of the mushroom.» (LLC, 2009)

### *Relevance*

Given the latest trend of mushroom-based health supplements, Paul Stamets' company Fungi Perfecti LLC is considered an early pioneer, bringing their first supplements to market in 2009. The person of Paul Stamets and his companies are in debate within communities of amateur mycologists and researchers. One critique is the product containing cryo-desiccated mycelium instead of fruiting bodies. Critics on various mycology forums online claim the lower amount or even absence of active substances in such products and the pills containing large amounts of up to 30% grain substrate. (u/filipkersey, 2018) In my research, I was not able to conclude this controversy but remain sceptical of such intensely marketed health supplements and their claimed benefits.

### *Topics of Interest*

Medicinal mushrooms
Medicine
Biohacking
Product design

### *Links*

Host Defense website
hostdefense.com

### *blackmagicalchemy.com (2016) – Company by Black Magic Alchemy*

#### *Synopsis*

«Black Magic Alchemy is a bi-costal-based California and Canada company producing and selling mushroom products such as teas, elixirs, and superfoods. Envision themselves «as being the Gucci & Prada of mushrooms». In their own words, they are cutting edge, innovative and a premier in the superfood space. They claim to use revolutionary processes in their formulations, such as sustainably wild harvesting their mushrooms, leading the new wave approach to alchemy.» (Alchemy, 2016)

#### *Relevance*

Black Magic Alchemy is the younger, stronger marketed competitor to Host Defense Mushrooms. To me, the same reservations apply.

#### *Topics of Interest*

Medicinal mushrooms
Social media, influencing
Branding
Superfoods
Esotericism, «New Wave approach to Alchemy»

#### *Links*

Black Magic Alchemy website
blackmagicalchemy.com

## *Radical Mycology Mycoremediation Lab at Le Commun (2017) in Switzerland – Exhibition by Peter McCoy*

### *Synopsis*

In February 2017, Peter McCoy of Radical Mycology went to Geneva, Switzerland, to participate in a month-long exhibition on art, bioremediation, and human-ecological relationships. Along with three workshops and presentations, Peter worked alongside international artists to install a mini-mushroom lab and mycoremediation demonstration site. (Peter McCoy, 2017)

### *Relevance*

This exhibition inspired my practical diploma project and my exhibition. I particularly like the way the different steps in mushroom cultivation and examples of mycoremediation are portrayed.

### *Topics of Interest*

Exhibition
Art
Workshops
Demonstrative Lab

### *Links*

Video of the exhibition in Geneva, Switzerland on Youtube
youtube.com/watch?v=nEKmitphqp4

Radical Mycology website
radicalmycology.com

Mycologos website
mycologos.world

## *Southwest Mushrooms (around 2017) – Company by Michael Crowe*

### *Synopsis*

«Mushroom Mike has built a business around his interest in mycology. He maintains a Youtube channel with more than 40k followers and a successful business operation growing gourmet and medicinal mushrooms based in Phoenix, Arizona, in the US. Mikes view of mycology as inter sectioning art and science is inspiring.» (Crowe, 2017)

### *Relevance*

Southwest Mushrooms is one of the most impressive young mushroom farms I have come across. Michael Crowe openly shares his know-how on his Youtube channel.

### *Topics of Interest*

Mycology
Do it Yourself
Laboratory
Grow Operation
Gourmet and medicinal mushrooms

### *Links*

Video portrait of Southwest Mushrooms by PARAGRAPHIC:
youtube.com/watch?v=417Qbwn9yso

Southwest Mushrooms YouTube channel:
youtube.com/channel/UCTXP5BRecHpwa7_sFbbyMng

Southwest Mushrooms website:
southwestmushrooms.com

## *Mycelium Running, how mushrooms can help save the world (2005) – Book by Paul Stamets*

### *Synopsis*

«Mycelium Running is a manual for the mycological rescue of the planet. Growing more mushrooms may be the best thing we can do to save the environment. In his groundbreaking work, mushroom expert Paul Stamets lays out how. The basic science ensues: Microscopic cells called mycelium recycle carbon, nitrogen, and other essential elements as they break down plant and animal debris to create rich new soil. What Stamets has discovered is that we can capitalise on mycelium's digestive power and target it to decompose toxic wastes and pollutants (mycoremediation), catch and reduce silt from streambeds and pathogens from agricultural watersheds (mycofiltration), control insect populations (mycopesticides), and generally enhance the health of our forests and gardens (mycoforestry and myco-gardening).» (P. Stamets, 2005)

### *Relevance*

As can be assumed from the first two chapters of this thesis, this book was immensely influental to my work. It served as a neuronal jump-starter for my creativity and imagination. Later in the process I recognised a few assumptions I had layed into the text, and diversified my literature accordingly.

### *Topics of Interest*

Mycology
Literary works
Mycorestauration
Environmentalism

### *Links*

Mycelium Running on the fungi.com webshop:
fungi.com/products/mycelium-running

## *The Audobon Christmas Bird Count (1900) – Event by Frank M. Chapman, Audobon*

### *Synopsis*

«If you thought Citizen Science was a new thing, then think again. This Christmas Bird count is in its 113th (121st by now) year, with tens of thousands of Americans braving all manner of conditions armed with binoculars and checklists.» (Chapman, 1900)

### *Relevance*

Looking at Citizen Science projects in other fields offered inspiration for my project. Being one of the oldest and most popular, the Audobon Christmas Bird Count is undoubtedly a paragon for motivating and engaging people for contributing to scientific research. What's nice to see that environmentalism can be a catalyst for gathering people in the field and collaborating on large-scale projects.

### *Topics of Interest*

Citizen Science
Biology
Field Research
Environmentalism

### *Links*

audubon.org/conservation/science/christmas-bird-count

### *climatprediction.net (2003) – Web Platform by Oxford University*

#### *Synopsis*

«Climate prediction.net is a volunteer computing climate modelling project. We run climate models on people's home computers to help answer questions about how climate change affects our world, now and in the future.» (University, 2003)

#### *Relevance*

This project by Oxford University has caught my eyes because of its similarity to foldingathome.org. I like the idea of using distributed computing power for science. Also, this kind of low entry barrier citizen science projects is appealing to participate in.

#### *Topics of Interest*

Citizen Science
Computing
Environmentalism

#### *Links*

climateprediction.net

### *Bento Lab (2013) – Product by Bento Bioworks Ltd.*

#### *Synopsis*

A mobile genomics setup, Bento Lab combines a portable PCR machine, a microcentrifuge, gel electrophoresis and a transilluminator. Furthermore, it fits into any laptop bag, so Bento Lab can travel wherever your science goes. (Ltd., 2013)

#### *Relevance*

The Bento Lab inspired my work on open hardware laboratory equipment. It is a beautifully designed and marketed product. To me, it was still too pricey. I wanted to see if I could build something similar with low to no cost and make it accessible to the public.

#### *Topics of Interest*

Biology
Lab Research
Citizen Science
DIY

#### *Links*

bento.bio/product/bento-lab

inaturalist.org

stardustathome.ssl.berkeley.edu

discovermagazine.com/the-sciences/
top-20-citizen-science-projects-of-2020

natureindex.com/news-blog/
how-to-run-successful-citizen-science-project

ayeletlab.net.technion.ac.il/files/2015/11/final-virsion1.pdf

## *3.3 Field Research*

The field research for this thesis encompassed reaching out to experts in the field of mycology, generally talking to as many people from as diverse of a background as possible and conducting workshops. Scouting for expert mycologists turned out a challenge. Starting, I was intimidated by contacting research institutes at the ETH and other universities. Gradually, I got more comfortable just calling researchers on the phone and asking them for a few hours of their time.

### *3.3.1 Meeting Kaspar König*

When I decided that Mycology would be the topic of my diploma project, I reached out to Kaspar König. His title at ZHdK is «Artistic Staff Member Sustainability». I knew him from an input he gave us in the Soft Architecture course in our second year, from the Nachhaltigkeitswoche and his mentoring of Marcial's bachelor thesis. I was excited to hear his thoughts on the topic of mycology.

Kaspar was just as excited to talk about fungi as I was. We engaged in a vivid exchange of references and ideas. He shared some of the mushroom related projects on which he was working. Later I attended his presentation of the «Biologisch Abbaubare Maske», the design of which relies on fungi. The idea of growing a biologically decomposable face mask is indeed very timely. The questions his project provoked in the audience were of exceptionally high interest to me. Some reacted with disgust or just wanted to know exactly why the material would not damage the wearer's health.

On the roof terrace of Toni Areal, Kaspar is running a mushroom garden until July. He encouraged me to participate by placing spawn in the garden.

I then shared my motivations and the experiments I had done so far and my interest in both mycology and electronics, sound synthesis. Kaspar shared some project ideas, and we discussed them. They reached from establishing a new gold standard in crypto coin by surveying global fungal biomass to experimenting with different species' problem-solving skills in labyrinths.

I am very grateful for all the inspiration Kaspar offered me in this conversation. He offered his support and even proposed to mentor my thesis.

### *3.3.2 Meeting Dr Reinhard Berndt*

The first mycologist I met was Dr Reinhard Berndt. Dr Berndt is the curator of the ETH fungarium. *(Fig. 18: on page 42)* He oversees a collection of close to one million dried specimens of fungi. Some of them are the type for the respective species. That means whenever scientists anywhere on the globe are looking to compare specimens for identification, and they borrow the type from ETH. It is sent out, and a small piece is dissected, rehydrated and then examined under a microscope. The collection contains mainly local Swiss species, but there is also a good part of international ones. Meeting Dr Berndt and being shown the fungarium was a unique opportunity and an experience I will never forget. I was very impressed and utterly fascinated. In a lengthy exchange on mycology, Dr Berndt said he had never heard of mycoremediation before. He had to look it up before our meeting and thought it sounded rather esoteric. I responded that it was precisely the fact that this knowledge is inaccessible that I wanted to tackle in my thesis project. He was excited about that and assured me of his full support, although he seemed to think there was not much he could help me with. I realised he has a particular, narrow, but tremendously deep knowledge within the field of mycology. I later realised that many scientists are of a similar profile.

### *3.3.3 Meeting Marc Dusseiler*

Early in the process, I also had a phone call with Marc Dusseiler from the open-source biology web platform Hackteria.org. (Hackteria, 2021) We had a short exchange on mycology and biology in general. Marc helped me solve the issue with colouring my agar media black by using finer ground active char and gave me tips on avoiding media that is not setting by using higher temperature and adjusting the recipe. I will definitively visit the Hackteria Open Lab space here in Zürich. Their Gene-

*Fig. 17: The author showing collected fungal samples to interessted children at the Masoala Halle, Zoo Zürich.*

ric Biology Lab Equipment has later been inspirational to the equipment I have built. *(Fig. 13: on page 24)*

### *3.3.4 Meeting Dr Ivano Brunner*

Looking for an opportunity to sterilise my large backup mother culture jars, I talked to Duy Bui from my class. I was aware that he had guest status at the Swiss Federal Institute for Forest, Snow and Landscape in Birmensdorf (WSL). *(Fig. 19: on page 42)* (WSL, 2021) Duy had mentioned that the WSL had biology laboratories and that as a guest, he was free to use them. So I asked him if they by any chance had an autoclave that was capable of sterilising twelve jars of each 1.5 Liter contents. Luckily they had such equipment and were open to letting me use it. Duy introduced me to Dr Ivano Brunner, Beat Stierli, Dr Beat Frey and the other researchers at the institute. I found the WSL to be a place that would never stop amazing me. In the ensuing months, I visi-

*Fig. 18: The fungarium at ETH Zürich. An estimated million of samples is archived here.*

*Fig. 19: The seed bank at the Swiss Federal Institute for Forest, Snow and Landscape in Birmensdorf.*

ted the institute multiple times, and the people and the infrastructure I had access to proved critical in many of my projects.

### *3.3.5 Workshops*

Finding a suitable medium for transferring mycological knowledge and skills to as many people as possible was challenging. I sketched out ideas around sending out experimentation kits to people or conducting remote or self-guided workshops online for some time. Eventually, I realised that the only way to do this right was meeting people in a physical space and a classical workshop setting. The idea of performing in such a context seemed daunting to me. I questioned my qualifications in the subject and teaching and working with people. Still, I decided to go down this path as it seemed the most beneficial to my cause of spreading mycoliteracy and mycophilia.

### *3.3.6 Building my own tools*

As I embarked on this mycological journey, it was apparent that time and material resources such as money, scope and scale would be the defining parameters for what my project could potentially be. I was going solo since I had failed in convincing any of my peers of the fantastic world of fungi. In hindsight, I would have put more effort into finding a partner in crime. However, as it goes, together you go far, alone you go fast.

## *3.4 Findings and Next Steps*

### *3.4.1 Findings*

Working out early ideas such as the «Fungal Organ» as far as possible in a time frame as short as possible helped me evaluate project ideas in a very experiential, evidence-based way. I continued this approach of embodying my ideas as early as possible.

In conversations with people from such diverse backgrounds, I found invaluable insight into my research topic and the developing project ideas. Talking to Kaspar König and joining Merlin Sherldrakes lecture at ZHdK boosted my confidence and reassured me to pursue the topic further. Exchanging common interests in a topic works very well for that purpose, especially for a one-person team.

My exchanges with the scientists at WSL and others uncovered holes in my concept and were a valuable source of inspiration. Namely, in these conversations, I recognised how I had fallen into the trap of coming up with concepts that could not be supported by the science I cited. It was hard to step back from emotional responses to such findings and continue with a sober mindset. That was the point where I pivoted from having a real-world mycoremediation project as an outcome.

In essence, I had concluded that my contribution had to be much more fundamental. In order to advance the field in the ways I imagined, I had to spread the knowledge and teach people mushroom cultivation.

### *3.4.2 Next Steps*

No matter what application I would eventually work on, I now had to design a method and the tools to cultivate mushrooms efficiently. I would contrast protocols for cultivation techniques and synthesise my approach. Extensive experimentation would then serve as the base for developing my designs further.

# *4.0 Project Development*

## *4.1 Mycological Protocols*

One of the two parts of my practical work was developing a series of mycological protocols for mushroom cultivation. For this, I researched example protocols in printed literature as well as online forums. I then chose the most promising instructions for each technique (called «tek» by amateur mycologists online). I then started with replicating the exact protocol and evaluating the results. That allowed me to iterate on the pre-existing protocols and develop my own proven teks.

The cultivation of mushrooms is thought of in four consecutive stages. Stage one is the isolation and purification of the desired cultivar. That is done on a liquid culture medium in a jar or agar medium in a petri dish.

Stage two is the creation of spawn. Here, the inoculum created in stage one is inoculated onto spawn media such as grain or sawdust. That is helpful for rapidly multiplying, for example, one grain spawn jar exponentially within a few generations of grain to grain transfers.

Stage three describes spawning the spawning media onto the fruiting substrate. For example, a fully colonised jar of millet grain spawn is spawned onto a bag of wood chips supplemented with wheat bran.

Stage four describes putting the fully colonised fruiting substrate into fruiting conditions. Often this means exposing it to light and the correct temperature and humidity range depending on the species that is being cultivated.

If all four stages have been successful, the colony will now produce fruit bodies that can be harvested. From here, the routes of tissue cloning individual fruit bodies selected for desirable traits onto agar dishes or liquid culture jars, and the production of spore prints or spore syringes, are next. The mushrooms life cycle has thus come full circle. When collecting spores from the fruiting bodies, sexual reproduction will provide fresh genetics and avoid senescence in the cultivars. I will now go into detail on all of these techniques.

*Fig. 20: The author filling syringes with liquid cultures for inoculating grain spawn.*


PARAFILM
PARAFILM
PM-996

### *4.1.1 Liquid Culture*

Like the agar technique explained in the next section, growing fungi in liquid cultures is considered stage one among cultivation techniques. These are the fundamental steps that have to be mastered to isolate and propagate mushroom cultures. In the following, I will cover the reasons and methods around this technique.

Growing fungi in liquid cultures is a technique that originates from professional biology laboratories. It is also done on an industrial scale, where colonies are grown in huge fermentation tanks in order to extract certain enzymes the fungi produce. The online community of amateur mycologists worldwide has scaled down these techniques and adapted them, resulting in an easy procedure for multiplying mycelial mass in a modified canning jar.

### *4.1.2 Agar*

Growing fungi on agar is considered stage one among cultivation techniques. This section will give an overview of the method and when and why to rely on it.

Agar or agar-agar is a jelly-like substance gained by mixing the linear polysaccharide agarose and a heterogeneous mixture of smaller molecules called agaropectin. This substance is formed in the cell walls of certain algae species. It is extracted by boiling.

In microbiology, an agar plate or petri dish is used as a nutrient medium to grow cultures of microorganisms such as bacteria or fungi.

The agar powder is mixed with water and sometimes supplemented with nutrients such as yeast, malt extract, dextrose or others. It is then stirred and heated up to 85 °C – its melting point. If the agar is poured on glass Petri dishes, it can be cooled to 40 – 32 °C, where it starts solidifying again. The glass Petri dishes are then sterilised at 0.8 PSI for 45 minutes and left to cool in the unopened pressure cooker overnight. They can then be sealed using parafilm and allowed to cool out and solidify. Sealed agar plates are wrapped in zip lock bags and stored upside down at 4 °C for several weeks. In order to test sterility, a dish can be left at room temperatures for a day or two. If it stays clear of any bacterial or mould growth, the batch can be considered sterile for use.

*Fig. 21: A liquid culture jar of G. lucidum.*
*The mycelium displays captivating shapes and movements.*

As much as many amateur mycologists dislike working with agar, as inevitable it is. The uses for agar are manifold. Most importantly, it is a first cultivation technique for liquid cultures or spores acquired from commercial outlets. Further, tissue clones or spores from specimens gathered in the wild or from other fresh cultivars are plated out on agar. The plates allow for easy inspection for contamination, as the mycelium is forced to grow in a reasonably two-dimensional, flat structure. This flat growth allows for easy identification for promising strains for isolation from less promising ones or from contaminated areas to purify a culture over three generations. Petri dishes are easy to manage, handle and store. It also allows for easy transfer to further generations of agar, liquid culture, grain spawn or even fruiting media such as manure or sawdust. Another drawback of agar, next to its steep learning curve, is senescence. Just like us humans, fungi age, too. Senescence is why three generations of growing out a particular culture on agar plates is considered the right balance of isolation and purification and senescence of the organism. The mycelium will lose vigour over time – only sexual reproduction will ensure its viability for long periods. The organism has to be coerced into fruiting, spore prints taken and genetically new tissue grown.

After taking some time to get used to it, this technique proves immensely valuable for many aspects of mycology. One nice experiment I did was colouring the agar media using food colouring. I most like my black petri dish. They offer great contrast for photography. Before switching to food colouring, I experimented with charcoal. However, I never got that to work. The activated charcoal I got from a beauty store was too coarse and never dissolved.

### *4.1.3 Grain*

Grain such as rye berries, wheat berries, corn, sorghum and millet are commercially used for spawn production. Growing fungi on grain are considered a stage two technique. Since most cultivated mushroom species are not readily fruiting on pure grain substrates, it is used as an intermediary growing stage. In this section, I will explain the methods and benefits of growing fungi on grain substrates.

*Fig. 22: Mixing colonised millet grain spawn into a tub of coconut coir substrate.*

Grain spawn is created by inoculating cooked and sterilised grain with a healthy, vigorous inoculum that is contamination free. Grain substrate may be inoculated with wedges of colonised agar or liquid culture that has been drawn up in a syringe. It is called grain spawn for its use of later «spawning» into a fruiting substrate, such as a mushroom patch, supplemented sawdust or wood chips, manure or coconut coir at stage three. In order to spawn fully colonised grain spawn, it is simply mixed into the fruiting substrate under hygienic, ideally sterile conditions and then put into fruiting condition at stage four.

Due to its small, round shape and its optimal composition of over 30 different types of vitamins and minerals, I have found millet to be the most reliable grain. The tiny kernels offer a high amount of possible inoculation points when the mycelium has colonised them, and they are mixed into fruiting substrate. Using this grain spawn technique speeds up colonisation and ensures an advantage to any possible competitors such as moulds, bacteria, or other fungi.

The procedure for making grain medium is soaking the grain for 12 – 24 hours to geminate dormant bacterial endospores. The medium is then cooked, dried to field capacity, filled into bags or jars and sterilised in a pressure cooker. After cooling, the grain is ready for inoculation.

### *4.1.4 Straw*

In stage three, a fruiting substrate is prepared and inoculated. This substrate is chosen in accordance with the nutritious preferences of the cultivated species. A few commonly cultivated mushrooms fruit productively on a plain straw substrate. Including the Oyster complex, Pioppino and some Shiitake strains.

The benefit of fruiting on straw is its economic and abundant availability. The straw is shredded into 5 cm pieces for optimum surface area for the mycelium to grow on. It can then be soaked for 24 hours or 2 hours using castile soap. Some growers do not presoak their straw at all. Then it is pasteurised at a temperature above 63 degrees for 30 minutes. I typically pasteurise straw at boiling point for 45 minutes. It is then left to cool and packed into bags, jars, tubs or buckets. Now the fruiting blocks are ready for inoculation.

### *4.1.5 Coconut Coir*

Another option for a fruiting substrate is coconut coir. It is the natural fibre that is extracted from the outer husk of the coconut. Especially for the cultivation of Psilocybe Cubensis, the following «Bucket Tek» has proven highly productive. Bucket Tek has been introduced to the online forum shroomery.org by a user named «Damion5050» and further developed by another user called «boddhisatta». Bods iteration of the protocol is part of his «Easy As Fuck Tek» list, a great source for many other protocols. (Damion5050, 2012) (bodhisatta, 2013)

650 grams coco coir is mixed with two litres vermiculite, a cup of gypsum in a bucket. 4.5 to 5 litres of water are boiled and added to the bucket. The bucket is closed tightly with the lid and left to soak for 30 – 60 minutes until the coir block has completely dissolved. The substrate mix is then mixed thoroughly.

*Fig. 23: A jar of millet grain spawn is being colonised nine days after inoculation.*

*Fig. 24: Coconut coir substrate being colonised eleven days after inoculation.*
*Such ropy rhyzomorphs are highly sought after by cultivators.*

*Fig. 26: Staff at the WSL helping me chipping the freshly harvested beech wood.*

### *4.1.6 Wood Chips*

Most commonly cultivated mushrooms are wood lovers or saprophytes – meaning they live off decaying plant matter. For growing saprophytes, the gold standard as a fruiting substrate for these species is wood. Most of them thrive on sawdust, wood chips or even logs of hardwoods such as oak, beech, alder and others – the denser the wood, the higher the nutritious value and the better the yield.

It turned out to be rather challenging to find the pure sawdust or wood chips of a specific hardwood species here in Switzerland. I talked to all possible people around me about sourcing the substrate and called countless carpenters, sawmills and communal forestries in Zürich as well as Graubünden. Throughout three weeks, I had become somewhat discouraged. They all only had mixed refuse of hard and softwoods. Since the mushrooms I am growing are, according to the literature, not doing well on coniferous wood, this was of no help for me. After also scouring several reptile dealers and other pet stores to no avail, I decided to take

*Fig. 25: Roughly 500 kg of beech wood chips drying in a seminar room at ZHdK.*

matters into my own hands. I called the forestry service of Zürich one more time and asked them if I could gather wood from a freshly cut beech tree somewhere around the city. My thinking was that the harsh late winter had brought down branches and whole trees throughout the city, and there must be fresh-cut wood available somewhere. For 20 swiss francs, they handed me out a wood gathering license for a property around the Albisgüetli. The permit even encompasses permission to ride the car into the forest to gather freshly cut wood left and right from the road.

After loading up the van with as many 1.5 meter branches of beech and elmwood as I could, I brought them back to Toni Areal to find a place that would help me process them into chips or sawdust. That, too, turned out to be harder than imagined. Finally, in an exchange with Dr Ivano Brunner at the WSL, he told me about the large-sized wood chipper they had for their tractor. The gardeners at the WSL allowed me to use their tractor and wood chipper for a whole morning and even assisted me with the work. I went back into the forest early that morning to load up more wood before making my way to the WSL in time. It was pretty exciting to see the enormous powerful machine turn my fresh, moist and heavy logs into fine wood chips. The smell coming from the fresh wood was fantastic. We loaded the freshly produced chips into large 200-litre plastic bags – ten of them in total – and loaded them back into the van. I then drove off to Toni Areal and arranged for a room reservation to dry the wood chips over a few days – Marcial helped me with that.

### *4.1.7 Experimental Substrates*

During my diploma project, I conducted a few experiments on growing fungi on unconventional substrates. One I would like to point out here is polylactic acid (PLA) coffee capsules. PLA is used as biodegradable, compostable material for packaging and other applications. I knew that coffee is a proven substrate for especially oyster mushrooms, and I had read studies of fungi growing on plastics and, in some cases, even metabolise specific polymers. (Luz et al., 2015)

Based on this evidence, I hypothesised that the used PLA coffee capsules could be inoculated with a fungus and would successfully colo-


*Fig. 27: Biodegradable and compostable PLA coffee capsules are being halved and filled into a jar.*

*Fig. 28: PLA coffee capsule 2 days after inoculation.*

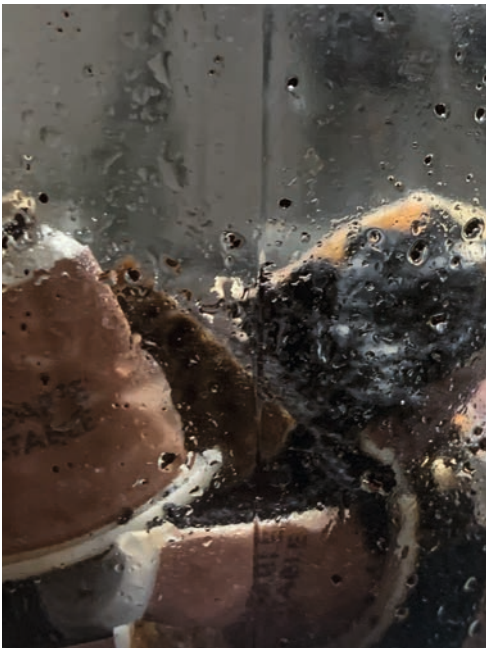


*Fig. 29: PLA coffee capsule 22 days after inoculation.*

*Fig. 30: Punching holes for injection and air ports into a canning jar.*


*Fig. 31: 475ml sized Mycoreactors ready for use.*

nise, perhaps even fruit. Of most interest was the question of whether the fungus could degrade the PLA completely.

I filled a Mycoreactor jar halfway with halved PLA coffee capsules, sterilised the jar for 45 minutes in a pressure cooker and inoculated it with approximately 2 cc malt extract dextrose liquid culture of Pleurotus citrinopileatus. From 8.4.2021 to 30.4.21 – within 22 days incubation time at room temperature, the jar was approximately 80 % colonised by healthy, snow-white mycelium. The experiment was a success. I still have to devise a method to evaluate if and to what degree the mycelium degraded the PLA. Also, an attempt to provoke the formation of fruiting bodies is still to be executed.

### *4.1.8 Backing up Cultures*

For long term storage of liquid cultures, I inoculate large, 1.7-litre jars of malt extract dextrose broth. I incubate them for a few days and then store them in a fridge. According to Peter McCoy, this method allows for up to several years of storage of mother cultures. (P. McCoy, 2016)

## *4.2 DIY Mycological Laboratory*

The practical part of my diploma project encompasses a series of DIY Mycological Laboratory devices designed and built based on available build guides from the internet and books. I improved upon these existing designs and adapted each device to my needs. I published build guides, bill of materials and blueprints freely available on the web platforms Instructables and Github. The product is part of my contribution to the field of amateur mycology.

### *4.2.1 Mycoreactor*

The Mycoreactor design is included here for integrity within this chapter. Refer back to 4.1.1 for further details.

When I received my first order of pure cultures, I had to decide how to continue growing them further. There was a bunch of options. The liquid cultures came in syringes, as is custom for mushroom traders. That meant they could either be plated on agar or injected into fresh-brewed liquid culture containers. I chose to start with the second option and use only 1 ml of the 10 ml syringes to start fresh 500 ml jars. That meant the jars would take a few weeks to colonise fully but offered me the opportunity to back up the cultures in giant jars later on and grow them out on agar to check for purity and viability.

The idea of modifying canning jar lids for liquid cultures stems from the founder of the mycology web forum mycotopia.net – hippie3. (hippie3, 2001) The late hippie3 is not only highly regarded for his liquid culture tek, but other iconic protocols such as PF tek or BRF tek. (hippie3, 2006), (hippie3, 2005)

The web store pilzzucht-shop.de sells not only liquid culture syringes of 27 different genera – but also offers cultivation supplies. One of the devices they offer is the «Mycotainer». (pilzzucht-shop.de, 2018) This polypropylene tub features an unscrewable lid with a self-healing injection port and exchangeable «highly efficient» paper filter. (Witt, 2018) I recognised the injection port jar design from various community designs from shroomery.org. («Shroomery,» 1997 – 2021) Amateur mycologists use these medical injection ports made from Bromo-butyl. These readily available self-healing ports are far superior to the DIY contraptions made from Shoe Goo or other silicone products.

Further, Tyvek is used as a filter material. I iterated on these designs by exchanging the polypropylene through a fully recyclable glass jar and metal lid. I found a supplier that features a food-safe, BPA-free «Bioseal» on their jars. («UNiTWIST Gläser/Flaschen mit Deckeln - nach Form,» 2005 – 2021) These jars are highly reusable and recyclable at the end of their life cycle. After testing a friends Mycotainers, I saw several superiorities in my design. The propylene deteriorates over time. The lids warp and do not seal airtight in many cases. The Tyvek I replaced through micropore tape – readily available at any pharmacy. I punched two holes off-centre into the lid by hand and flattened the created rim using a power press. Later I found the injured varnish on the lids to produce rust. I improved my design by varnishing the punched holes for injection- and air port with clear varnish to protect it from rusting. The

micropore tape is not an ideal solution for the air port filter. Using a rubber grommet with an integrated Tyvek piece would be an improvement to this design. I took several dozens of these «Mycoreactors» into rotation for liquid cultures and grain spawn production.

From my first steps in mycology two years ago, I remembered liquid culture cultivation as quick, simple and comparatively reliable. It allows for exceptionally effortless sterile work and is therefore resistant to contamination. The supplies are readily available and low cost. The biggest hurdle is the requirement of a typical household kitchen pressure cooker. Since I still had the one I had borrowed from a friend standing in my basement, I was pretty much set. To make use of the waiting time for my cultures to arrive, I got a dozen 500 ml canning jars, a pack of Bromo-butyl injection ports online and a roll of micropore tape from the pharmacy. I remembered it to be quicker than other methods, too. As a next step, I would prepare liquid culture jars for when the pure cultures I had ordered from Germany arrived.

### *4.2.2 Sterile Flow Hood*

With the constraints on material resources comes the question of laboratory equipment. There are a few minimal tools that are necessary for mycological work. For example, sterile work asks for some means to provide a flow of sterile air. Ideally, a professional lab bench, a so-called sterile or laminar flow hood, is used. They are the gold standard in laboratories throughout the world and across disciplines such as chemistry and biology. However, with hefty prices coming in at 3 to 5000 Swiss franks – this was off the bat. Forums such as shroomery.org or several mycological communities on Reddit suggest using a still air box (SAB). Essentially a transparent plastic tub with cutouts for the hands of the user to reach in. The SAB is thoroughly cleaned with alcohol, loaded up with all necessary tools and equipment and then covered with the lid. I used one of these contraptions in my early steps into the field in 2018. It is far from ideal in both practicality and efficacy.

As I have done throughout my studies, I just decided to build my own sterile flow hood. It was a project I had been dreaming of ever since I saw pictures of the devices in Paul Stamets' books. Now was the time

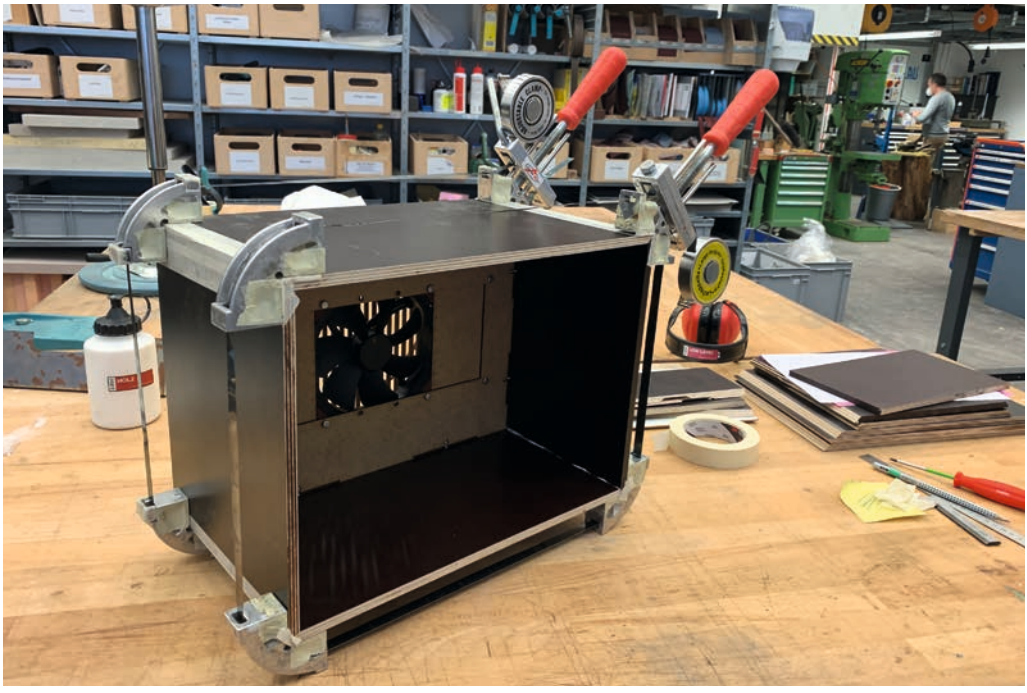


*Fig. 33: Glueing the wooden case for the sterile flow hood.*

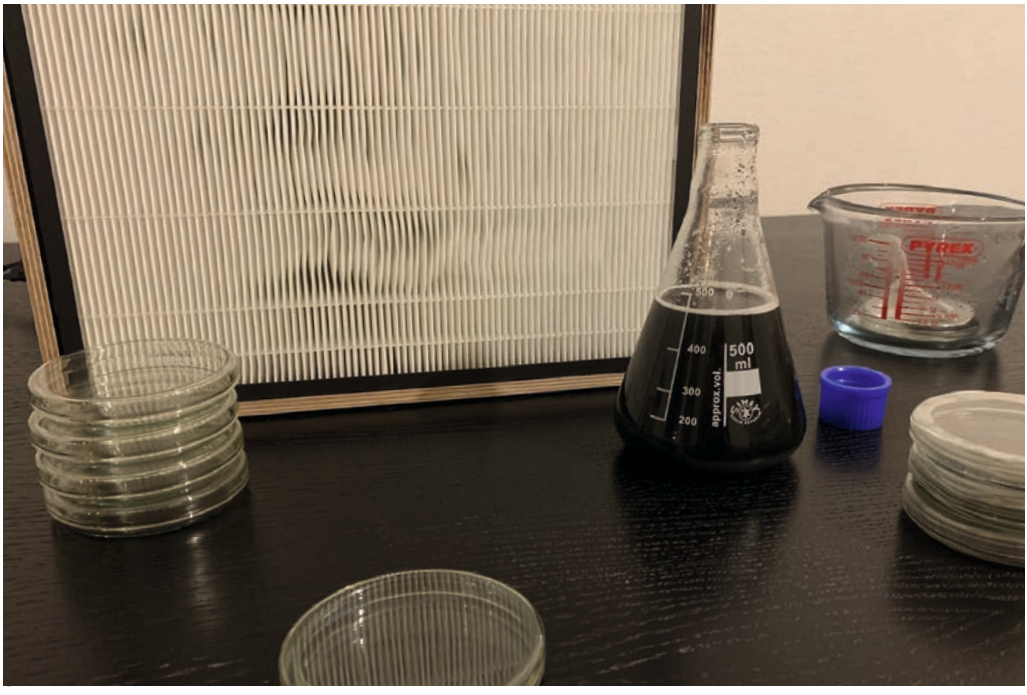



*Fig. 32: The sterile flow hood in use.*

for it. I scoured the web for a few promising designs and selected three favourites. I sketched out my own, improved design based on the three sources and hunted for the parts online. One of the requirements for my design was it being built entirely of easily source-able, affordable parts – preferably found at any hardware store. I ordered the parts, and off to the workshop, I went.

### *4.2.3 Magnetic Stirrer*

It is essential to have a convenient, ideally automated solution for stirring culture jars for liquid culture work and diminishing the need to open up the jars for stirring to avoid contamination vectors. Laboratories use magnetic stir bars and stir plates for this. These professional tools tend to be pricey, so I designed and built my own. My magnetic stirrer is built from an old computer fan and scavenged magnets from a broken hard disk. Reusing parts in this way kept the cost at a minimum. In the next iteration, I added a much stronger electric motor, a potentiometer for speed control, better and stronger magnets and a power switch. I used to split the 12V power supply into my flow hood and magnetic stirrer – in my user tests and workshops, this turned out to be not ideal since this means both devices are constantly running and interdependent in voltage. Adding power switches and voltage control to both devices would still allow for a shared power supply unit. As a replacement for the PE coated magnetic stir bars used by professional laboratories, I ordered long cylindrical neodymium magnets from supermagnete.ch. I tested a few different formats in 500 ml, 1000 ml and 1800 ml jars and chose the best working formats for each volume.

### *4.2.4 Incubator*

To complete my basic laboratory, I needed a climate-controlled incubator to grow my liquid cultures, agar dishes, grain jars and fruiting substrate blocks. I was able to borrow a reptile brood incubator from a friend. However, it being such an integral part of my lab – I decided to build my own. The «Mycubator» fits into the custom-built flight cases in the Pilzbüssli and features styrofoam isolation, an industrial 120 mm

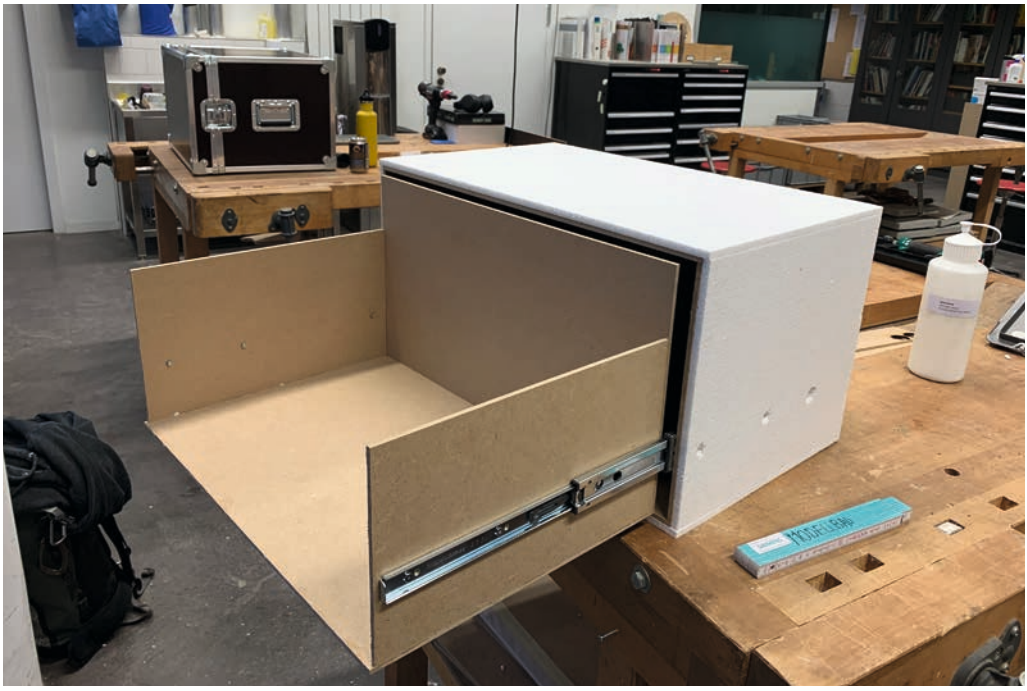


*Fig. 34: The incubator is isolated using styropropylene.*

*Fig. 35: Glueing the wooden frame of the magnetic stirplate.*

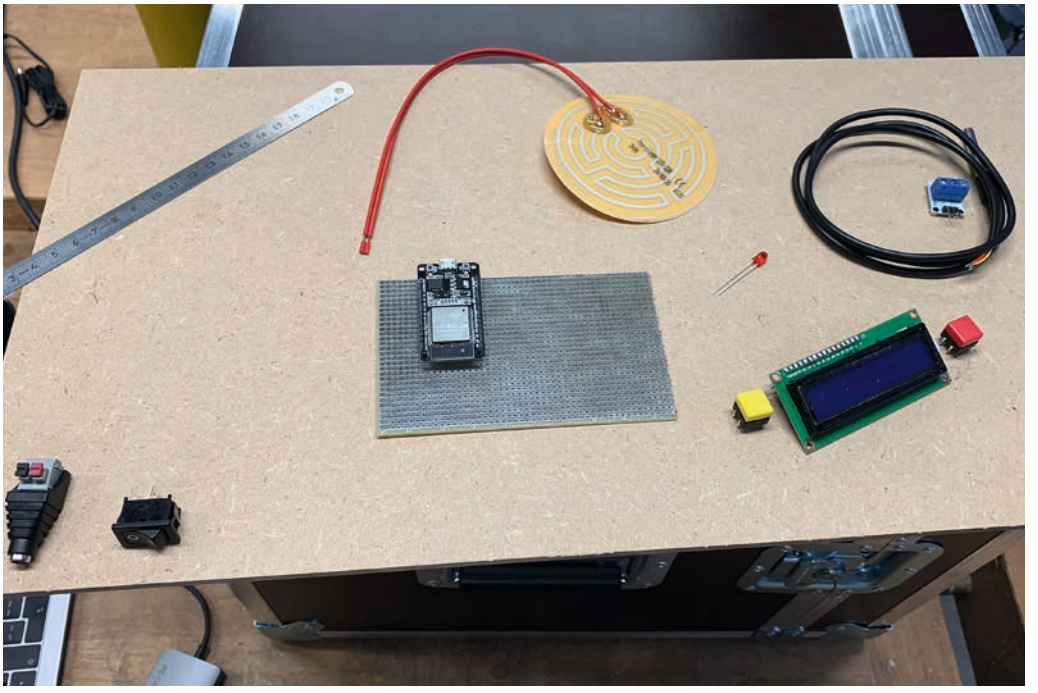


*Fig. 36: Electronical parts for the incubator.*

*Fig. 37: The magnetic stirplate ready for use.*

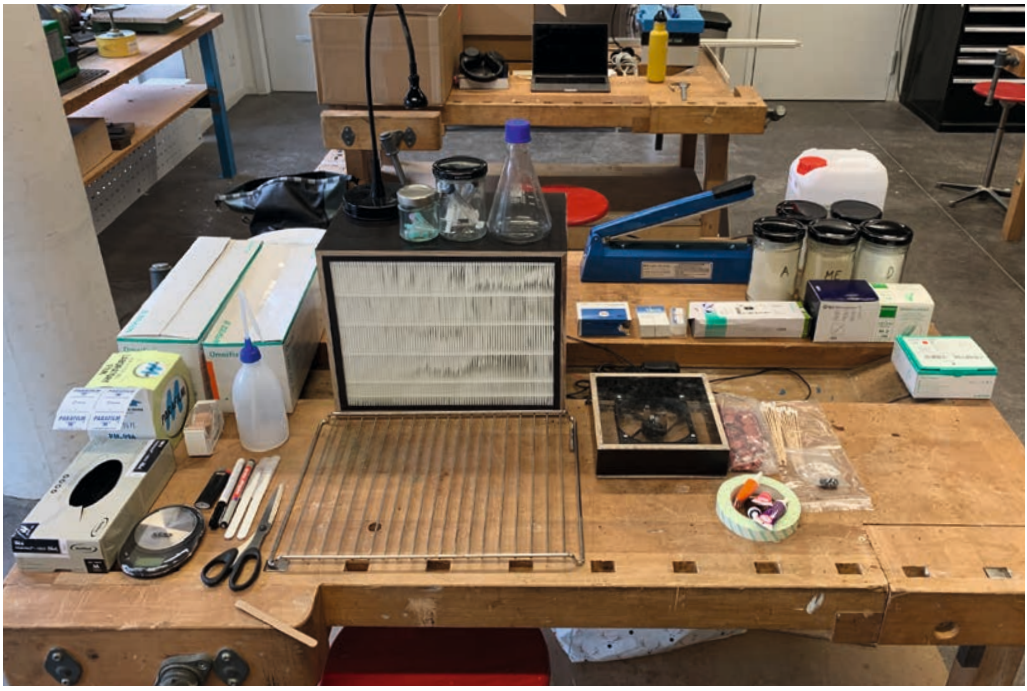


*Fig. 38: The lab equipment layed out. All this is to fit into the Pilzbüssli.*

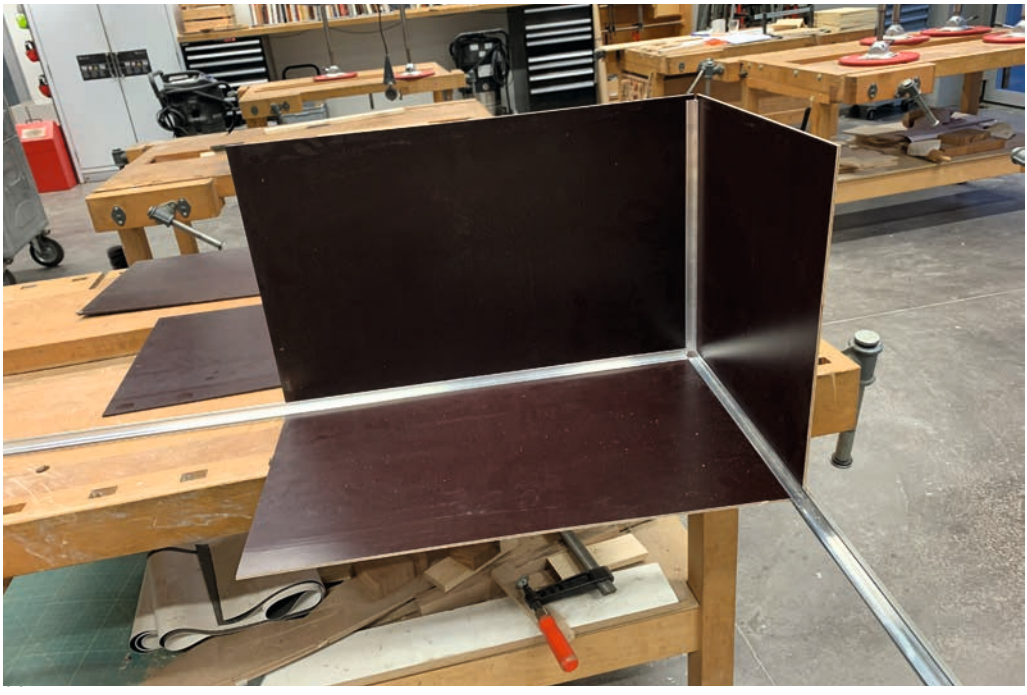


*Fig. 39: The flight cases are assembled. The aluminium profiles are riveted.*

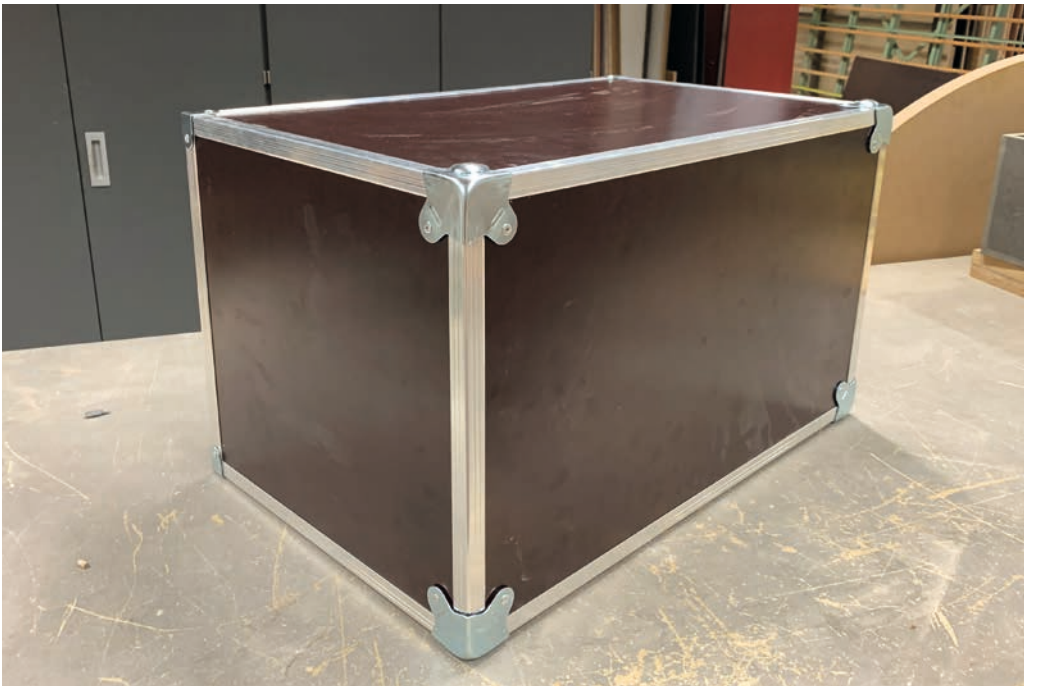


*Fig. 40: The aluminium fittings are rugged and heavy duty.*

*Fig. 41: The drawer frontplates had to be neatly milled before glueing.*

*Fig. 42: Flightcase with drawer module.*

*Fig. 43: All three flight cases are ready for use.*

computer fan, an OLED display, control buttons, a waterproof metal cased temperature probe and 12 V, 22 W polyester heating foil. All electronics are controlled by an ESP32 microprocessor board and can be connected to via WiFi and Bluetooth. The PID algorithm ensures safe and stable temperature maintenance.

### *4.2.5 Flight Cases*

In order to store, organise and transport the mycology lab equipment, I decided to build customised flight cases as they are commonly used by musicians and other event industry crews. They are heavy-duty, lightweight and handle with ease. I decided to build a modular system containing three individual cases that fit into the back of the van. Sascha from the workshop at ZHdK introduced me to Nik from the PA-nik flight case store in Glattbrugg. So I picked up the aluminium profiles and fittings necessary to build the first prototype. Sascha ordered a large 4 mm phenol resin-coated board, the material I decided on for building the cases. First, I was worried about the wood being too thin to result in a sturdy construction. However, after having the first prototype built, it turned out to be more than stable.

## *4.3 Workshops and Pilzbüssli*

### *4.3.1 Cultural Probes: Spore Printing*

As a very first methodical, collaborative intervention, I decided to ask my co-students and lecturers to bring store-bought mushrooms to our first progress session presentation. I sent out a digital flyer listing supplies such as a jam jar and aluminium foil. We then conducted a distributed spore printing workshop via Zoom call. People later reached out to me to ask questions on their printing and sent me back pictures of their results.

### *4.3.2 Kit and Workshop: Growing Fungi on Agar*

After not having interacted with third parties for quite some time, I decided to plan and execute another workshop. I seized the opportunity of pandemic restrictions being somewhat lifted, allowing indoor gatherings of 10 people. A group of tight friends would meet in the Obwalden mountains for the weekend, and I wanted to bring them a mycological kit and conduct an in-person workshop on agar technique. I quickly gathered supplies and packed kits consisting of a ready poured and sealed agar dish, a pair of nitrile gloves, a spray bottle of 70 % isopropyl alcohol, a liquid culture syringe of Pleurotus citrinopileatus, two strips of Parafilm and a fresh sterile 21 gauge needle. The proceedings and results of this workshop were mixed.

### *4.3.3 Workshop: Growing Fungi on Straw*

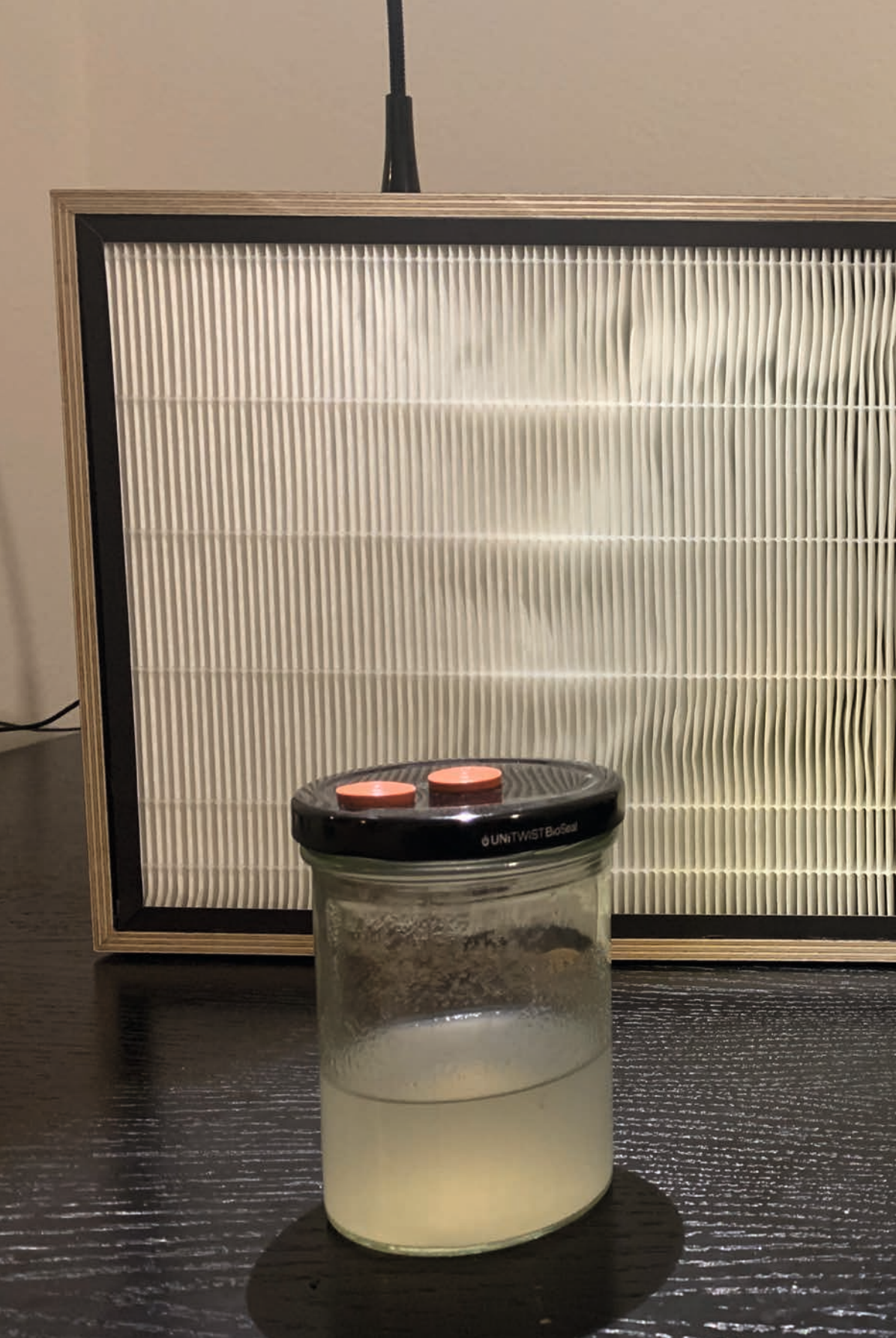
In May, I held a small scale workshop with two primary school teachers from Zürich. We prepared pure straw substrate in mushroom grow bags and pasteurised the substrate. We then inoculated the two bags with Hericium erinaceus and Ostreatus citrinopileatus.

### *4.3.4 Workshop: Growing Fungi on Wood Chips*

For another primary school teacher from Graubünden, I held a workshop on growing Shiitake on pure wood chips in a litre jar. We filled the jar with mixed soft- and hardwood substrate and sterilised it in a pressure cooker.

### *4.3.5 Workshop: Growing Fungi on the Schoolyard*

In mid-may, I visited two school classes of each around 25 6th grade children. In 4 groups, the classes cycled through different activities during the two days. We prepared straw and cardboard, hardwood chips and wheat bran and agar substrates to grow a selection of mushrooms.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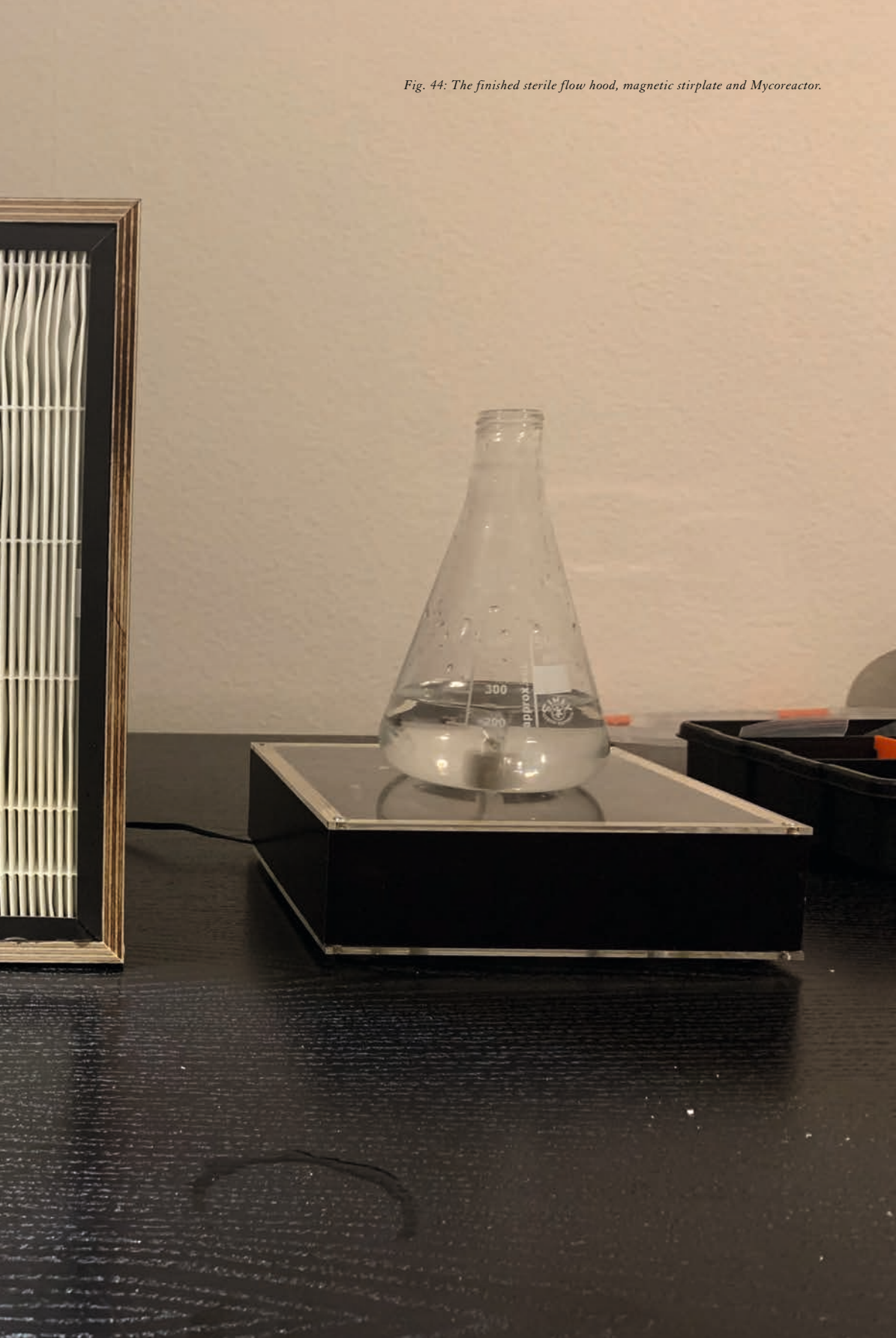


*Fig. 44: The finished sterile flow hood, magnetic stirplate and Mycoreactor.*

### *4.3.6 Pilzbüssli*

The primary distinction between my mycology workshops and others is the strong emphasis on nomadism. Mobility enables me to visit communities in specific locations, that would profit from the mediated knowledge. When I choose a location to visit or am contacted by a community inquiring a workshop, I research the parameters in locally occurring species and ecosystems as well as potential for projects, be it in remediation or otherwise. Visiting the location of a toxic chemical spill I would ensure to empower the community with the means necessary for restoring the site in a mycoremediation project. This site specific practice is only possible by physically visiting these locations and communities. It was this concept, that resulted in physical facilitation of workshops and the mobility aspect of my project, compared to earlier ideas of remote and online workshops. Here, my concept draws strongly from a rich history and tradition of mobile facilitation of teaching, especially by the means of a bus or van.

One reference that has influenced my decision to move my mycology laboratory around by bus was certainly a school bus called Furthur. In 1964, Neal Cassidy and his Merry Band of Pranksters went on a bus trip to experience roadway America on LSD. Their aim was to create art out

*Fig. 45: A view of the Pilzbüsslis inside.*

of everyday life. (Wolfe, 2018) Although I regard the drug use around the bus with reserve, the general societal and political backdrop of the countermovement and the playfulness and creativity these road trips exhibited are prototypical to the Pilzbüssli. (Dodgson, 2013)

The Pilzbüssli is a living, developing artefact, that carries the spores of knowledge and experience from one group of participants to the next. Over time it will gain a rich history and a dense network will unfold across the map – very much like the archetype of mycelial growth.

### *4.3.7 Website pilzbüssli.ch*

The website pilzbüssli.ch serves as a public documentation of my project. It shows the timeline of all conducted workshops and serves as a central repository for the mycological protocols and hardware designs I created. It will also offer the communication of future workshops and allow participants to register for these. It will serve links to the platforms instructables.com and github.com, where my designs are available for download in their latest iterations and can be discussed by the public.

*Fig. 46: An empty flightcase and the incubator loaded onto the heavy duty drawer.*


ENTANGLED LIFE
MERLIN SHELDRAKE
MYCELIUM RUNNING

*Fig. 47: The nomadic mycology laboratory inside the Pilzbüssli.*

## *4.4 Results*

### *4.4.1 Cultural Probes: Spore Printing*

I quickly realised that my instructions were not clear enough and that some form of the written protocol was needed to ensure success for everyone. Also, time was short, with roughly 2 minutes. Another realisation was that remote teaching for a hands-on subject such as mushroom cultivation techniques is far inferior to in-person gatherings.

### *4.4.2 Kit and Workshop: Growing Fungi on Agar*

The agar cultures we inoculated during the course of this workshop all grew healthy, there was a contamination rate lower than 10 %, even without having a sterile environment at our disposal during the workshop. This shows that diligent sterile technique allows for good results even without the use of heavier equipment.

From this first in-person workshop I took many learnings on how to conduct such an event. I learned that a maximum of five participants is optimal. Also, handing out kits or other objects to the participants right in the beginning is guaranteed to distract focus of the group. Any introductions and theoretical knowledge should be presented to the participants in advance of handing out any materials. Bringing printed materials with clear instructions in text and image are recommended. The participants should be held on to follow the demonstrated steps in sequence and not to rush ahead executing future steps ahead such as unwrapping sterile equipment.

Another experience I made, was the importance of participants being aware of and emotionally committed to the goal and product of the workshop. In this first workshop all participants decided not to take their personal cultures home, but left them with me. My solution for this would be bringing permanent markers for participants to label cultures with their names and more clarity in demonstrating possible future applications for the product of the workshop. These points will prove invaluable for my future workshops.

### *4.4.3 Workshop: Growing Fungi on Straw*

The final results of the workshop are still to be evaluated. The participants are sending me pictures of their cultures regularly. After the first few weeks, one bag seemed to be contaminated by cobweb mould. The other seemed fine. The two teachers were excited by the possibility of holding such a workshop for their classes. So I planned to do a two-day workshop with two 6th primary grade school classes of around 25 children each. This workshop will be held in mid-may, after the school holidays.

### *4.4.4 Workshop: Growing Fungi on Wood Chips*

Since Shiitake is known to grow on hardwoods such as oak preferably, I regard this softwood substrate as experimental. For the first week, there was no sign of growth in this culture, and the participant is continuing to send me pictures regularly.

### *4.4.6 Workshop: Growing Fungi on the Schoolyard*

Visiting the school children at Schule Wehntal was a highlight for my diploma project. It represents the user testing for my designs that was strongest in quality and in quantity.

Conducting this workshop I was able to build upon my learnings from previous iterations. Still I did not improve thoroughly enough on some aspects. I had brought some printed materials, such as the illustrated portraits of all species the Pilzbüssli had available for cultivation, but not the printed pamphlets containing the used protocols. In a future iteration this will be an important improvement.

Splitting up a large group into smaller units that can individually be guided was a big improvement and allowed for much higher quality in mediation. Next time I will prepare the activities of the unguided groups in higher detail and make sure to have additional activities prepared to bridge waiting times.

*Fig. 48: Straw workshop with Daria and Luca.*

*Fig. 49: Students choosing liquid culture syringes with different species.*


*Fig. 50: Woodchips Shiitake workshop with Bruno.*


*Fig. 51: Inoculation of woodchip substrate at Schule Wehntal.*

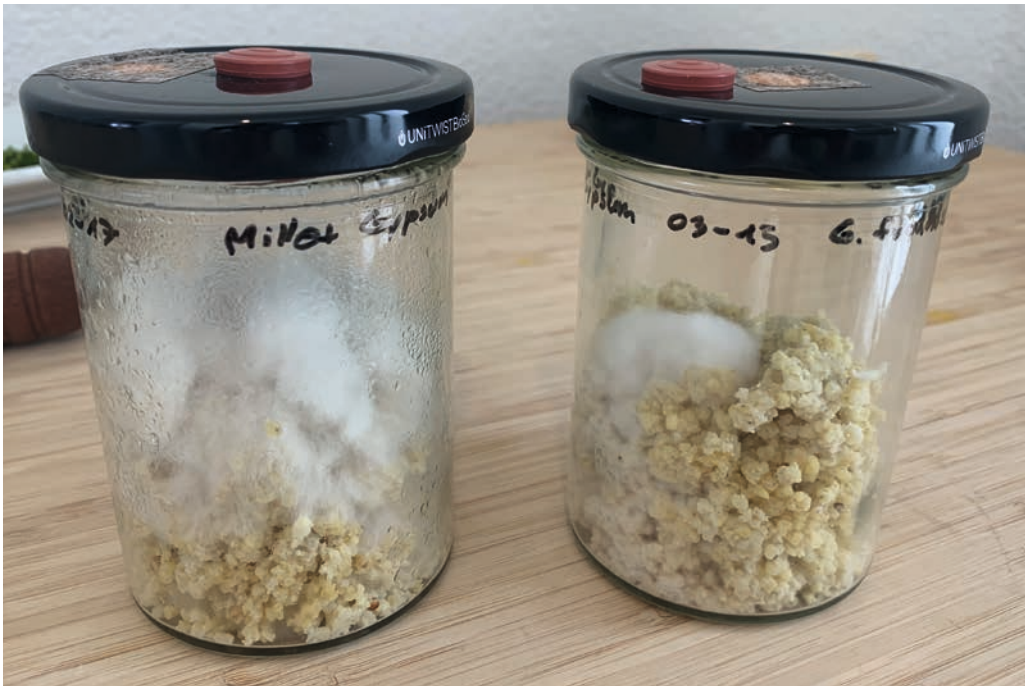



*Fig. 52: Millet grain substrates, 8 days after inoculation.*

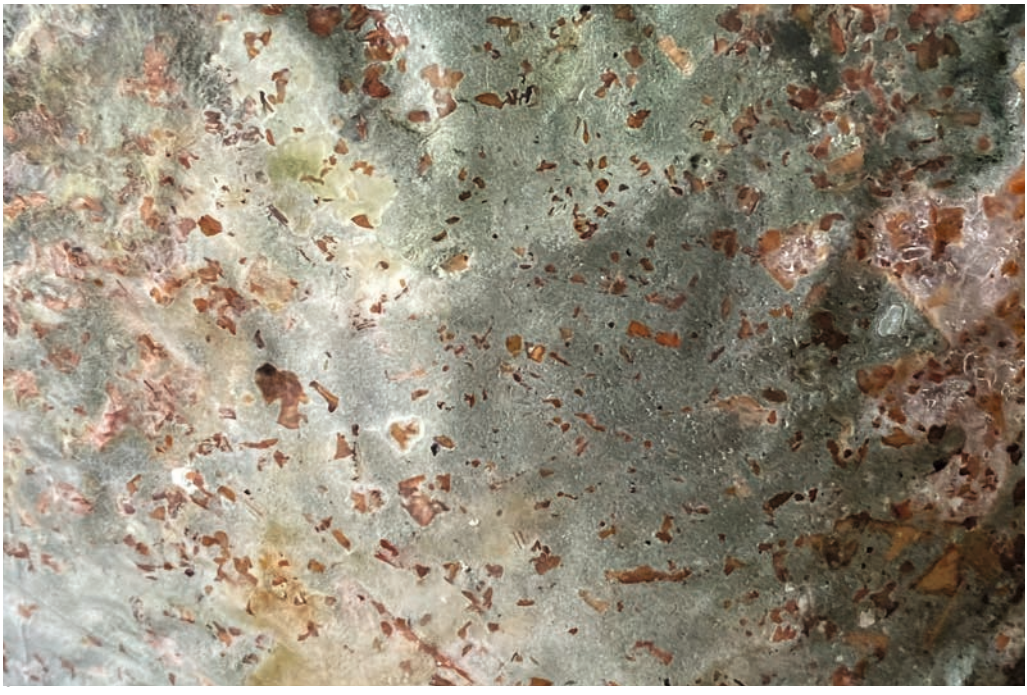
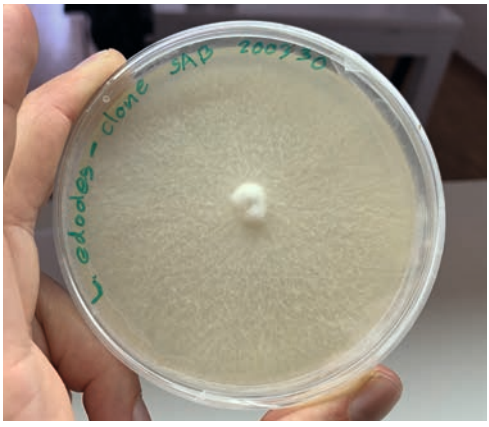


*Fig. 53: Fierce contamination of Coprinus comatus on woodchip substrate – most likely Trichoderma.*


*Fig. 54: Hericium erinaceus and Pleurotus citrinopileatus on millet substrate, 28 days after inoculation.*

*Fig. 55: Ganoderma lucidum on beech woodchips, 16 days after inoculation.*



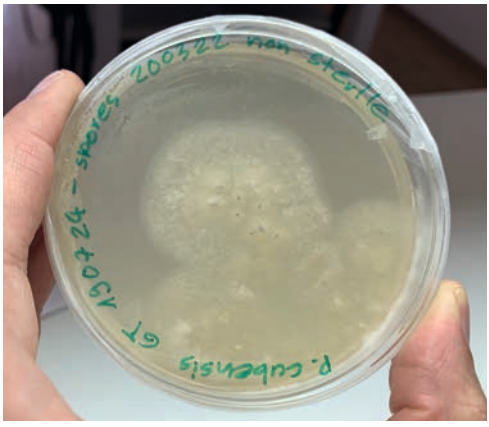







*Fig. 56: Agar cultures from my first attempts at the technique.*

*Fig. 57: Bruno is expertly knocking the air out of his filled syringe.*

*Fig. 58: Fadri is drawing up liquid culture broth from a jar.*

The feedback I got from children and teachers was very positive. The teachers said they valued the offer of guided activities especially in relation to the nature study curriculum. They mentioned they were always on the lookout for such opportunities, and that they are rare. Incorporating the practical experiences and learnings from the workshops back into the regular curriculum the children could connect the theoretical knowledge deeper. The children gave a range of positive feedback. A few mentioned aspiring a career in medicine and that they enjoyed the laboratory work we had done. They were visibly motivated and talented in handling syringes and Petri dishes. One of the groups asked when the Pilzbüssli would return again, they had enjoyed this escape from their usual curriculum so much. As they put it, «regular school is so boring compared to these two days». I ensured them I would visit again to see the fruits of our work. I also pointed out that this was to be understood as an integrated part to their usual curriculum rather than a separate thing.

Most memorable was one particular boy who did not show much interest in the activities on the first day. He seemed to quickly get bored and started distracting his peers. By giving a group of boys fooling around a special task, I was able to motivate them anew and keep them from disturbing the other students. On the last day the boy asked me if he could stay longer, since he had not conducted any of the experiments. He said he had suddenly found interest in the activities and would like to finish his projects. I offered to stay and guide him through the experiments if he would help me carry the equipment to the bus afterwards. We worked on his project with focus and a nice dialogue.

### *4.4.7 Public Reactions to the Project*

Sharing my work with people resulted in very helpful and motivating feedback. The sterile flow hood I built found much appeal at the WSL. A gave me commission to build one before even before he had physically seen the design. Another connected me to an artist collaborator who photographs their mycelium cultures. The photographer is very interested in the device and I expect to have a commission from her soon. It is rewarding to see people getting excited by my work and their disposition to pay hard currency for my designs.

The WSL also incorporated my liquid cultures into their «Mykothek», where they will be stored and maintained for decades to come. The archival of my cultures in their refrigerated and professionally maintained library makes me proud.

I had been sharing my process on the social platform reddit.com, particularly on the subreddit r/mycology. (Reddit, 2009) This subreddit has 312 000 community members and several hundred active users at any given time. I soon started getting messages from users worldwide. They encouraged me by sharing their interest and appreciation for my project. Many reached out to buy my liquid cultures and spore syringes. I am happy to share my work and if I can make a bit of a monetary income to compensate for my hobby that is even nicer. I plan on offering my cultures on a web store on etsy.com.

## *5.0 Conclusion*

In this chapter, I present the results and answers to my research questions and talk about future steps for my project and what it means to me personally.

One big question I wanted to answer in my thesis was the feasibility of mycoremediation projects as a designer. At some point in researching the science, I realised that I had fallen into a trap. I had read popular science literature and – as designers do – imagined fantastic solutions and applications for the research presented. I speculated about cleaning up lead ridden soils of Switzerlands some-thousand target practice shooting ranges or extracting toxic polychlorinated biphenyl (PCB) from the river Spöl. Reading the primary research papers those claims and speculations were based on again at a later point, I realised our knowledge of these phenomena are not very rigid. Presenting the bioaccumulation of lead in Pleurotus ostreatus as a fact with possibilities for practical application seemed not very robust of an argument. Much more research is needed, and the proper study of these applications certainly surpasses the scope of a bachelor diploma.

Coming to these realisations left me somewhat discouraged and lost. One way I could progress from here would have been by creating speculative design ideas for some of these remediation scenarios. Doing so would have certainly allowed drawing attention to the field. There are many examples of speculative design projects inspiring researchers out there. After some thought, I concluded that I could have a much more substantial real-world impact if I came up with ways of teaching as many people about the cultivation of mushrooms as I could. That was the solution that Peter McCoy proposes to tackle the neglect of mycology in the academic world – empowering citizen scientists with the tools and knowledge to conduct their experiments in a grass-roots fashion. I see this not necessarily as a negative answer to my initial hypothesis on mycoremediation. The result was a need to reframe and approach the field from a more fundamental level. My concept still had the same far aim. If people gain knowledge about fungi and learn about their cultivation, they will discuss and experiment on the remediation strategies from a factual position based on their own practical experience.

The future steps for the Pilzbüssli are clear. I have received many inquiries for further workshops and general reports of interest in the

project and the topic. At least over this summer, after my graduation, I will continue conducting workshops. A workshop is planned for a few friends from different circles that have asked for participation. Visiting more primary school classes would be great. I am in contact with three primary school teachers and hope to organise another visit before the final presentation of my diploma.

Further, I have more improvements for the laboratory equipment and the space organisation in the bus in mind. Every iteration of workshops yields a new list of things that can be improved or are missing. For example, it would be great to have a solar panel and battery onboard to grant independence from unsustainable power sources such as the gas burner or gasoline power generator when working on projects in remote places. The pamphlets containing the mycological protocols and the build guides for the laboratory equipment are subject to constant iteration.

As to how mycophobic people could be turned into mycophiles, talking to participants in my workshops indicates success. I found hands-on work in the cultivation of mushrooms to lead people to a closer, more positively connoted relationship with fungal organisms. Fear of the unknown and of possible toxicity turned into a critical interest in researching the facts on an encountered species. I met people who looked at the fuzzy growth in liquid culture jars and myceliated petri dish only from a far distance and uttering sounds of disgust. After hearing about the biology of the fungi and getting their questions answered, they lost fear of touch. Some of them had the most fun at transferring mycelium from one agar medium to the other. They started touching the glibber in a culture jar and describing what they felt. Even following the sterile work protocols and handling syringes and needles was suddenly okay because of understanding what aim their work followed. They had achieved their first steps towards Mycoliteracy.

For me, working on this project had a powerful impact on my career choice. I decided to follow my desire to become a biologist and enrolled for the bachelor in biology at the University of Zürich. Through this diploma, I uncovered a long lingering wish, going back to a deep curiosity in my childhood to study all things related to life. Following this path will enable me to take advantage of my strengths in comprehending complex systems and researching and understanding various topics rapidly and thoroughly.

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## *Figures*

*(Fig. 02: on page 6)*
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