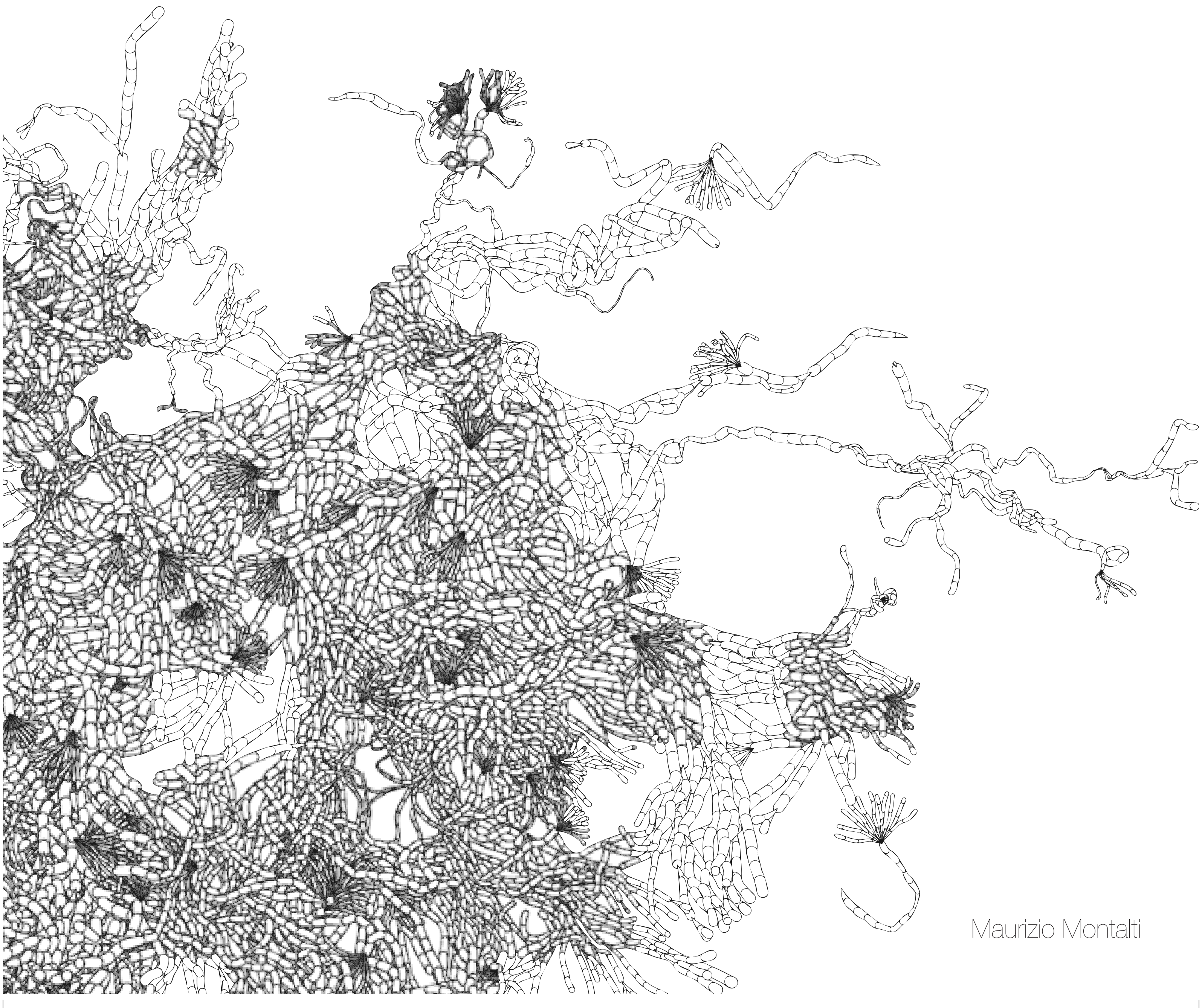
CONTINUOUS BODIES

cycles of decomposition triggering a symbiotic partnership between humans and fungi



Maurizio Montalti

CONTINUOUS BODIES

cycles of decomposition triggering a symbiotic partnership between humans and fungi

completed in fulfillment of the requirements of Master Thesis
by Maurizio Montalti

IM Master Course - Conceptual Design in Context

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The spirit of this thesis is inspired by Edward Wilson's leading scientific theory[1], guiding through a connection and love of all living things. That all life is interconnected and ecologically bound.

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Abstract

In my investigation I look at physical death and physical decay as natural processes, without which there could be no new life.

Throughout the process, I find myself operating as an interdisciplinary translator, facilitating communication between different fields of action and in particular between biologic science and design.

My attention is primarely placed towards a better understanding of the realm of fungi and at their fundamental importance in the environment with regard to decomposition and transformation of both organic and inorganic substrates and the resultant cycling of elements.

By directly collaborating with mycologists, I explore the potential of recent scientific discoveries related to fungi's abilities, in order to open up to a general audience the content of subjects otherwise out of reach.

This process lead me to create two different projects - one organic, one inorganic - through which I make use of these organisms, envisioninng alternative possibilities, while questioning different attitudes related to modern human culture and "development".

Within this context I try to inspire and stimulate a reflection leading to a requalification of the general perception towards the fungal kingdom and to the acceptance of the necessity of a true re-connection with the natural world, for a reciprocal symbiotic exchange of benefits.

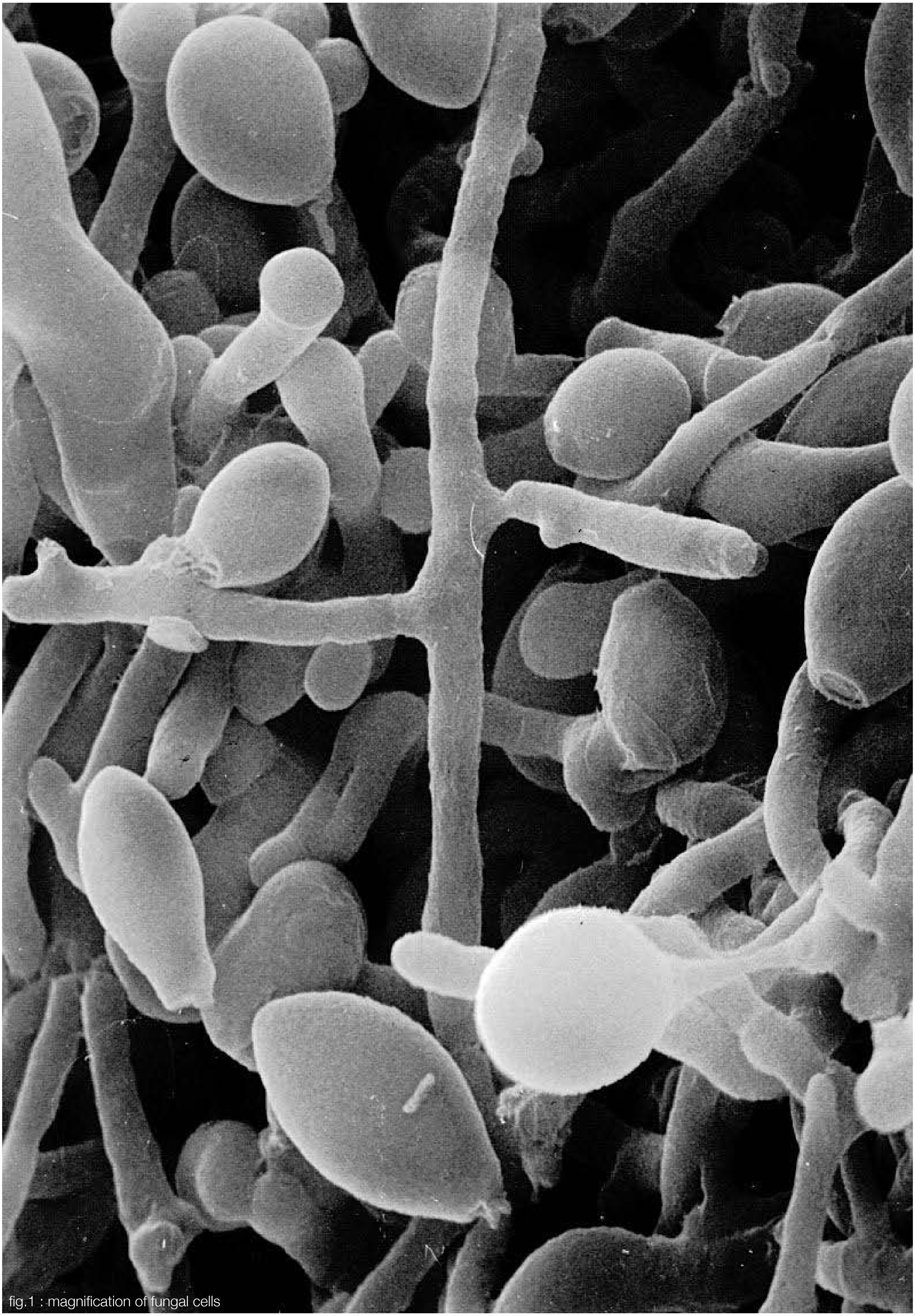


fig.1 : magnification of fungal cells

Introduction

The “Continuous Bodies” are intended as systems in themselves and points of accumulation in the course of larger cycles.

I am a designer interested in life and in bigger and smaller insights about it. What i try to do is to use design to explore the implications of emerging, unfamiliar “technologies” related to the natural world, we’re also part of; I think that the role of design includes imagining and designing compelling narratives that allow us to question our unprecedented future.

I feel this approach to be vital if ever we human beings are willing to learn to live in sustainable, symbiotic relationship, rather than at odds with our natural dynamic neighbourhood.

In this way I use design as a tool and a strategy for questioning culture.

By exploring the fungal kingdom, I discovered their extreme similiarity to human beings and their ability in performing a lot of different fundamental activities that allow us and our planet to survive: fungi are both the grand molecular feeders and disassemblers of nature.

Within my process I developed **two different scenarios**, through which I make use of two specific fungal species - *Schizophyllum Commune* and *Phanerochaete Chrysosporium* - designing with them both “for life and for death”, highlighting the complementarity of these two existential parts.

In the first part of my project my attention is mainly placed on the human body. For the development of this part I worked and experimented with *Schizophyllum Commune* employing it in performing the role of main “disassembler” within a new burial practice.

With this I aim to **explore and demistify denial and anxiety, related to the acceptance of the loss of a loved somebody**, by transporting the process of decomposition of human remains to a more natural level, through an ecological connection with our changing environment.

On the other side and as a direct continuation, I direct my attention to the study and the application of *Phanerochaete Chrysosporium* to things that do not exist in nature, materials that do not naturally decompose and that are found to provoke unhealthy, risky consequences; by doing so I create an image to tell a story, a social narrative that can help us **questioning our “throw away” culture and the same time exploit, in a beneficial way, the resources that this social behaviour created.**

These insights have been set within the context of understanding complex ecosystems and how we can best study and connect with them. **I believe we could benefit from starting becoming symbiotic with other organisms, by learning how to communicate with them, reciprocally understanding and exploiting each other in a mutual beneficial way.**

The fungus provides a welcome element of poetry, individuality and spontaneity.

The fungus takes a supporting role: furthering the healthy development of the Social Culture.

1

HYPOTHESIS

fig.2 : fungal spore

Hypothesis

Through scientific analysis of data and visual experimentation, the intention of my exploration is to be able to create a shift in the perception of the generally ”unknown” wonders of life and in the beauty of the decay and in how, by observing them, we could amplify the awareness of us, the human beings, as part of a complex system in which the pattern of life repeats as a paradigm on the macro as well as on the micro scale.[2]

PERCEPTION SHIFT

The human being seems to feel repulsion for some kinds of organisms, that are supposed to be dangerous and harmful for the human body. This certainly applies to spores and fungi. We could call it “mycophobia”, the irrational fear of the unknown.[3]

How could I develop something beneficial and attractive out of what we generally tend to associate with disgust?

Fungi are everywhere - beneath your feet, almost everywhere you look, and even in the air you breathe. Without these strange and fascinating life forms, neither we, nor the inhabitants of our native forests, would survive for long; this because they are both the grand molecular feeders and disassemblers of nature. Fungi are a fruit of decay and of its beauty. They are an active methapor of the cycle of all things.

Could we make use of fungi’s activity and knowledge as a guidance for better understanding the cyclicity of life and consequently accept death?

LIFE,DEATH, CYCLES

I’m extremely fascinated by the human body, considered in its whole incredible complexity, a universe in itself, and at the same time so incredibly ephemeral and temporal.
In my research I investigate the role of body during life, at the end of life and beyond.

So much of life is about loss. Going through life is to endure a series of losses, which include the loss of health, roles, identity, homeland, and loved ones through betrayal or death. Grief is the normal emotional response to loss, a response all too familiar to us.

I consider life and death as two sides of the same coin. There is no life without death and there is no death without life. On the contrary, traditional existentialism focuses on how people make sense of life in the shadow of death.
In particular **the Western model of death is one of euphemism and denial** sequence of stages: denial, typically followed by anger, bargaining, depression, and if one is lucky, acceptance.

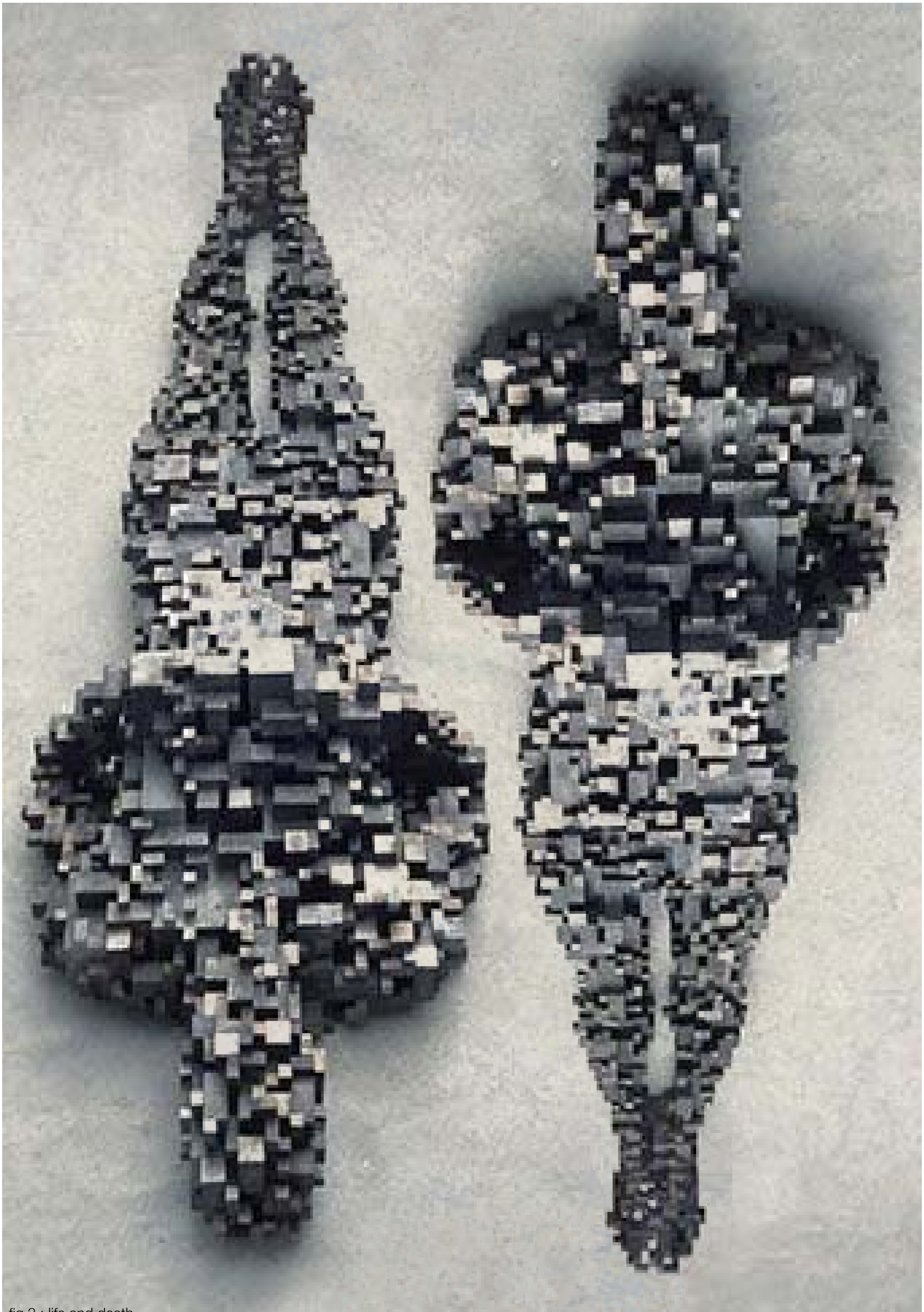


fig.3 : life and death

Of course there is a great deal of anxiety involved in embracing and accepting the loss of a loved somebody. Getting inspiration from Alan Rayner's theory[4], **I propose that an "inclusional life" is one which does not merely suffers, but explores the stages of a continuous transformation and a final decay.**
Decay leads to death. On a human level death is loss.

Through my first project I try to explore this anxiety, and hopefully demystify it, through the design of a new burial practice.

In almost every culture, when an individual is prepared for burial or cremation, his body is dressed in a garment that will literally and symbiotically become part of the body during the decomposition process.

But if we are no longer dressing for life, what are we dressing for?

Which considerations are involved in the rituals of death?

I aim to offer a new alternative to the traditional attitudes, that overtake the current western denial of death, by exploring the relationship between nature and deceased body, through an ecological connection with our changing environment.

Rituals shape the sensitivity of society and often incorporate hidden goals that are directly connected with profit and control, without creating any "cure".

I believe it would be better if we would allow and encourage Nature performing her job, instead of neglecting our own belonging to Nature itself.

MODERN LIFESTYLE AND TOXIC MATERIALS

As a following step of my investigation I ask myself if it could be possible to transfer the analysis of the process of decomposition to inorganic materials that do not naturally decompose and that are found to be harmful for the human being.

By analyzing the quality of the indoor environments, which are the places we, humans, use to spend most of our time in, research has shown that they are far more polluted than we use to think.[5]

It's important to notice that most of the toxic compounds that we usually unconsciouly breathe come from plastic.

Not only we are surrounded by it, but generally when we dispose of these materials they usually get accumulated in landfills with no possibility to degrade; they are spreaded in the environment, enter the food chain and affect the entire ecosystem, until they come to us.

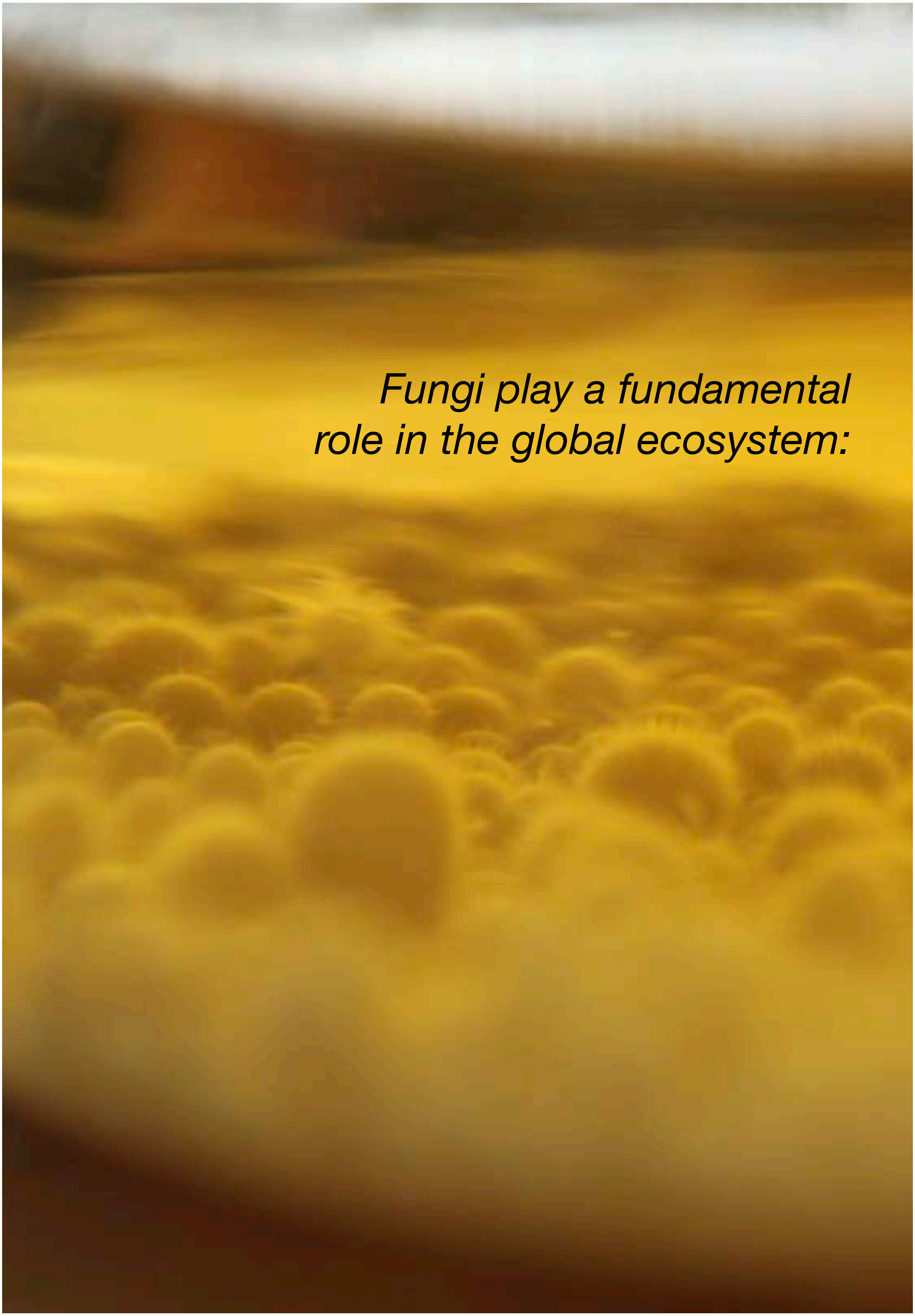
As a result, this toxic pollution lives inside of us and it's quickly accumulating: it has become something "personal", a part of the background chemestry in our bodies.[6]

Could fungi be able to open up new possibilities and provide us with responsible solutions in remediating the harmful consequences that our modern civilization has been creating during the last century?

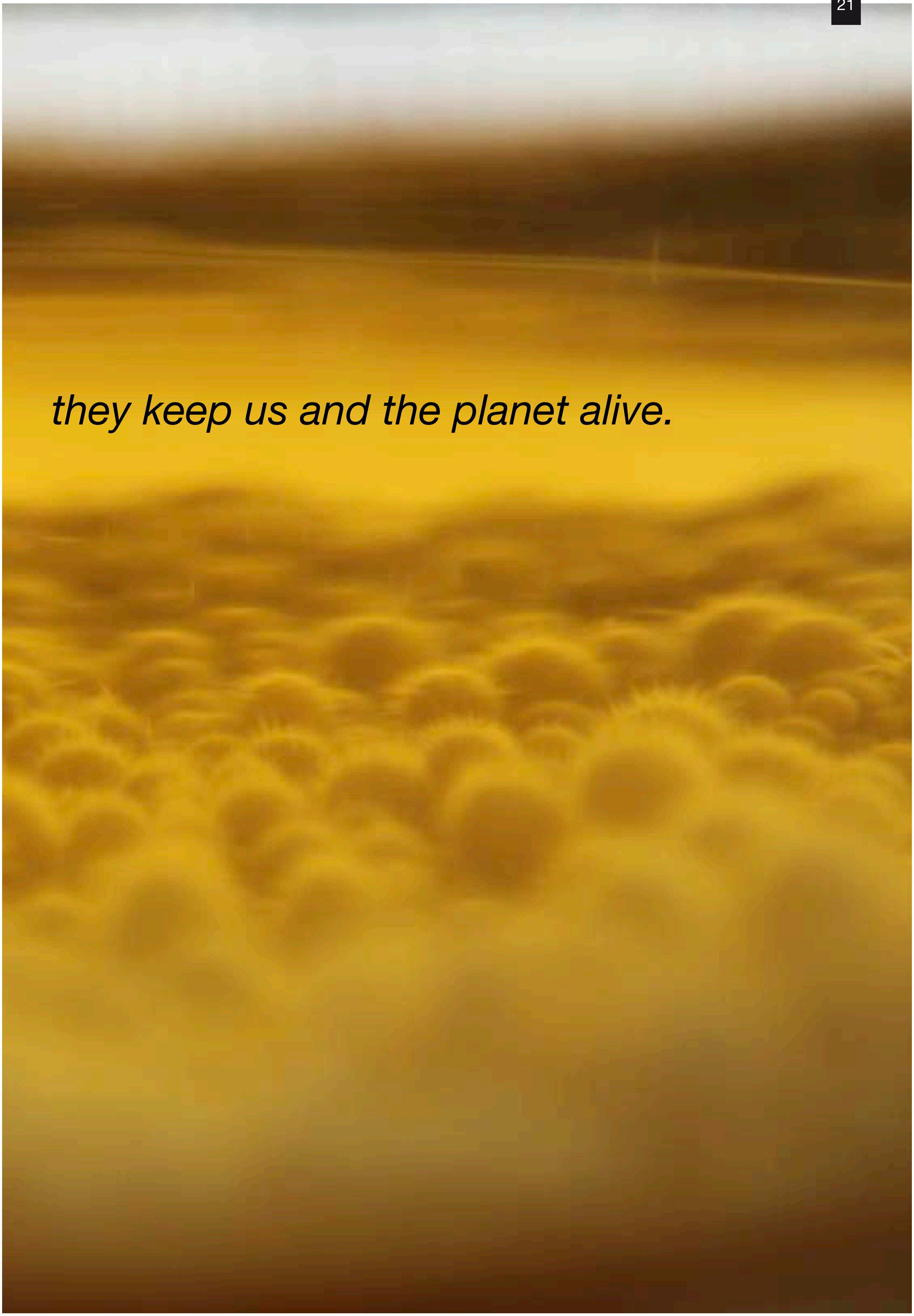
...if we are no longer dressing for life, what are we dressing for?

fig.4 :current burial dresses and rituals

fig.5 : body and nature



Fungi play a fundamental role in the global ecosystem:



they keep us and the planet alive.

2

RESEARCH

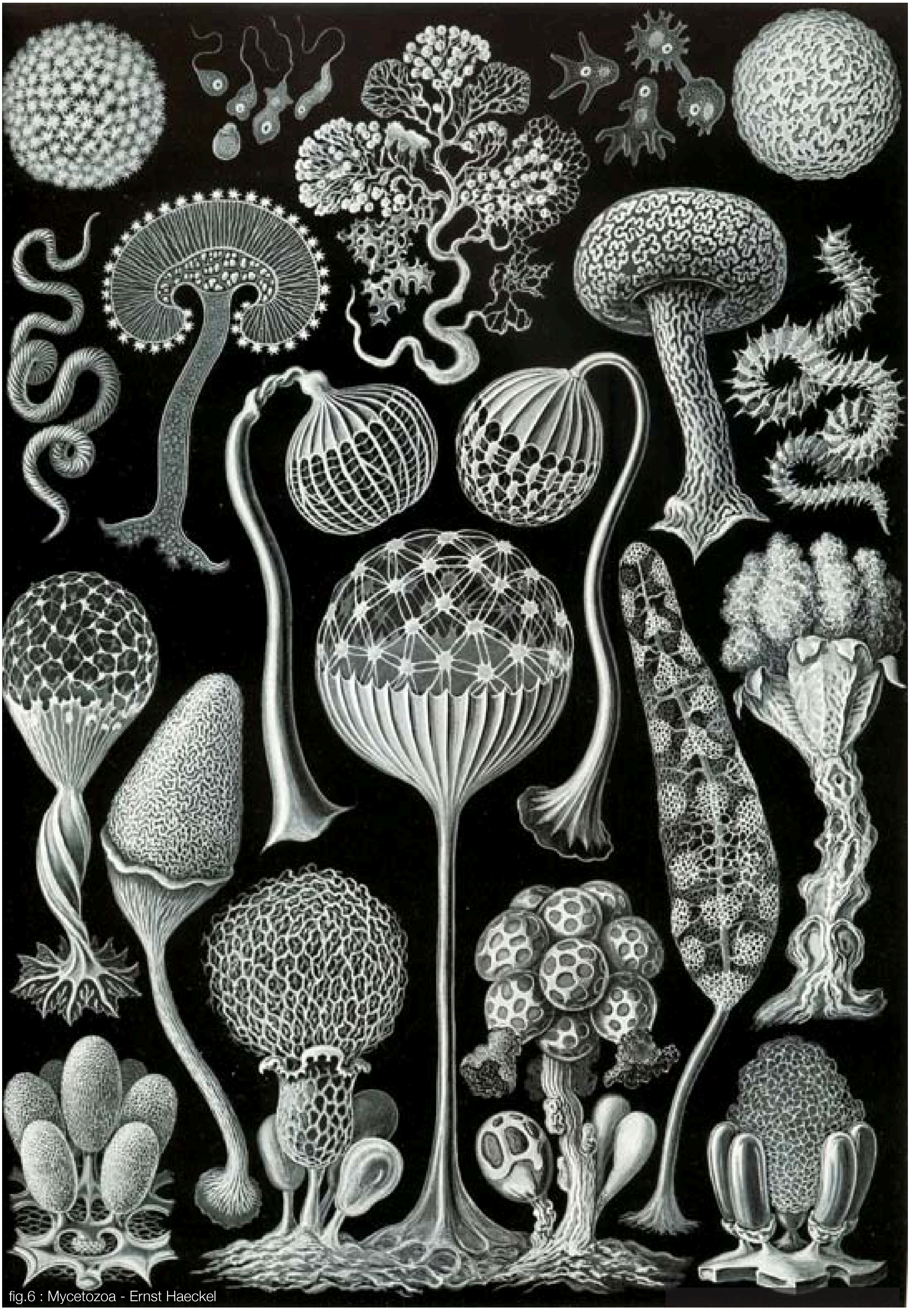


fig.6 : Mycetozoa - Ernst Haeckel

Research into mycology

By looking directly at the symbiotic inter-relation between human being and fungi I take a step into a “nowhere land”, as few research has been conducted until today in that direction.

METHODOLOGY

My process developed by collaborating with mycologists (mycology is the branch of biology concerned with the study of fungi) and researchers from the “Utrecht University” and CBS; by directly discussing my vision together with them, while also experimenting in the laboratories, I’ve been able to directly test and verify scientific truths as a basis for the progress of my work.

The establishment of this close collaboration is the way I choose to add value to my research; by using scientific data and techniques that make possible to visualize the aesthetics and the functions of technical informations, I aim to open up to a general audience the content of subjects otherwise out of reach.

I investigate the borders between different fields of action: design, science and industry. This in order to establish a connection that could give life to a “marriage of disciplines”, creating reciprocal benefits that could end up in new perspectives and thoughts.

WHAT IS A FUNGUS?

What we call a mushroom is the reproductive organ (“fruiting body”) of a larger living entity, the mycelium. A mushroom is a small part of an organism that is mostly hidden from view, living as long strands of cells that grow in the ground or inside of dead and dying trees.

A mycelium (fig.7) can be miniscule: spreading though the body of a dead ant; or it can rank among the largest, heaviest and oldest living things on the planet.[7]

While the individual threads of hyphae are microscopic, there are so many of them, often clustered together, that they can become visible to the naked eye (fig.8).

Fungi are everywhere, almost everywhere you look, and even in the air you breathe; they could colonise from spores or mycelium originating from within or outside the nutrient source.

The fungi have made up their own kingdom since the late 1800s, but we understand now, better than we used to, at least, what they are. Like us, mushrooms don’t like to rot from bacteria, and as we share in common the same pathogens, our best antibiotics come from fungi.

What is harder to take is that these disreputable organisms are our kinfolk. **The fungi are not plants at all; they are closer to animals, to us.**

Whereas plants get their energy directly from the sun and atmosphere using photosynthesis, fungi get theirs by digesting living or dead organic matter, as animals do. Fungi work their way through or over their food, absorbing nutrients directly through their cell walls and simply grow into new food as the local environment becomes nutrient depleted.

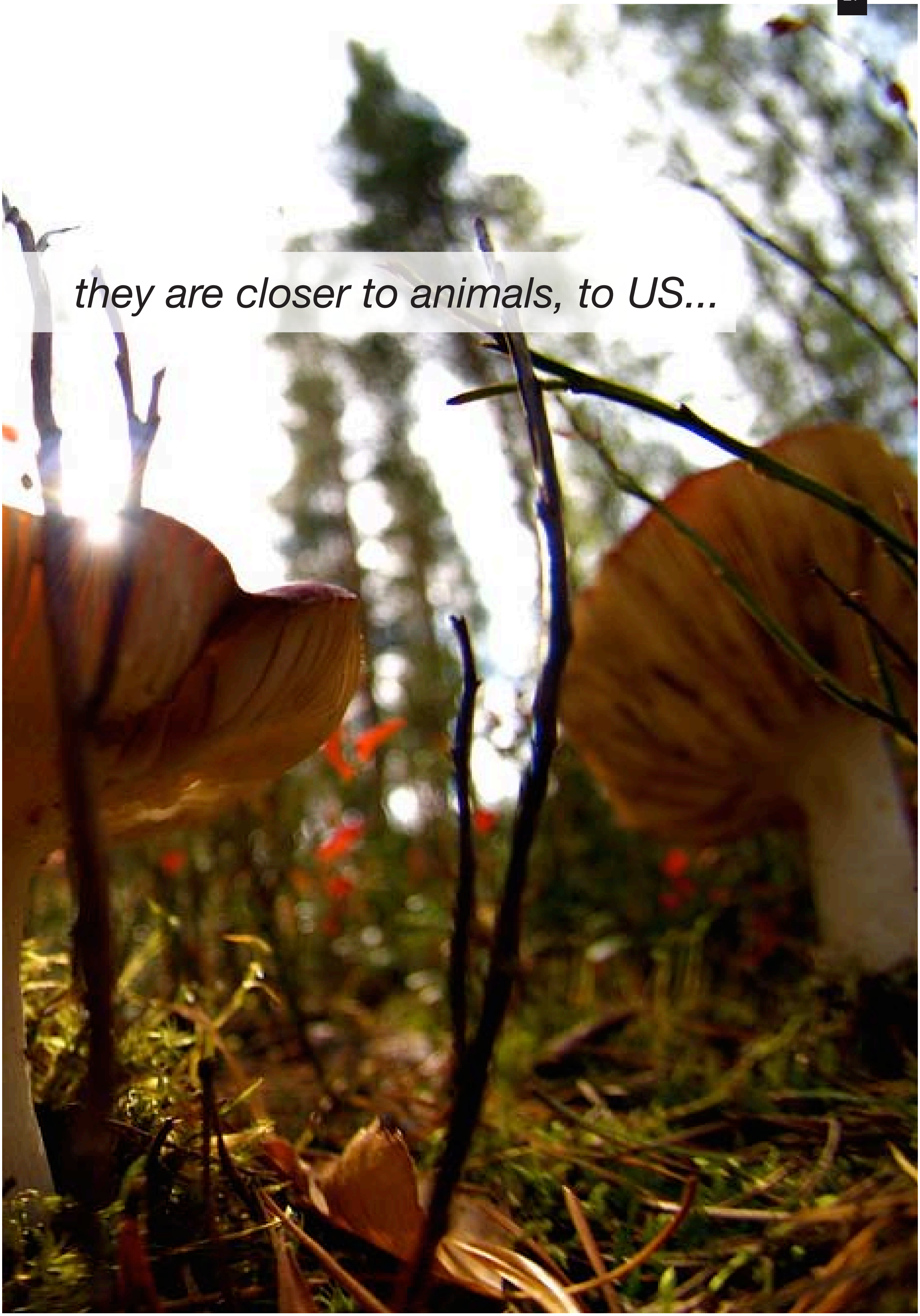
The key role of these recyclers is to break down any dead matter and return the nutrients to the soil to become available to plants once again[8] (fig.9).

The fundamental importance of fungi in the environment with regard to decomposition and transformation of both organic and inorganic substrates and resultant cycling of elements is of obvious relevance to the treatment of wastes, while the branching, filamentous mode of growth can allow efficient colonization and exploration of, for example, contaminated soil and other solid substrates.

In the area of environmental applications, harnessing of fungi in bioremediation of industrial effluents contaminated with heavy metals and other toxic substances is a major new development. Fungi have the ability to absorb heavy metals on their surface because of the charge on their cell walls. They are even able to bind metals because of their aptitude to produce certain metal binding peptides and proteins. Also, they are capable to degrade complex carbon compounds such as pesticides by virtue of an array of enzymes they normally possess.

The range of benefits they could provide us seems to be widely extended.


FUNGI are not plants at all:


they are closer to animals, to US...

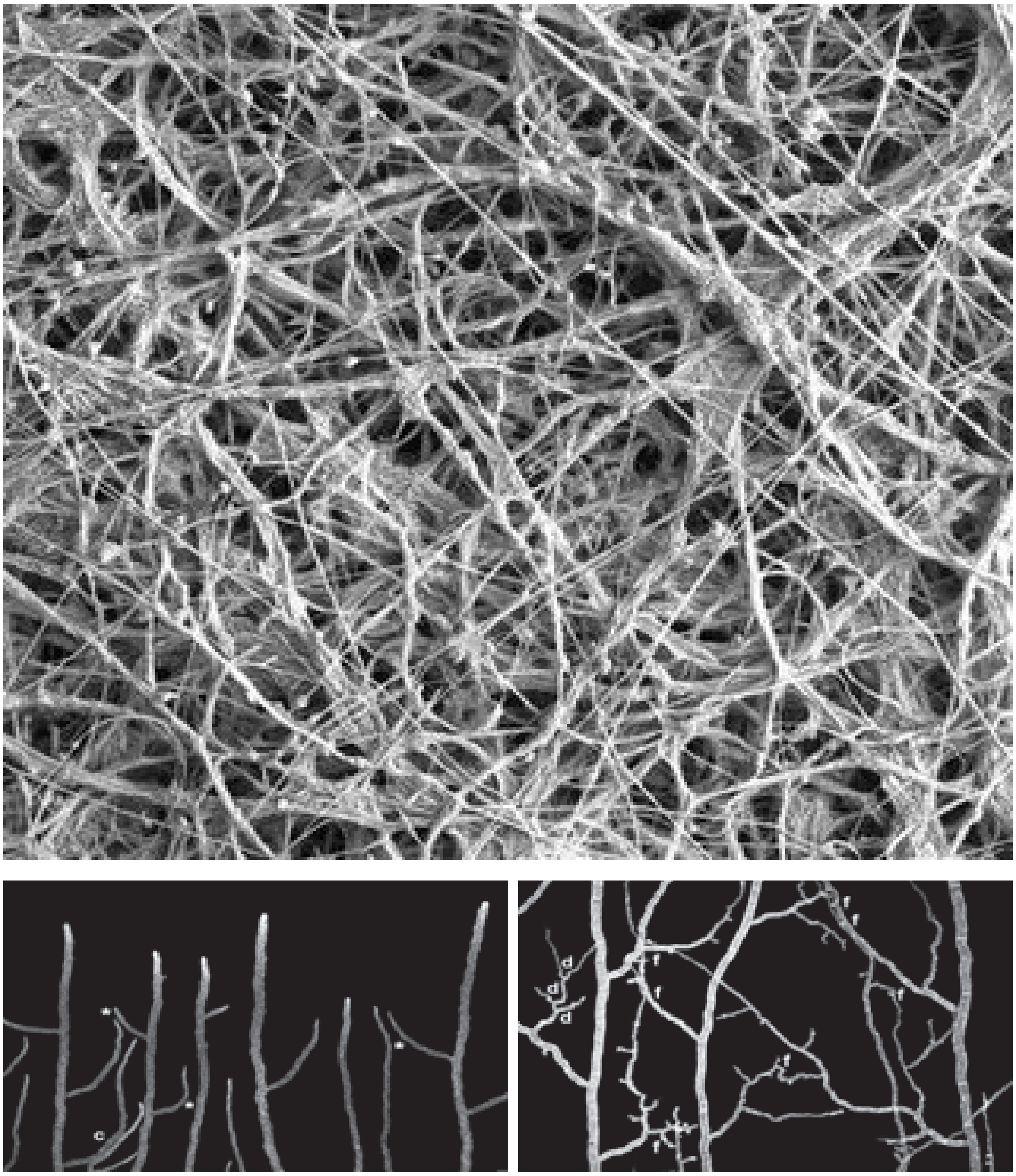


fig.7 : Mycelium - micro view

fig.8 : Mycelium on decaying matter

fig.9 : Mycelium providing nutrients to other forms of life

Symbiosis comes from the Greek "sym", which means "with" and "bios" which means life", so the whole word means "the state of living with".
It is the interdependence of life.

SYMBIOTIC RELATIONSHIPS

It is not only plants that live in symbiosis with fungi. We animals do it too.
Fungi, in particular yeasts, are normally found on human skin and in most locations of the human body. It is normal for yeast to be present in living creatures.

We are mutants evolving through the magic of symbiogenesis; this is the process in which two or more different organisms integrate in a mutually beneficial union.

Symbioses are widespread and central to the mainstream of evolution and are essential to existence.

Perhaps the most important role of ecology in general and of fungal ecology in particular, is to understand and appreciate the complex fluid relationships of life forms in the context of their dynamic natural neighbourhood.

The symbiotic phenomenon is a common occurrence rather than a rare event, and according to Margulis, "…it is a product of an evolving interspecific beneficial relationship."[9]

(Appendix - Symbiotic relationships between fungi and other species)

LAB RESEARCH

My main contacts and supporters have been Prof. Ronald de Vries and Dr. Ad Wiebenga, from the CBS – Fungal Biodiversity Centre – and Prof. Han Woesten, together with Dr. Karin Scholtmeijer, from the microbiology department of the Utrecht University.

Within the lab environment I performed a series of different experiments related to the growing of cultures and the subsequent observation of the interaction between fungi and materials (fig.10); this in order to understand how fungi prefere to grow and spread in different directions and attach to different kind of surfaces.

Thanks to these tests, I had the possibility of identifying some favourite materials that fungi like to grow on with a fast response; in particular, fabrics, paper, and cotton-like materials. In the case of *Schizohphyllum* it was interesting to notice, regarding the behaviour on fabric, the fact that the strain immediatly started to produce fruiting bodies, differently from the usual attitude on flat petri-dishes, in which mainly the mycelium develops extensively: these kind of observations created the basis for the rising and development of my initial design idea, leading to my final proposal.

(Appendix - Working in the microbiology lab)

fig.10a : Material’s tests

fig.10b : Material's tests

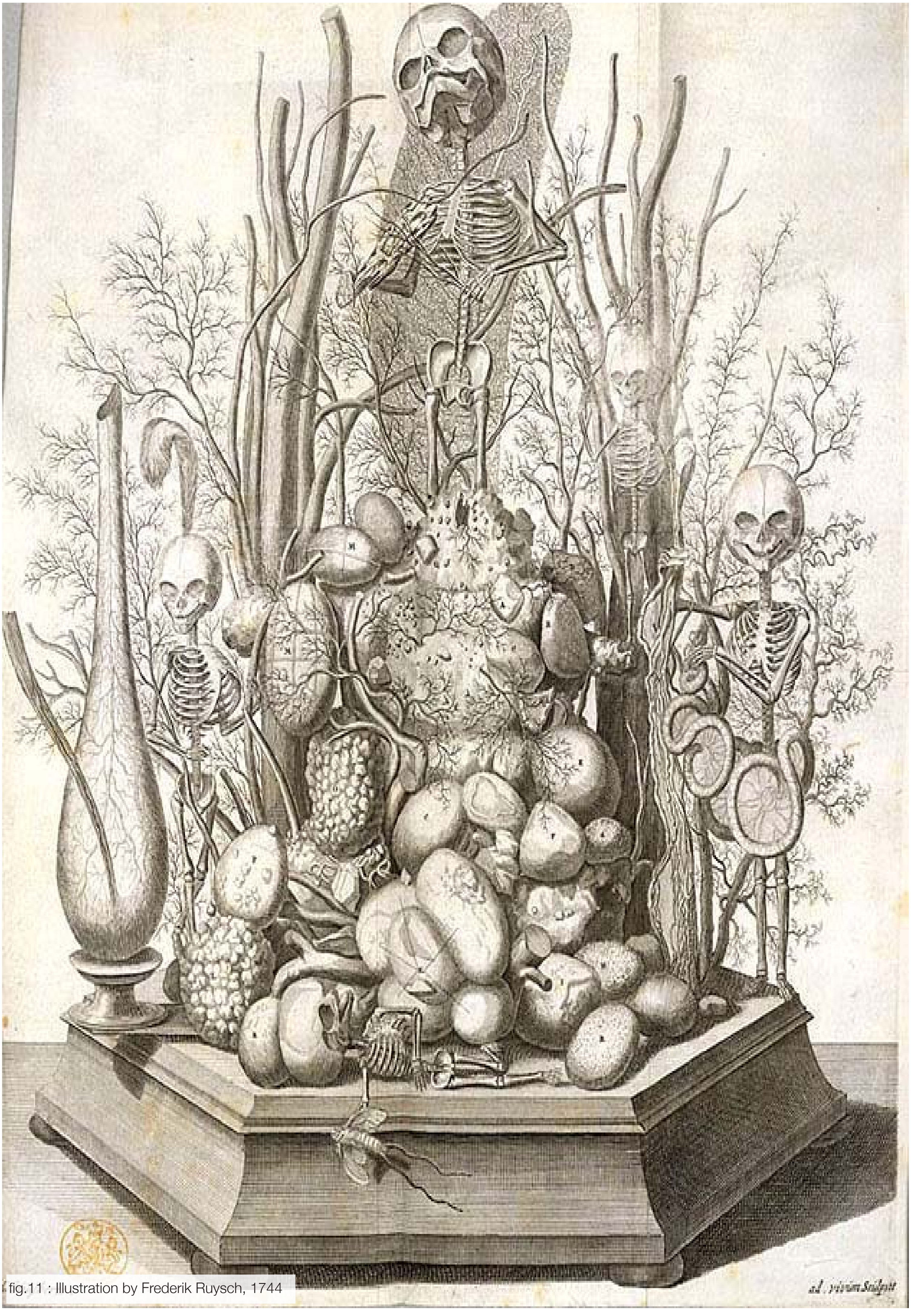


fig.11 : Illustration by Frederik Ruysch, 1744

Research projects

Organic: the funerary process

People consciously and unconsciously tend to defend themselves against the terror of death.
The defense mechanisms include denial, avoidance, cultural defense, and self-esteem.

(Appendix - Death and Grief)

This attitude is enhanced by current burial practices, like cremation and embalming, that act like a tool which gives power and reinforce the concept of denial; one example can be found in the elaborate, expensive display of an open casket with all the makeup and the clothing, enforcing the belief that the person is only asleep.[10]

There is another aspect to the funerary industry: waste management. **Cremation and burial harm the environment and waste energy.**

Cremation[11] pumps dioxins, hydrochloric acid, sulfur dioxide, and carbon dioxide together with mercury compounds into the air, the water and the soil.[12]
According to some estimates as much as 11% of UK atmospheric dioxin resulting from combustion comes from crematoria and dioxins are linked with all sorts of diseases including cancer.

Almost 90% of the coffins sold within the world's funeral industries aren't solid wood, but consist of a wooden veneer pasted onto chipboard; this contains the chemical formaldehyde that gets burned during the cremation process or which leaches into the soil as the coffin breaks down. Also the shiny handles are very rarely made of brass these days, but they are generally plastic replicas, again raising pollution issues.

On the contrary, in natural processes, the microorganisms that are involved in decomposition are not the kind that cause disease. And most viruses and bacteria that do cause disease cannot survive more than a few hours in a dead body.

(Appendix - Funeral Industry, fungi and related patologies)

The key role of fungi in the environment is the one of recyclers; they break down dead matter and return the nutrients to the soil to become available to plants once again.

Decomposition is nature's way of recycling the body's elements and we need to keep this in perspective.

While it wouldn't be wise to bury bodies very near a stream or water table, the natural microorganisms in the soil do a good job of breaking down and filtering the products of decomposition: "...although there is some evidence of microbiological contamination in the immediate vicinity of cemeteries, the rapid attenuation of these microorganisms suggests that they pose little risk or none at all."[13]

IN THE LAB

During my personal process of experimentation in the laboratories of the Utrercht University, the observation part took a main role; by growing a culture on agar medium with a single strain of "schizophillum commune"[14], I noticed the property of this species in developing a highly hydro-repellent mycelium. This surface, looking like pure cotton, allows the water to evaporate, but not to penetrate. **When wet the "mat" is able to start acting as decaying agent**. Indeed, *Schizophyllum* revealed to be the ideal choice to bring forward the actual development of a material that would fit the needs of my design.

One of the main points that i had the necessity to clarify has been the understanding of the possibilities that the interaction between fungi and human tissue can create.

Thanks to the contribution of Prof. R. de Vries and Prof. H. Woesten, i found out that fungi can technically perform the role of decomposers also on human tissue, contributing to the degradation of human remains, as fungi generally love to feed on proteins: of course the complete process would happen in collaboration with other organisms, like bacteria.[15]

In principle human tissue is easier to digest than plant material.[16]

(Appendix - Working in the microbiology lab)

These considerations brought me to a final experiment regarding the possibility of growing a mycelium culture from schizophyllum on a textile surface, to be modeled on a body.

In principle fungi can digest
dead human tissue
more easily

than plant material, as they love to feed on proteins

...plastic might be quietly poisoning us!

Research projects

Inorganic: plastic and toxicity

FUNGAL BIOFILTERS

Mycological research has shown the ability of some fungal species in being successfully implemented in processes of biofiltration for air purification and water reclamation, mainly within industrial activities, like for instance the dye and paper-pulp industries.[17]

The study of the application of a specific fungus, *Phanerochaete Chrysoporium,* as a biofilter[18] has shown its rather good ability in removing gaseous aromatic compounds, solvents and more generally volatile organic compounds, from contaminated sites.[19]

It is interesting to notice that technically **every biomass placed in the environment is able to act as a biofilter** with different values of efficiency related to the closer achievement of the ideal conditions.

(Appendix - Fungi in Biotechnology: the cleaning agents)

PLASTIC “FOOD” FOR FUNGI

By analyzing the current progresses that try to implement fungi’s action in the development of biofiltering applications within industrial processes, I got in touch with recent researches that demonstarate the ability of a famous “white-rot” fungus (fig.12) in decomposing phenolic resins and more generally in degrading plastics.

Plastic is an odorless and tasteless parasite.

Only recently we became aware of the fact that **plastic might be quietly poisoning us** and this means that we are risking future generations with the cheapest, most ubiquitous, everlasting material ever invented.

(Appendix - Plastic: impact and exposure)

Research has shown that **some fungal species are able to grow on and degrade plastic** and *Phanerochaete Chrysoporium* has been studied as the model fungus in this field, due to its very good performance in achieving this goal.

Due to *Phanerochaete Chrysoporium* specialized degradation abilities, extensive research is seeking ways to understand the mechanism in order to enhance the bioremediation of a diverse range of pollutants. Therefore, *Phanerochaete Chrysosporium* is the first member of the Basidiomycetes to have its complete genome sequenced.

It has initially been found capable of digesting different kind of plastics such as styrene or formaldhyde polymers and it showed a rather good ability in chewing up pollutants such as polychlorinated biphenyls (PCBs), but only recently it’s been discovered its ability in degrading and literally feeding on polycarbonate and more in general phenolic resins, the most resistent and undegradable plastics ever produced.[20]

IN THE LAB

I started conducting different experiments in order to personally test and verify the process in which different fungal species and strains react on different plastic materials[21] (fig.13).

In order to try to visualize more rapidly the action of the fungus, I’ve choose to use small polystyrene models, as a theoretical simulation: this because the “DNA” of polystyrene and its overall structure is far less compact than the one of a tough plastic, thus allowing the fungus to penetrate easier within the “body” of the material (fig.14).

As prof. de Vries from CBS told me during one of our talks, a whole efficient process related to plastic degradation is not that simple and fast to be achieved yet: this because of the fact that this finding is still very young and in need of further explorations to gain extensive research, regarding the optimal conditions in which the process would happen.

Theoretically it would also be possible to develop a genetically modified organism that would be able to perform the decomposition of plastic in a faster way; the problem is that, particularly in Europe, this would not be possible at this time due to legislative issues.

Just the thought of having microorganisms work for you, simply by feeding them with natural and synthetic substrates and having hazards turned into minerals and nature’s own basic constituents, revealed to me really intriguing.

All these tests, considerations and discussions brought me to the definition of the way in which i thought it could be better to develop an efficient process, by objectifying a techno-biological discovery into a speculative product.

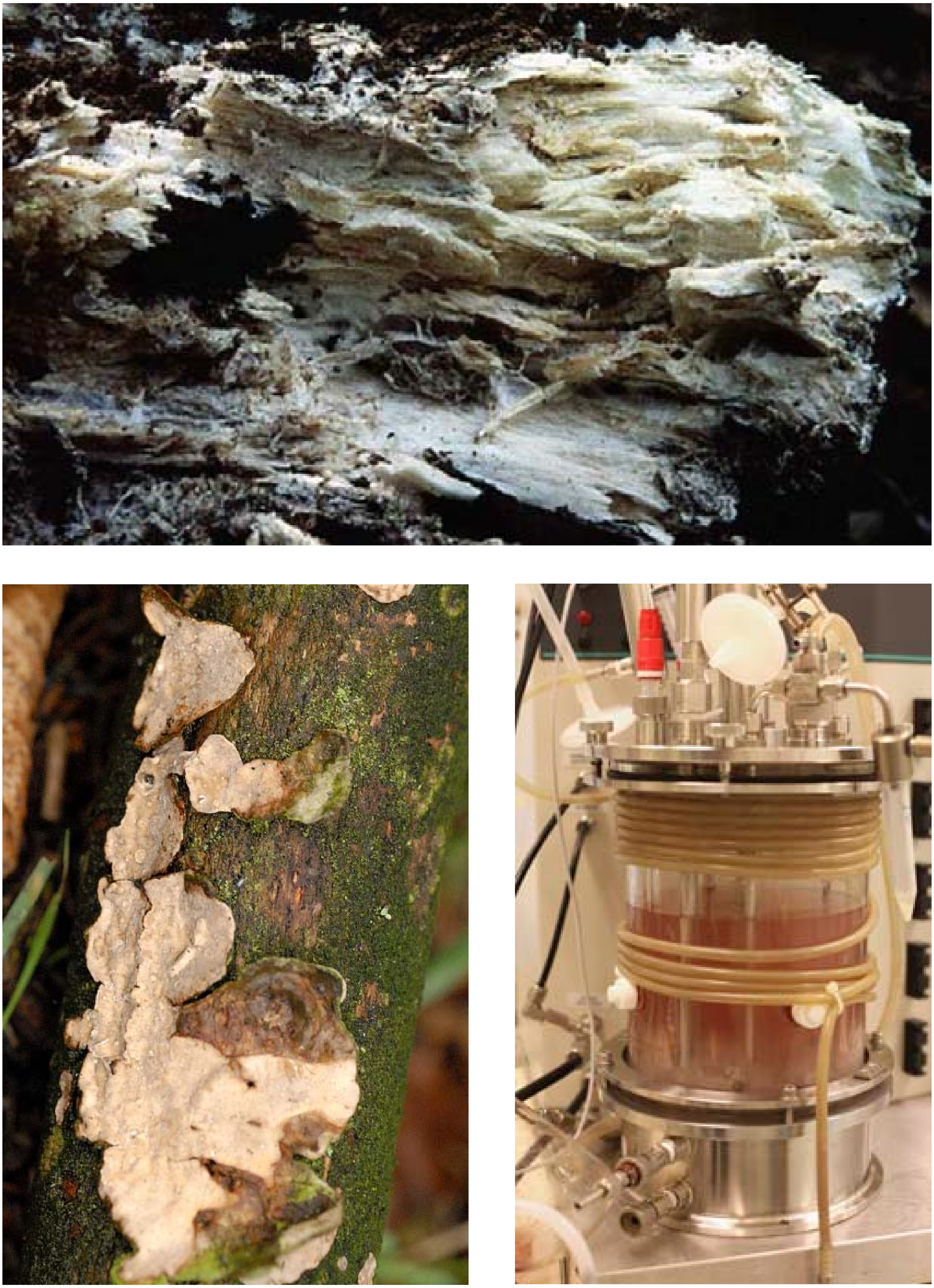


fig.12 : Phanerochaete Chrysosporium: white rot and biofiltering experiment

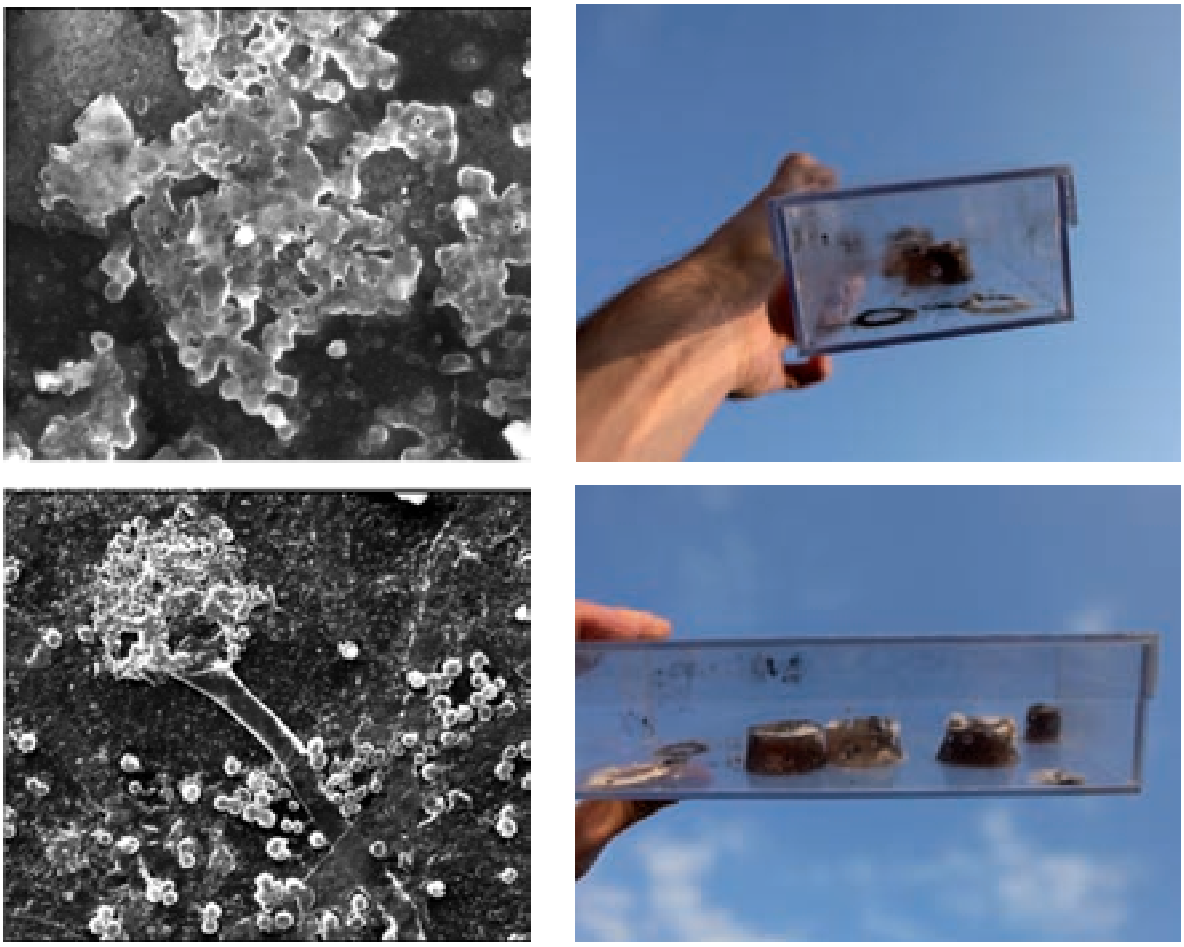


fig.13 : Phanerochaete Chrysosporium: plastic degradation experiment

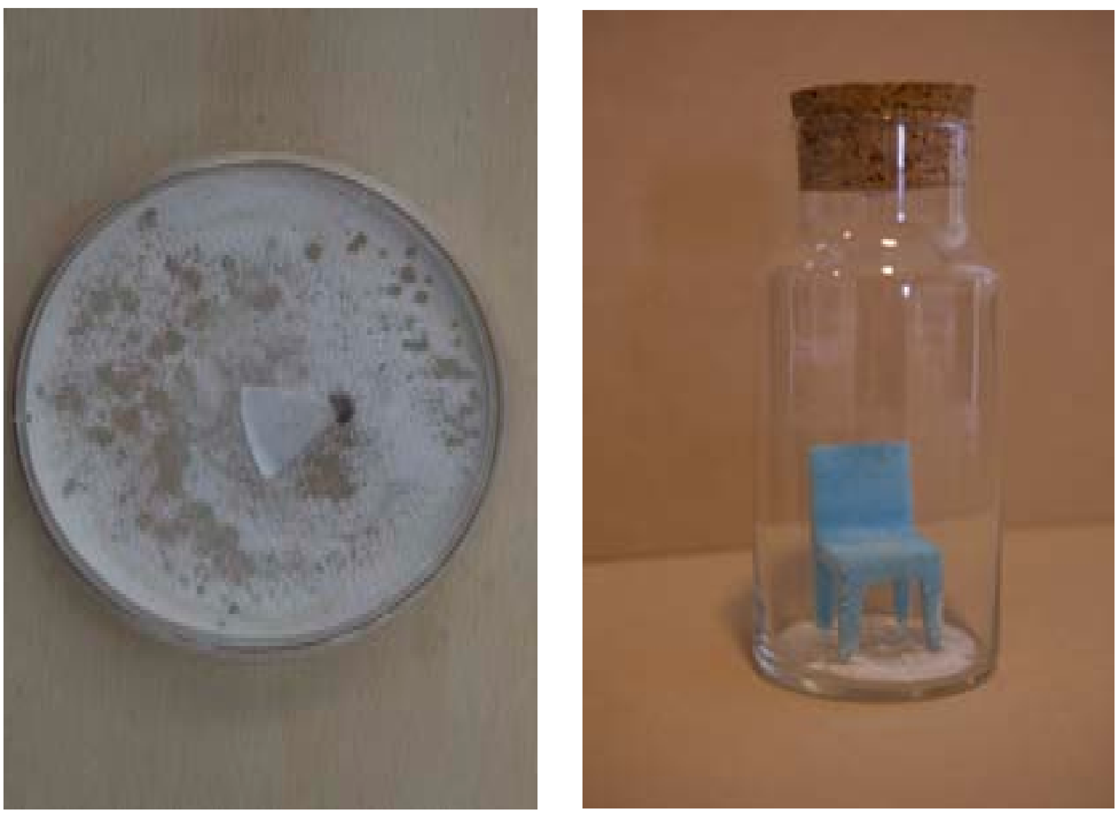


fig.14 : Phanerochaete Chrysosporium: experiment on plastic chip and polystirene model

3

DESIGN

"Suddenly I realize that if I stepped out of my body
I would break into blossom."
- James Wright -

Design

My final design project consists of 2 parts, that are a result of my process.

First Part
BODIES OF CHANGE:
the dynamic lifecycle of fungi as a remedy for denial

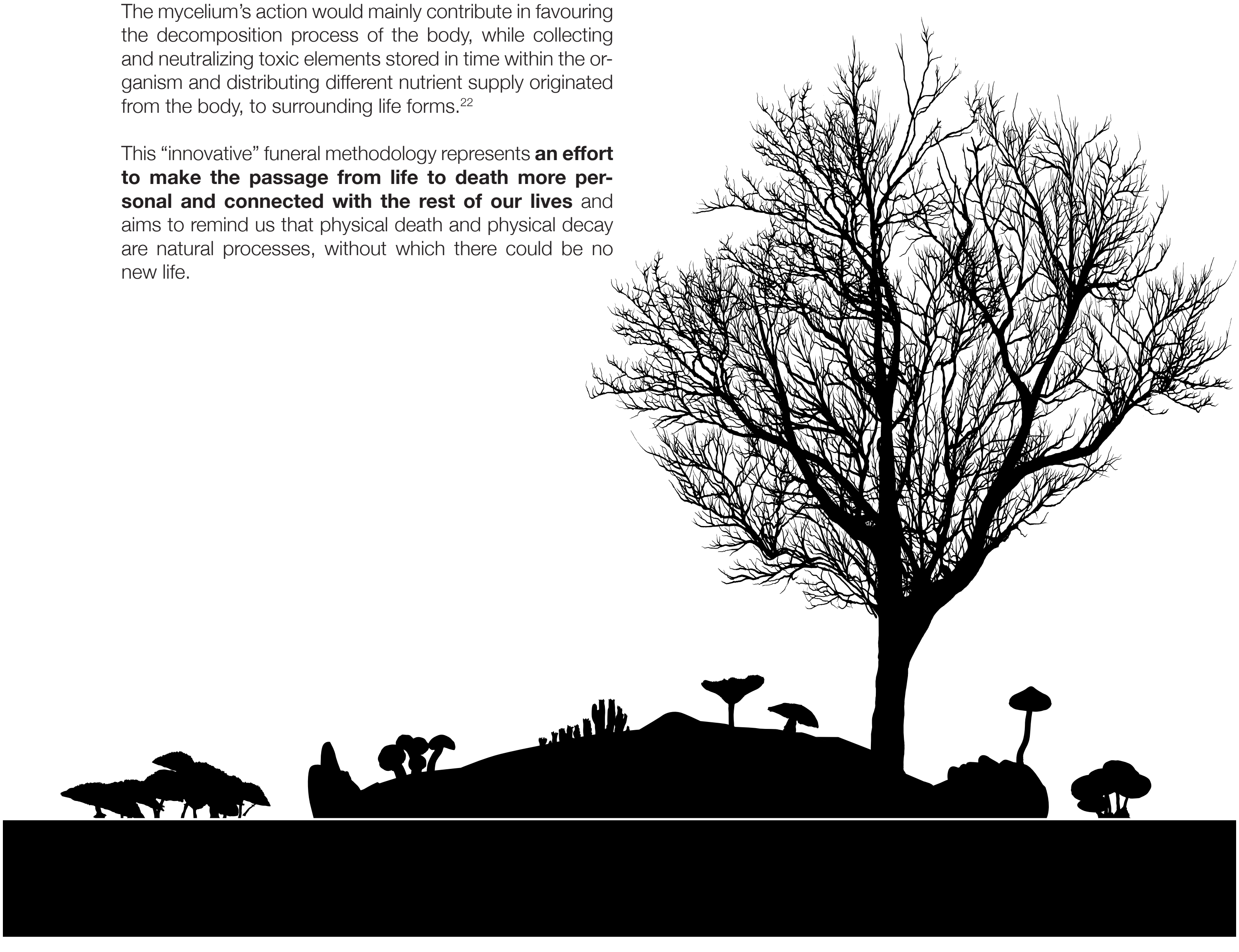
MYCELIUM SHROUD - WEARING FUNGI FOR DEATH -

After investigating current burial practices, i designed a new possibility and a new scenario in which **fungi act as the primary decomposition agent on the human body**.

This design, consisting of a shroud inoculated with fungal mycelia, is a **direct challenge to the general attitude of denial**, that most of the traditional practices tend to enhance.

The mycelium's action would mainly contribute in favouring the decomposition process of the body, while collecting and neutralizing toxic elements stored in time within the organism and distributing different nutrient supply originated from the body, to surrounding life forms.[22]

This "innovative" funeral methodology represents **an effort to make the passage from life to death more personal and connected with the rest of our lives** and aims to remind us that physical death and physical decay are natural processes, without which there could be no new life.



Design

Second Part
THE EPHEMERAL ICON:
“death-cycle” of a plastic chair

BIO-COVER

In order to translate my overall topic and adress issues related to plastic toxicity, and the possibility of having fungi being able to “kill” this immortal materials, i decided to focus my attention on a globally well-known pragmatic object: **the plastic monobloc chair.**

I find it to be a perfect iconic example for adressing issues related to plastics and disposability; it is ubiquitous in the world, very cheap and not very sturdy.

I use this chair as a statement about the life-cycles of consumer products in direct comparison with the immortality of the materials, most of the consumer products are made of.

Every 70 seconds a monobloc chair comes out from a single press; consisting of a single piece of about two kilos of polypropilene, it was initially costing around 60 dollars but as more and more were manufactured, the price dropped to less than $3.
Monoblocs are a universally accessible, mass-manufactured object, landfill sites are stuffed with them, and millions more are on their way.

Highlighting the complementarity of life and death as a whole, with my design **i play with the idea of infusing life in a dead everlasting material, in order to trigger a process of final dissolution.**

Why should not a chair, completely made out of synthetic, inhert, immortal material, dress up for death?

I initially thought about developing and designing a sort of “infectious fungus” patch[23], as a tool for transferring life in an inanimate object; the fungal mycelia would start spreading from the patch on the object while slowly colonizing it, until it would decompose and die. The quality of this “solution” resides in its extreme flexibility and adaptability, as the patch could be applied on every different kind of plastic surface.

However, in order to facilitate the action of the fungus on plastic and to favour its survival and a faster colonization process, I decided to develop the design of a coating for the plastic chair, a layer that would trigger the decaying process, while providing an all-round surface of mineral nutrients (sulfur, nitrogen, phosphor, potassium, calcium, magnesium) and allowing the inoculation of the decomposing fungus from multiple points.

The “Bio Cover” is intended as a tool-product for turning an inanimate synthetic object into a living entity.

By the action of being covered the plastic chair gains a new aestethic quality that requalifies it, while at the same time **the cover provides enough nutrients to trigger the action of the fungus**, that can start the colonization process.

While the fungus feeds on the plastic it gradually chews and substitute the material, whereas at the same time **the growing fungal biomass acts as a natural purifier, accumulating volatile toxic compounds** (biofilter).

Once the chair gets fully colonized the user can dispose of it, by placing it in the garden or litterally burying it, as if celebrating the death of the plastic[24].

The action of killing the “plastic chair” aims to act as a statement, referring to a reflection on the way we deal with our own “toxic” waste, while showing the potential of the waste itself for providing “free” health benefits to the conscious user.

What next?
HFI - Human Fungi Interaction -

Beyond design, a new scenario; fungi as an organizational model

We have seen how symbiotic relationships between organisms have been used to solve problems of survival. Human symbiosis may well be the key to solve many of the problems that face mankind, but **we cannot become a symbiotic world society unless we learn to become symbiotic individuals.**

Decompiculture[25]: fungi as an organizational model

I propose that we adopt the fungi as the organizational model for life in the 21st century.

HFI - Human Fungi Interaction, would explore the nature of surfaces and processes required to facilitate mutually beneficial interaction between humans and fungi.

HFI necessarily takes a symbiotic approach, being shaped by the questions it poses, such as:

- How can this two-way interface be realised?
- What assumptions are we making with regards to how we understand humans and fungi?
- Do we need individual, specialised interfaces for each species, or are there more general approaches?
- How would they work? Where, or what is the point of contact between the humans and fungi?
- What changes are required, and what further changes would occur in the fungi, or humans using such interfaces?
- What can we learn from each other?
- How can we form a closer symbiosis and better understanding between the human and fungal kingdoms once we open the gates between them? Communication, or pollination?

By suggesting “fungi as organisational models i aim to underline several urgent human needs:

- to understand the value of diversity and collaboration

- to approach problem-solving through whole systems thinking, rather than pure reductionism

- to redesign industry and economics to adopt more cyclical processes.

We now need to learn how to grow (culture) a lot of smaller, complex communities of microorganisms (fungal degrading basidiomycetes, bacteria, invertebrates) on a big scale and in ideal configurations, to achieve rapid, clean results as bio- conversion, bio-detoxification of waste into compost and useful biomass for biochemicals, feed and food.

I can imagine Decompiculture probably becoming a major new applied field in the biological sciences. Within the next hundred years decompiculture is inevitable.

(Appendix - Human Fungi Interaction)

4

CONCLUSION

Conclusion

My aim in the beginning was to make use of fungal organisms's abilities and knowledge in order to let them accomplish their main roles of feeders and disassemblers of nature, as well as their role of symbolic entities, within the "human world", and by that inspire the beginning of a symbiotic relationship between the two organisms (humans and fungi), leading to reciprocal benefits.

What I tried to do until now is to adopt fungi as a new "material, designing with them both for life and for death.

What I wanted to test and verify since the beginning of this project was the possibility of using fungi as a suitable remedy for curating the harmful consequences that our cultural progress and development has been creating.

My project developed in a "limbo" between design and science. Until now I incredibly enjoyed this process, as I find the communicative intention of my investigation together with the methodology i adopted, to be one of the main points I want to develop in my future.

I feel like being the intermediator, who comes in and tries to change the public perception, often based on unverified prejudice, and create a shift, a mind-change, by disclosing the actions and thoughts of the specialists to a divulgative integrity, by showing their potential.[26]

That's why my final projects are not about predicting but about envisioning possibilities, as some of the practices I started are looking at something new, not yet explored in the biological studies until now.

I truly tried to emphasize in my whole work the need of accepting the transitory nature of everything that exists. As far as we know, no existing thing lasts forever; everything is or should be potential material for transformation and for change into other uses and forms.

We could call it "Design for Ephemerality"; I aspire to redeem conventional bodies (organic and not) from oblivion and neglect, to give them new value and another life, and to finally "celebrate" their death.

The reader have probably noticed in my inquiry a persistent emphasis on the connection between things, across different states and contexts. Bodies are deconstructed and reconstructed and the politics of these transformations are examined. Nothing, it seems, is ever static. We are porously, viscerally enmeshed with the world at all times and so the extent of our responsibility is revealed.

These are in fact the basis on which my work is founded: to help develop a more empathic, more fulfilling way of thinking/feeling about relationships amongst ourselves, other organisms (fungi) and our living space, which acknowledges the fact that the boundaries we inhabit are not absolute and fixed but rather inform dynamic, interactive domains that allow a rich variety of patterns to emerge and transform our lives (and death).

If nothing else, my exploration has produced (and will go on producing) a series of unorthodox material transformations that challenge certain habits of perception – especially our tendency to see the world in terms of fixed entities rather than processes of change – and provide the possibility of experiencing and constructing both the world and our place in it differently.

fig.15 : Ana Mendieta, earth-body work

The celebrated astronomer and biologist, Sir Fred Hoyle, once said that the solutions to major unresolved problems should be sought by the exploration of radical hypotheses, while simultaneously adhering to well-tried and tested scientific tools and methods.
This is the basis of innovation.

I

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II

ENDNOTES

Endnotes

1 Biophilia Hypothesis: http://en.wikipedia.org/wiki/Biophilia_hypothesis

2 To better understand the systemic complexity of our body, in relation to our habits, it is interesting to notice "The Hygiene Hypothesis": http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1299202/

3 Fear of mushroom poisoning pervades every culture, sometimes reaching phobic extremes. The term mycophobic describes those individuals and cultures where fungi are looked upon with fear and loathing. Mycophobic cultures are epitomized by the English and Irish. In contrast, mycophilic societies can be found throughout Asia and eastern Europe, especially amongst Polish, Russian and Italian people. These societies have enjoyed a long history of mushroom use, with as many as a hundred common names to decribe the mushroom varieties they loved.

4 Alan Rayner: http://people.bath.ac.uk/bssadmr/index.htm. Inclusionality: http://www.goodshare.org/, http://www.inclusional-research.org/

5 Indoor air pollution; http://articles.sfgate.com/2004-05-19/home-and-garden/17427669_1_toxic-chemicals-breast-milk-indoor-air

6 http://www.ewg.org/chemindex/chemicalsfoundin-people

7 One example is the gargantuan *Armillaria Ostoyae* that occupies 965 hectares in Oregon's Blue Mountains in the US.

8 Nutrients with simple molecules, such as sugars, can be absorbed fairly readily. Larger, more complex molecules, such as proteins, are harder to tackle, and the fungi must then make use of various enzymes (chemicals that help to dissolve and simplify the molecules) so that they are easier to absorb. Should all food become depleted, sporulation is triggered.

9 www.secondenlightenment.org/The%20Evolution%20of%20Symbiosis.pdf

10 Embalming does not preserve the human body forever; it merely delays the inevitable and natural consequences of death. There is some variation in the rate of decomposition, depending on the strength of the chemicals and methods used, and the humidity and temperature of the final resting place.

11 Cremation: http://www.deathonline.net/disposal/cremation/process.cfm, http://hubpages.com/hub/cremation, http://www.lowcostcremation.com/what_is_cremation.html

12 The overall process of cremation consists of exposure of the body to intense heat, by dehidratation, evaporation, and mechanical processing. The ovens in crematoria operate at temperatures of up to 1100C and burn for 75 minutes per corpse. In the process they consume around 285 kilowatt-hours of gas and 15kWh of electricity. That's pretty much the same amount of energy as an average person would use at home in a month.

13 Source: "Infectious disease risks from dead bodies following natural disasters." Rev Panam Salud Publica. 2004, Volume 15, no. 5. A publication of the PAHO. Available at: http://journal.paho.org/index.php?a_ID=441

14 *Schizophyllum Commune* is the world's most widely distributed fungus, occurring on every continent except Antartica. It belongs to the family of Saprotrophic Basidiomycetes, that have the ability of decomposing organic material.

15 During my reasearch within the kingdom of fungi i discovered a particular kind of mushroom that caught my attention. There is a small group of mushrooms that requires some other trigger than just moisture and the right temperature. Some will only fruit when ammonia is available. Such mushrooms are called ammonia fungi, as they only form fruit-bodies where ammonia and similar chemicals are available in great quantities. Hebeloma radicosoides from Japan is a striking example. Forensic archaeologists and criminal investigators employ many different techniques for the location, recovery, and analysis of clandestine graves. Hebeloma Radicosoides is one of these "tools". The fruiting structures of the ammonia and the postputrefaction fungi have been recorded repeatedly in association with decomposed mammalian cadavers in disparate regions of the world. They provide a means to detect illegal graves and has the potential to estimate postburial interval.

Endnotes

16 It's interesting to notice that fungi could potentially dissolve human bones, that tipically take decades before being decomposed. This ability can for instance be found within Lychens, organisms born from the mutual relation between algae and fungi; they have the ability of growing in very extreme condition, where nothing else can grow. Usually it is possible to find these organisms in deserts or on statues, churches courtyards, monuments, on which they tend to erode rock by secreting acids.

17 J.W. VAN GROENESTIJN, W.N.M. VAN HEININGEN, N.J.R. KRAAKMAN (2001), Biofilters based on the action of fungi, TNO Environment, Energy and Process Innovation (NL)

18 Biofilters are beds packed with biologically active materials, such as compost, through which the gases are ventilated.
Schematically they consist of a relatively large vessel, typically made of cast concrete or metal, which holds a filter medium of organic material such as peat, heather, bark chips and the like. The gas to be treated is forced, or drawn, through the filter. The medium offers good water-holding capacity and soluble chemicals within the waste gas, or smelt, dissolve into the film of moisture around the matrix.
Fungi, and other micro-organisms present, degrade components of the resultant solution, thereby bringing about the desired effect. The medium itself provides physical support for the growth of the micro-organisms.. Properly maintained, biofilters can reduce odour release, caused by volatile organic and inorganic compounds, by 95% or more.

19 H.J. COX, J.H.M. HOUTMAN, H.J. DODDEMA, W. HARDER (2005), Enrichment of fungi and degradation of styrene in biofilters, TNO Institute of Environmental Sciences, Delft (NL)

20 A. GUSSE, P. MILLER, T. VOLK (2006), White-Rot Fungi Demonstrate First Biodegradation of Phenolic Resin, Departments of Biology and Chemistry, University of Wisconsin-La Crosse, http://botit.botany.wisc.edu/toms_fungi/feb2007.html

21 In the laboratory this is done by creating the right media for the specific fungus. For the Phanerochaete Chrysosporium I've been producing a media with the following composition: 30g/L malt extract, 20g/L glucose, 1g/L peptone, 15g/L agar.

22 The current problem with the way a corpse decomposes at the bottom of a grave is that there isn't enough oxygen to get a good aerobic compost going. The main by-products of aerobic decomposition include carbon dioxide and water, while anaerobic decomposition produces methane, a greenhouse-gas 23 times as powerful as CO2. More than that when a corpse is buried the nutrients in the body aren't returned to the cycle of nature but remain trapped six feet under, away from the reach of most plants.

23 By starting thinking about the way in which we, humans, use to transfer organic substances in our bodies, through the use of syringes, needles or alternatively patches, as vehicles for injecting substances and cures in our bodies, i tried to figure out which would have been the right way to transport these methods of inoculation to the "physicality" of a synthetic object. The initial idea of the patch was inspired by the medical treatments for quitting smoking; this remedy typically serves the purpose of getting rid of the cigarette's need by releasing nicotine into the body, through the skin.

24 The new organic material, once plastic, can be now used as a natural fertilizer, providing extra nutrients (carbon, nitrogen, sulfur...) to the soil for the growing of new life.

25 Decompiculture: human symbiosis with decomposer organisms – T.G. Myles (March, 2003)

26 Also, I can imagine that on a practical level, the output of my thesis would encounter a big amount of skepticism from institutions and decisional apparatus, as it challenges some of the most dogmatic cultural positions and moral issues of human's "modern" society. During my process and my discussions with scientists I've been often warned about the fact that the project I developed would easily encounter oppositions and skepticism by the general public, due to a reluctance related to the integration of "repulsive" undesirable organisms in a product; I perfectly understand the fact that this audience's reaction is what usually stops scientists in exploring and deep-diving into research topics that would not be successfull beacuse of the disbelief they would ran into, but it's exactly because of that, that I find this to be my perfect role.

III

APPENDIX

Working in
the microbiology lab

This kind of research is very interesting from the point of view of design.

While biotechnology is functioning at all scales, scientists working in this field are working at the scale of the contents of a petri dish (and smaller). Design, however, works at the human and global scale. We're trained to look at the bigger picture. So how can these two separate scales overlap?
What role might design have in a biotech revolution?

By establishing a close relationship with professional scientists and biologists at the microbiology laboratories of the Utrecht University I've been able to achieve a more complete understanding and knowledge related to the behaviour of fungi.

Over time I've been conducting a range of different experiments in order to get familiar with microbiological techniques and to the way different fungal species react during their growing process in diverse conditions (fig.16).
The initial fungal species I've been using for this experiments are:

Aspergillus versicolor
Rhizoctonia solani
Fusarium graminearum
Phycomyces blakesleeanus
Pleurotus ostreatus
Sclerotinia sclerotiorum
Schizophyllum Commune

As a media giving nutrients to the cultures I used PDA (Potato Dextrose Agar).
After the inoculation with a specific fungus, all the cultures were incubated at a temperature of 25 °C.

Concerning the **first part of my project**, related to the body degradation, one of the main points that i felt like clarifying has been the understanding of the possibilities that the interaction between fungi and human tissue can create; my biggest skepticism was based on the uncertainty regarding the ability of fungi in degrading organic material, like tissue or skin and i did not want to base my exploration and my final design on personal assumptions.

For this reason and due to the difficulties in obtaining permissions in using human tissue chains, I started performing empirical experiments on meat (fig. 9), inoculating it with *Schizophyllum*. Unfortunately these experiments were not successful, as the quality of the "material" used was not ideal for reproducing the carachteristic of human tissue.

More than that, as when a human body dies is not sterile, it would be very difficult to make possible for fungi to achieve the supremacy within the body itself; that's why the better way in which fungi could "attack" the body would be from outside.

Thanks to the contribution of Prof. R. de Vries and Prof. H. Woesten, i found out that fungi can technically perform the role of decomposers also on human tissue, contributing to the degradation of human remains, as fungi generally love to feed on proteins: of course this would happen in collaboration with other organisms, like bacteria.

In principle human tissue is easier to digest than plant material.

With regard to the **second part of the project**, about the "death" of the plastic, I tried to trigger the action of Phanerochaete Chrisosporium in the degradation of the materials. By doing so I've been able to better understand how the process develops in reality.

The results were not extremely successful from a visual point of view, as the process in regular conditions takes a long time and the degradation results are meseaurable mainly by controlling the loss in weight that the chips are subjected to, when eaten by the fungus.

It's important to comprehend that not every strain, even if belonging to the same species, would react in the same way while interacting with plastic; this means that multiple tests need to be performed in order to be able to select the right strain that would act in an optimal way on the specific type of plastic.

Also, it's important not to think that the fungus itself could feed, grow and expand, by only having some plastic available as a nutrient.

As well as we, humans, need to have a diet based on different nutrients (sugars, salts, proteins, corbohydrates, minerals...) in order to live and evolve, so the fungi need to find the most ideal conditions for their survival.
This means that it is pretty necessary to make their life easier by providing them the right substrate with a good range of nutrients that would favour their growth.

Another point worth emphasizing, in order to make life easier for the fungus, is to be able to avoid the presence of competitors; one way in which this could be done, as in case of bacterial competitors, is to keep a very low pH (acidic) in the substrate, as bacteria are generally mostly found in basic condtions environments. Another case could be the necessity of avoiding the co-presence of competing fungi, and that can be achieved by developing a strategy that would not allow the unwanted organisms, as in the case of the fungus coated wood, developed by TNO (fig.17).

Technically if the material that needs to be decomposed, in this case plastic, would end somewhere, where there's a high concentration of relevant fungi and not a lot of competitors, then the degradation and the consequent bioremediation processes would be faster.

Theoretically it would also be possible, though not easy, to develop a genetically modified organism that would be able to perform the decomposition of plastic in a more efficient and rapid way; the problem is that, particularly in Europe, this would not be possible at this time due to legislative issues.

Also, due to the skepticism and the reluctance that can be found in the public perception, fed by groups of idealist and nourished by a flow of negative information, the development and introduction of a GMO would not realistically be possible at this time; this because the scientific world tends to avoid focusing and putting a lot of effort in the exploration of bio-technological solutions that would be immediatly not accepted and discarded by the public audience, because of a sort of negative "underbelly feeling".

That's why, as the scientific research related to this recent finding is still very young, in my project i try to envision the ideal aestethic qualities of the process of transformation, imagining them on the base of empirical experimentation and scientific informations.

In the lab i studied how to grow cultures in different ways. The three techniques I've been using until now are:

- regular culture media in petri dishes
- flloating mats in petri dishes
- liquid media shaked suspension in erlenmeyer flasks

By getting experienced with this last option i've been able to find out the properties of the resulting suspended biomass product (fig.18), which i found to be the most interesting and suitable "material" to be used for 3-dimensional visualization purposes.

It is actually mycelium biomass that is usually discarded after the preparation of the media, becase of no big interest for the lab itself. On the contrary I found it to be extremely interesting: it resembles something like wet bread and we could say it is a sort of clay-like material, easily moldable around a shape.
After being molded is still wet and if incubated in the right moisture and temperature conditions, it grows on its top a white fluffy layer that make it completely hydrophobic.

Thanks to this practical training together with the research in scientific literature I conducted, I've been able to establish the basis for the development of my whole project.

The atmosphere in the lab has been very exciting; on a side it has been a completely new experience that allowed me to learn more about fungi and increase my knowledge regarding micro-biology techniques; on the other hand, my "unusual" approach to the lab environment has been creating curiosity and interest in the department and have been involving various researchers around my experiments, willing to contribute to the achievement of a successful outcome.

fig.16 : Growth experiments

fig.17 : wood coated with fungus to increase its resistance to environmental factors and its durability

fig.18 : growing techniques and resultant biomass

fig.19 : visual experiment on chair’s degradation

Fungi in Biotechnology: the cleaning agents

Bioremediation is an expanding area of environmental biotechnology and may be defined as the application of biological processes to the treatment of pollution.

Up until today much bioremediation work has concentrated on organic pollutants, although **the range of substances that can be transformed or detoxified by microorganisms includes both natural materials and inorganic pollutants, such as toxic metals, or plastics.**

The principal aims of environmental biotechnology are the manufacture of products in environmentally harmonious ways, which allow for the minimisation of harmful solids, liquids or gaseous outputs or the clean-up of the residual effects of earlier human occupation.

In many respects, this field stands as the purest example of the newly emergent bioindustry, since it is the least refined, at least in terms of the basis of its action. In essence, all of its applications simply encourage the natural propensity of the organisms involved, while seeking to enhance or accelerate their action.

Concerning the implementation of fungi as bio-remediating agents, it is interesting to point out that virtually all of the transformation processes, revolve around intrinsic properties of fungi that underpin fungal growth and survival, and are integral to environmental function.

That's the reason why **fungi** revealed to me as the perfectly fitting organism to work with, as they **have the ability to sequestrate and concentrate heavy metals and toxic compounds in their body.**
This was particularly evident after the Chernobil disaster, where boletus fungi where the only organism that was able to survive even without any sugar supply left, just by absorbing radioactivity and sesequestring cesium...feeding on energy (pigments absorb energy)! How? Nobody knows it yet in a complete clear way and few people believe it.

What is known for sure is that for having this ability the organism should be in an environment with no competitors; these extreme conditions lead to the evolution of special features.

Mechanisms for breakdown of recalcitrant plant residues can also act on synthetic pollutants and this has led to much interest in ligninolytic fungi, especially the white rots exemplified by Phanerochaete Chrysosporium. The metabolic versatility of this organism provides a foundation for different ranges of possible applications, and much organic bioremediation knowledge arises from working with this organism.
One example is the treatment of dye wastewater from the textile industry, which presents a major problem; biotreatment with white rot fungi seems to be a viable option and the same happens in the pulp industry in which the chemicals used for the whitening process of the paper are being replaced with this fungus.

Cleaning up contamination and dealing rationally with wastes is, of course, in everybody's best interests, but for most people, this is simply addressing a problem which they would rather had not existed in the first place.

Within a very short time, the implementation of fungi in biotechnology is coming to play an increasingly important role in many aspects of everyday life. Once an expensive and largely unfamiliar option, it is now becoming a realistic alternative to many established approaches for manufacturing, land remediation, pollution control and waste management. Against a background of burgeoning disposal costs and ever more stringent legislation and liabilities, the application of biologically engineered solutions based on fungi seems certain to continue its growth.

Plate XII.

S.Price,del. W.H.Fitch,lith.

Vincent Brooks,Imp.

Funeral industry, fungi and related patologies

Burials only in the US deposit 827,060 gallons of embalming toxic fluid - formaldehyde, methanol, and ethanol - into the soil each year. In the last decades, regular use of embalming was encouraged, and the new “professionals” used it to suggest they were keepers of the public health.

Funeral industry members frequently claim that dead bodies are a source of contagion to the public, and that embalming is necessary to prevent the spread of disease. Some will also claim that unembalmed dead bodies must be buried in a casket and a vault to prevent “contamination” of groundwater. These assertions are not true.

The Centers for Disease Control, the World Health Organization, and the Pan-American Health Organization have all published data backing up this position; According to recent opinions from the “Center for Disease Control” in Atlanta, there is no public health purpose served by embalming; it is not even required by law.

The US Centers for Disease Control has also stated: “We have not at any point prescribed embalming as a method of protecting public health.” (Source: Bernadette Burden, spokeswoman for the Centers for Disease Control and Prevention(CDC) - Atlanta, Georgia, as quoted in Mortuary Management magazine, October, 2006)

The myth of contagion from dead bodies is one of the most persistent of the funeral industry, and it’s important
to know there is no evidence to justify it. In fact, there is scientific evidence against it.

Of course fungi can also cause a wide variety of diseases in humans and by growing on human tissue as parasites, thay can perform the role of potential pathogens.

This pathologies can sometimes be found within the oyster mushroom industry, due to a prolonged exposure to the enormous amount of spores that is possible to find in the air.
The same performance can occurr with a lot of other species, like for instance the *Aspergillus*: in the case of people with an already reduced immune system, due to pathologies like HIV and diabetes, or cancer treatments and others(...), the activity of the spores can be very dangerous because, by entering the lungs, spores can easily find their way through blood vessels and start performing their decomposing action, feeding on carbon, and causing internal bleeding that can easily lead to death.

Confronted with bacterial infection, mostly easily recognizable by the immune system, fungal infection has potentially a lower incidence but extremely higher consequences.

Specialized fungi that grow on skin, in any case, cannot penetrate deeper, because the human body has a temperature of 37 ºC and most fungi cannot grow on that temperature level. Some theories sustain the hypotesis that the evolutionary reason for human being of having such a high body temperature is that it prevents us from having fungal infections.
However, within the thousands of fungal species, only about 160 can perform the role of potential pathogens.

Death and Grief

Grief is a universal experience, more commonly experienced than death.

So much of life is about loss. Going through life is to endure a series of losses, which include the loss of health, roles, identity, homeland, and loved ones through betrayal or death. Grief is the normal emotional response to loss, a response all too familiar to us. As we grow and age, we grieve the yesterdays and all that entails, the lost loves and missed opportunities, the good friends and broken relationships, the gains and the losses, the good times and the bad. We remember, therefore, we grieve. In grieving, we relive what has been lost in time and space.

Strictly speaking, **grief is a complex pattern of cognitive, existential, spiritual coping processes in reaction to the disintegration of existing structures of meaning related to physical structures**.

This loss of meaning with respect to relationships, life goals, and daily living creates an existential crisis. To the extent that death of a significant other disrupts one's continuity with the past, grief also entails existential struggles regarding the meaning of one's own identity.

Therefore, grief, in particular when related to the loss of a loved somebody, is usually accompanied by denial. From this broader perspective, grief work necessarily involves the transformation of meaning structures.

The desire to get the body back is intertwined with the irrational energy that we put into denial and also sometimes associated with what we believe to be the spiritual well-being of the dead.
According to this view, people consciously and unconsciously defend themselves against the terror of death.

Of course there is a great deal of anxiety involved in embracing and accepting the loss of a loved somebody. Inspired by Alan Rayner's theory, I propose the vision of **an "inclusional life",** which **is one that does not merely suffers, but explores the stages of a continuous transformation and a final decay.** Decay leads to death. On a human level death is loss.

Through my work I try to explore and hopefully demystify this anxiety in the design of a new burial practice, with the aim of breaking through the inhibitions into a more active engagement with continuity, so to be able to accept death.

"...it would be kinda nifty if wonderful coloured mushrooms popped out of our heads when we died; think of how different cemeteries would be. We would just leave the bodies lying in rows, and you could come back later to see what color Grandma had bloomed into. Tend her little garden."

Plastic: Impact and Exposure

If we take a closer look to what surrounds us in our everyday environments and we try to confront it to the way it was less than a century ago, it's not difficult to notice how much we became addicted to plastic.

Plastics are everywhere, in almost every object we use, in everything we touch.
It's a sort of magic material that can change according to needs, style, colour, taste. We could say that in the last century **plastic has become the modern clay**; a new material highly malleable, acid resistant, extremely durable, designed from the molecular level, up.

Plastics allowed the consumers to buy into lifestyles; it was known as **cheap** and **disposable** and so quickly it became **invisible**.

Because of this massive implemenation and because of its low cost of production, plastics have been making possible the development of the current lifestyle together with a massive cultural shift: everything in our life has become disposable, our food, our tools, our furniture...
Unfortunately this revolution that this material created brought with it a lot of negative "unexpected" consequences related to pollution, exploitment of natural resources and human diseases.

All this is clearly evident today: it's enough to take a look into the ocean and see how much plastic gets into there. Our oceans have become a "plastic soup".
Researchers found that the amount of plastic in the oceans is ten times higher than the naturally occuring food; more plastic than organisms.
That's why plastic gets usually to be mistaken for food by different species of animals and it is not only tough and hard to digest, but it also accumulates oily pollutants such as pesticides and herbicides that fall into the see from rivers.
This phenomenon creates a process of **bioaccumulation** in the food chain that originates dangerous circumstances of survival for both the human beings and for the entire ecosystem (fig.23).

Only in the last 2 decades or even less we started being concerned about the way we dispose of this materials and about the way they interfere with our own health and biological evolution.

Almost every plastic releases in the environment and in the air we breathe, on a continuous rate of low emissions, dangerous chemicals as, for instance, DEHP, the most commonly used plasticizer, or phenil's compounds; these substances basically dose us with hormones, regulating the expression of genes, and altering the development of every cell, from our brain to our immune system.

We're constantly exposed to over a thousand synthetic chemicals and they can be found in every consumer product; they are in the water we drink, in the food we eat and in the air we breathe.

Dangerous chemicals as BPA can be found in polycarbonate and in all kind of phenolic resins. These plastics have a wide range of various comercial, industrial and manifacturing applications. The problem is that they are difficult to dissolve and cannot be melted or recast.

These properties have generated a large market for such durable polymers, but also make them extremely challenging to degrade or recycle, so that the long term accumulation prospects are vast.

The very durability that makes plastic so useful to humans also makes it incredibly harmful to all the natural life cycles in every ecosystem worldwide.

That's why we should be higly concerned by the amount of plastic that is sorrounding us; the most dangerous pollution, it turns out, comes from commonplace items in our homes and workplaces and there are actually more things that we don't know than we do.

Households are the biggest producers of plastic waste: more than 80% of the plastic is used once and the goes into landfill sites and only 7% of the plastic we produce is currently recycled.

Only in Europe 12.2 million tonnes of plastics waste still ends up in landfill and it's estimated that since 1950s about one billion tons of plastic has been discarded.

Until recently virtually no organism was supposed to be able to degrade plastic: that means that every piece that's ever been made, if not incenerated, still exists.

Now it seems something is changing: time has come to rethink our relationship to synthetic materials.

fig.20 : TIME Magazine, “Throw Away Limits”, 1955

fig.21 : plastic is promoted to liberate women for having a more fulfilling life

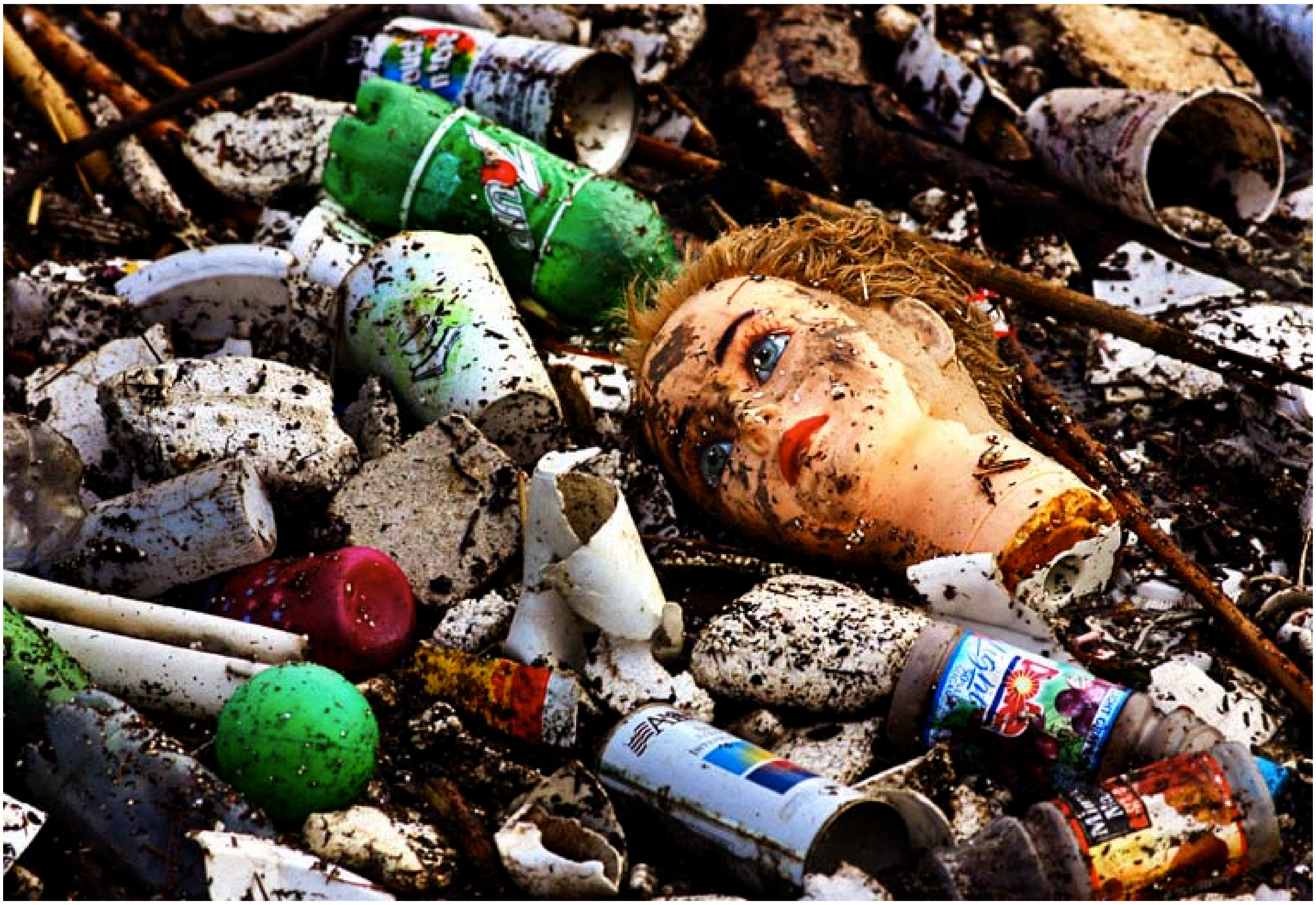


fig.22 : disposing of plastic; the way to the landfill

Indoor Chemicals

Heavy Metals Compounds:
lead, mercury, arsenic,
cadmium

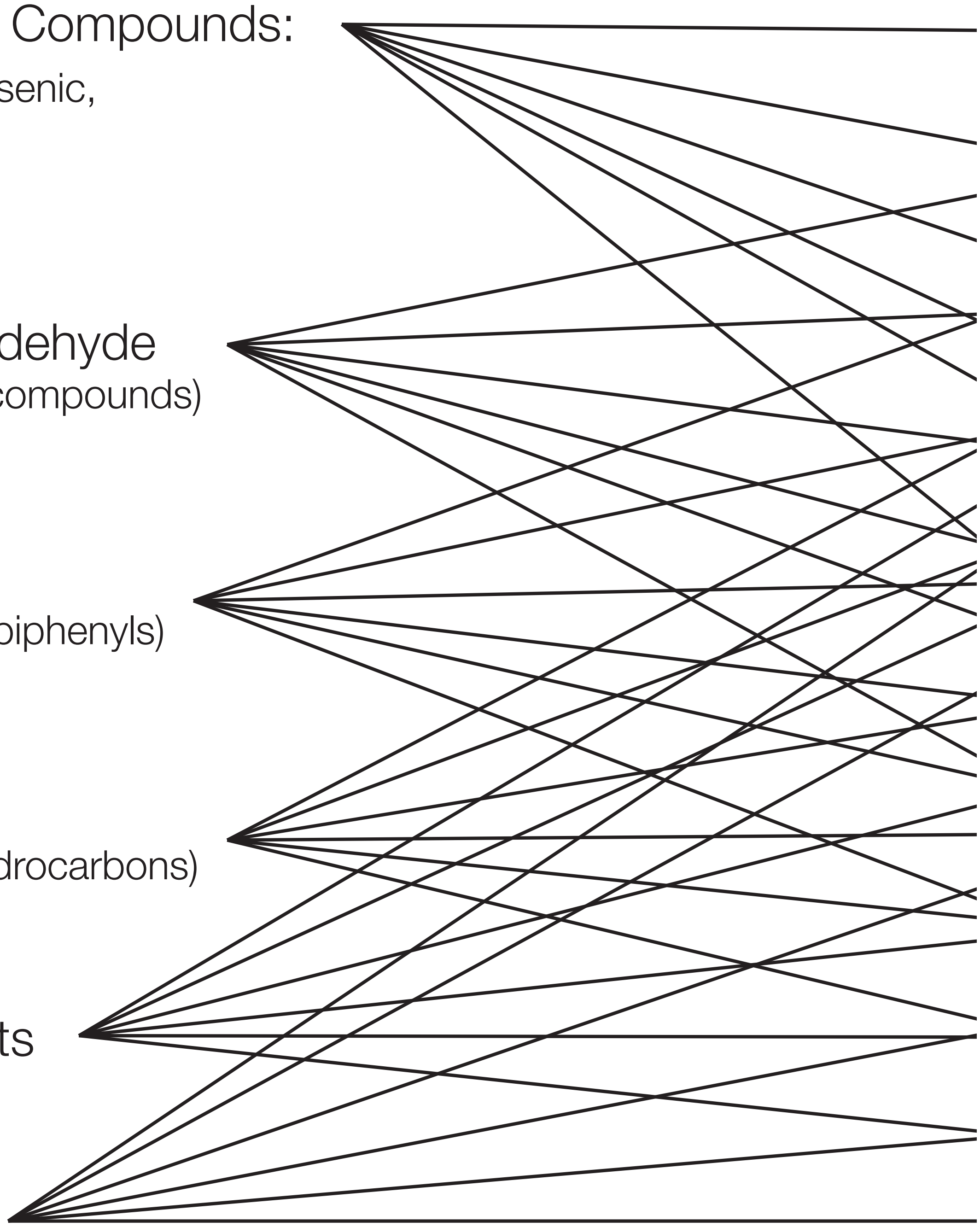
VOCs, formaldehyde
(volatile organic compounds)

PCBs
(polychlorinated biphenyls)

PBDEs
(polyaromatic hydrocarbons)

Fire Retardants

Bisphenol A



Consequent Diseases

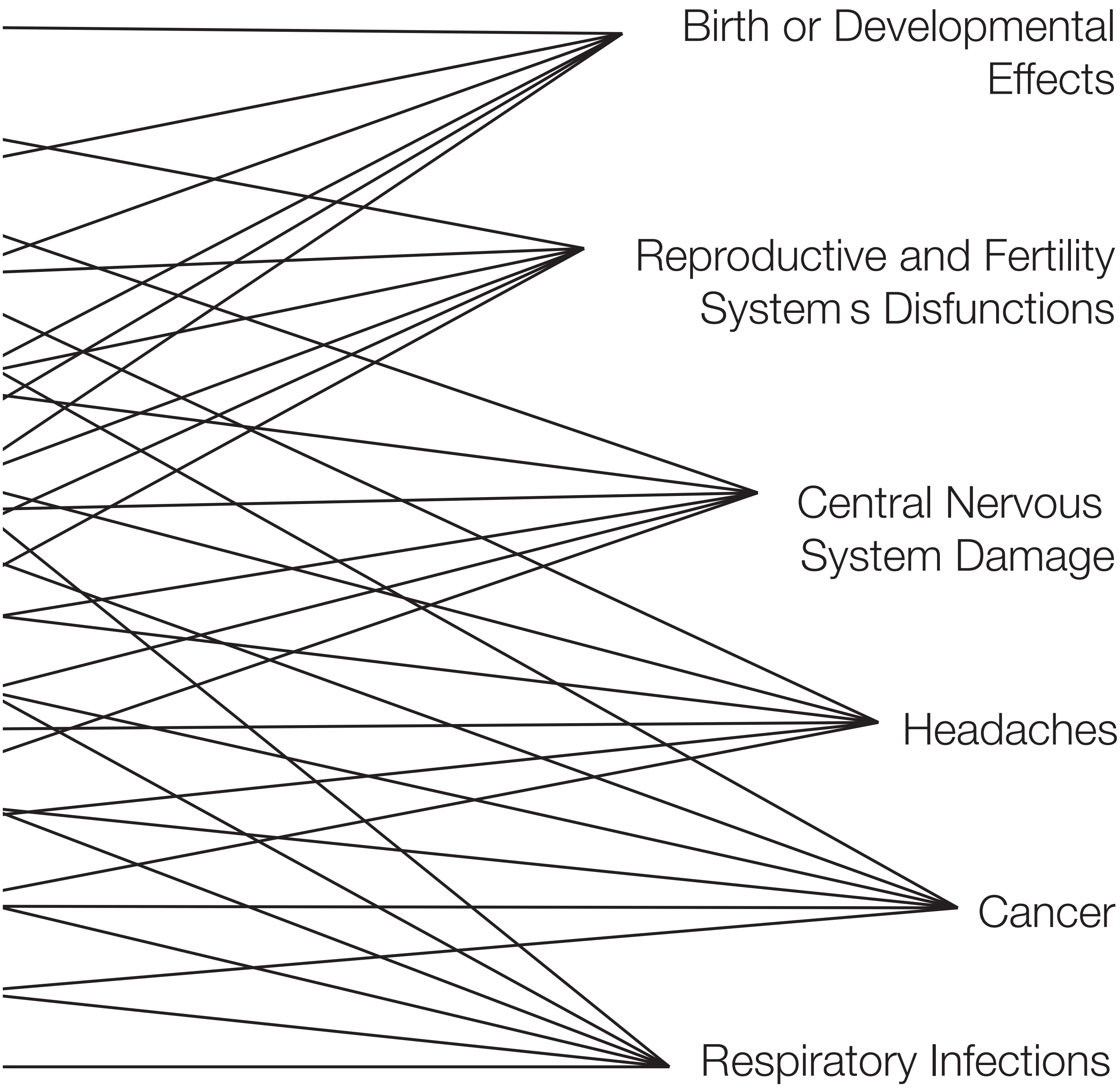


fig.23 : Midway, message from the Gyre, Chris Jordan

Ethnomycology:
Mushrooms in cultures & religions

420 million years ago, an organism called “prototaxites” existed. Prototaxites, laying down, was about three feet tall. The tallest plants on Earth at that time were less than two feet. Dr. Boyce, at the University of Chicago, published an article in the Journal of Geology this past year determining that Prototaxites was a giant fungus, a giant mushroom (http://www-news.uchicago.edu/releases/07/070423.fungus.shtml)

Across the landscapes of Earth were dotted these giant mushrooms. All across most land masses. And these existed for tens of millions of years.

Mushrooms have been incredibly influential in affecting the course of human evolution.

Medicinal fungi have been used for millennia in the traditional medical practices of the Orient. So revered were these fungi that their usage was often exclusively retained for the Emperor and aristocracy. Fungus such as Ganoderma lucidum (Reishi, Ling Zhi) were believed to be an elixir of life, capable of doubling one’s life span and warding off all disease and the ageing process.

True to their beguiling nature, fungi have always elicited deep emotional responses: from adulation by those who understand them to outright fear by those who do not.

The oldest archeological evidence of mushroom use discovered so far is probably a Tassili image from a cave which dates back 3,500 years B.C. (fig.24). The artist’s intent is clear. Mushrooms with electrified auras are depicted outlining a dancing shaman. The spiritual interpretation of the image transcends time and is obvious.

The oldest traces of mushroom use in Africa is dated back about 9.000 to 7.000 years BC.
Rock paintings, mushroom objects and mushroomlike symbols have been foundin a lot of different sites in Africa. It is curious to notice that there are very few reports on the use of hallicinogenic mushrooms in Africa, even though the hallucinogenic species Psilocybe are not uncommon on dung in eastern and southern Africa.

Scientists have only recently confirmed what ancient cultures have known for centuries: mushrooms have within them some of the most potent medicines found in nature.

We know that their cellular constituents can profoundly improve the quality of human health. This volume of attention has arisen in response to continued findings that they may be profound allies in some of today’s gravest diseases. The most important being those where the immune system is involved.
(http://www.ted.com/talks/lang/engpaul_stamets_on_6_ways_mushrooms_can_save_the_world.html)

Medicinal mushrooms have remained a praised and somewhat mysterious healing tool across millennia. It is only now that we have the means to back up what has been portrayed in the traditional texts. The mushrooms were often seen as an elixir of life, and it is becoming more and more apparent that they may offer a genuine solution to some of today’s gravest conditions, and uncomfortable chronic disorders.

Several species of Ganoderma, for instance, have been used in traditional Asian medicines for thousands of years. Collectively, the Ganoderma are being investigated for a variety of potential therapeutic benefits, like, for instance, anticancer effects, immunoregulatory effects, antibacterial effects, antifungal effects, reducing blood cholesterol, protection against radiation-induced damage, increasing endurance for vigorous exercise and many more beneficial actions.


fig.24 : the “tassili” mushroom-man

Symbiotic relationships between fungi and other species

The strong partnership between termites and their fungus is a very representative one. Macrotermes colonies host a remarkable symbiotic relationship with a basidiomycete fungus, Termitomyces. The termites cultivate the fungi in a fungus garden, an assemblage of structures built from chewed up grass and wood, and inoculated with fungal spores.
The fungus garden is, therefore, a kind of extracorporeal digestive system, to which termites have 'outsourced' cellulose digestion. The fungi also play a significant role in the emergence of social homeostasis in Macrotermes colonies. Indeed, in a remarkable way, **it is not the termites that cultivate the fungi, but the fungi that are cultivating the termites.**


fig.25 : termite's mound


fig.26 : termite's fungus garden

Another symbiotic interaction is the one called mycorrhiza (Greek for fungus roots). Mycorrhizal relationships are fascinating partnerships that take place when the hyphae of certain fungi wrap around, or penetrate the roots of a plant, whereupon a mutually beneficial exchange takes place. The fungus, which cannot obtain energy directly from the sun itself (as it lacks the chlorophyll found in plants), is able to obtain sugars that the plant produces using photosynthesis. In return the fungus provides the plant with vital nutrients that it extracts and transports from the soil, and that would otherwise be unavailable to the plant. Surprisingly, **most of the plants in virtually all of the world's terrestrial ecosystems rely on these relationships for their healthy growth.**


fig.27 : mycorrhiza

This gives some perspective on the importance of fungi when we consider that without them the world's forest ecosystems would collapse.

One more astonishing interaction is the one between carpenter ants and the cordyceps fungus (fig.28); the fungus infects the ants and turns them into the walking dead getting them to die in a spot that's perfect for the fungus to grow and reproduce, by sporulating. (http://www.livescience.com/animals/090812-ant-fungus.html , http://www.youtube.com/watch?v=CCOQ0VU24xw)

Mind-controlling parasites are nothing new, nor are they restricted to fungi. The micro-organism Toxoplasma gondii, which infects rodents and alters their behaviour, making them more susceptible to being caught and eaten by cats. Toxoplasma infects humans too, and there's been a lot of discussion on how it may possibly manipulate our own behaviour. (http://scienceblogs.com/loom/2006/08/01/a_nation_of_cowards_blame_the.php)

fig.28 : carpenter ants and grasshopper parasitized by the cordyceps sinensis

Human Fungi Interaction (symbiosis, communication, pollination)

SYMBIOSIS: THE HUMAN REALIZATION

The species “Homo Sapiens” is the highest evolved organism on this planet thanks to symbiosis and myriad other forces, such as natural selection. Given the evolved human intellect, man has the potential to grasp the essence of his existence, to perfect himself, and to direct himself toward a purpose.

Within the last couple of decades, we have witnessed a knowledge explosion in all areas of science. This scientific period of enlightenment has given us much insight to our existence, but we can no longer afford to continue our exploitive abuse of knowledge without running the risk of destroying ourselves.

It seems we have yet to realize that in order for us to survive as a species we must learn to live symbiotically with our fellow man, with other species of the earth, and with earth itself. Unfortunately, we are still parasitic and sometimes even pathogenic in our relationships to other men, to other forms of life, and to the earth. But even so, there is still hope for mankind; according to Margulis, **“…parasitic relationships may become benign and even obligate…and thus these relationships would become symbiotic”.** (source: Parasites and Symbiosis: http://www.biomedcentral.com/1471-2148/9/124#IDAGNEJ1)

HUMAN FUNGI INTERACTION

With the understanding that we are a part of an interconnected and interdependent planetary eco-system, contemporary **human culture** (interpreted as the cultivation of human minds and behaviours) **slowly moves from a culture of consumption and segregation to a culture of participation, integration and generation.**
Our technological inquiry is finally rediscovering the robust beauty of growth and interdependence in complex systems – from food to fabrics, from genetics to global networks. We are beginning to see design which aims to produce and recycle, rather than relentlessly consume resources and deplete energy.
I suggest that these changes in contemporary culture, economy and technology are beginning to resonate with the characteristics of our close neighbours in the domain of fungi.

The rise of nanotechnology and a “global, atmosphere-based energy economy” can be completely in harmony with detoxifying the natural environment and preserving biodiversity, if we as a species are willing to take the risks of reestablishing channels of direct communication with the planetary others, the minds behind nature.

Practically we can start adopting a new word and a new concept: Decompiculture. **Decompiculture is the growing of decomposer organisms by humans.**
The term is intended to establish a contrast with the term agriculture. Agriculture and animal husbandry are in fact the selective identification of a few key organisms which we have learned to symbiose with, by culturing them. Decompiculture, in contrast, is **human symbiosis with organisms of the decomposer food chains.**

HUMAN FUNGI COMMUNICATION

The notions of space, time, movement and persistence differ greatly between the human and fungal realms. Where human progress is often described as linear, the progression of fungi is cyclical, seasonal. On a larger scale, humans and fungi both occupy interdependent regional habitats, which define them. Even though many processes within fungi are fast, their growth is slow, balanced and steady, adapting to the environmental pressures and inner needs. In order to interface with fungi, humans would need to go through a gradual time-unbinding (slow down), by giving up the short-term, short-lived, incremental advances, for the sake of the slower cycles of growth and decay.

If we eventually succeed in time-unbinding, how would we communicate with fungi about our divergent perceptions of space and movement?

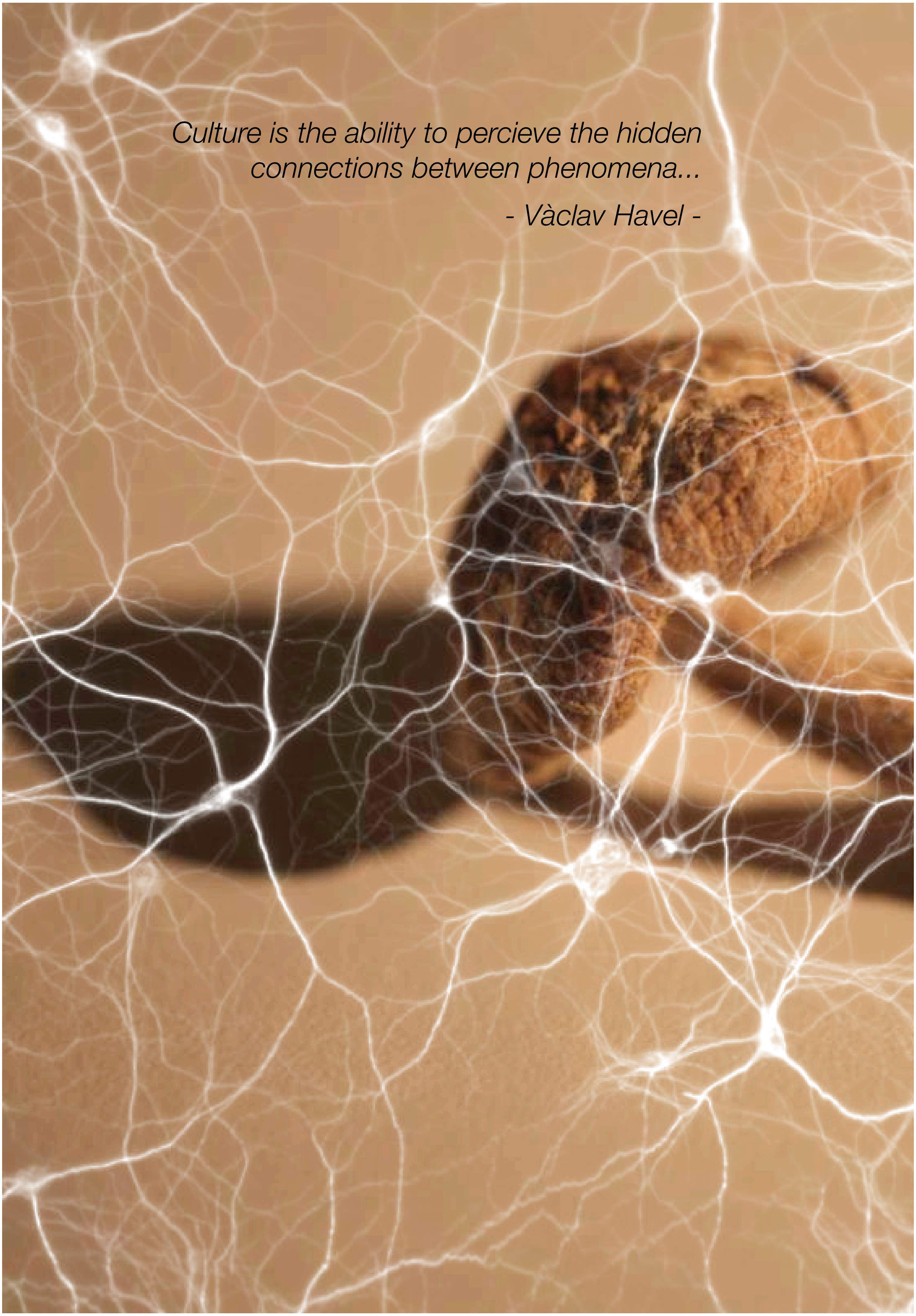
Would humans be able to feel what it is like to be a mycelium, consisting of billions of connections and rhizomes underground and fruits above ground? How would it feel to be so vast, flexible, able to bend and twist, curl and wrap but not crawl, walk, or run? Would our thinking become more reticulate, our logic less linear? On the other hand, what human abilities would appeal to fungi? Would they, over time develop something similiar to animal sentience? Or would we both, through these communications develop a more integrated, wholistic consciousness?

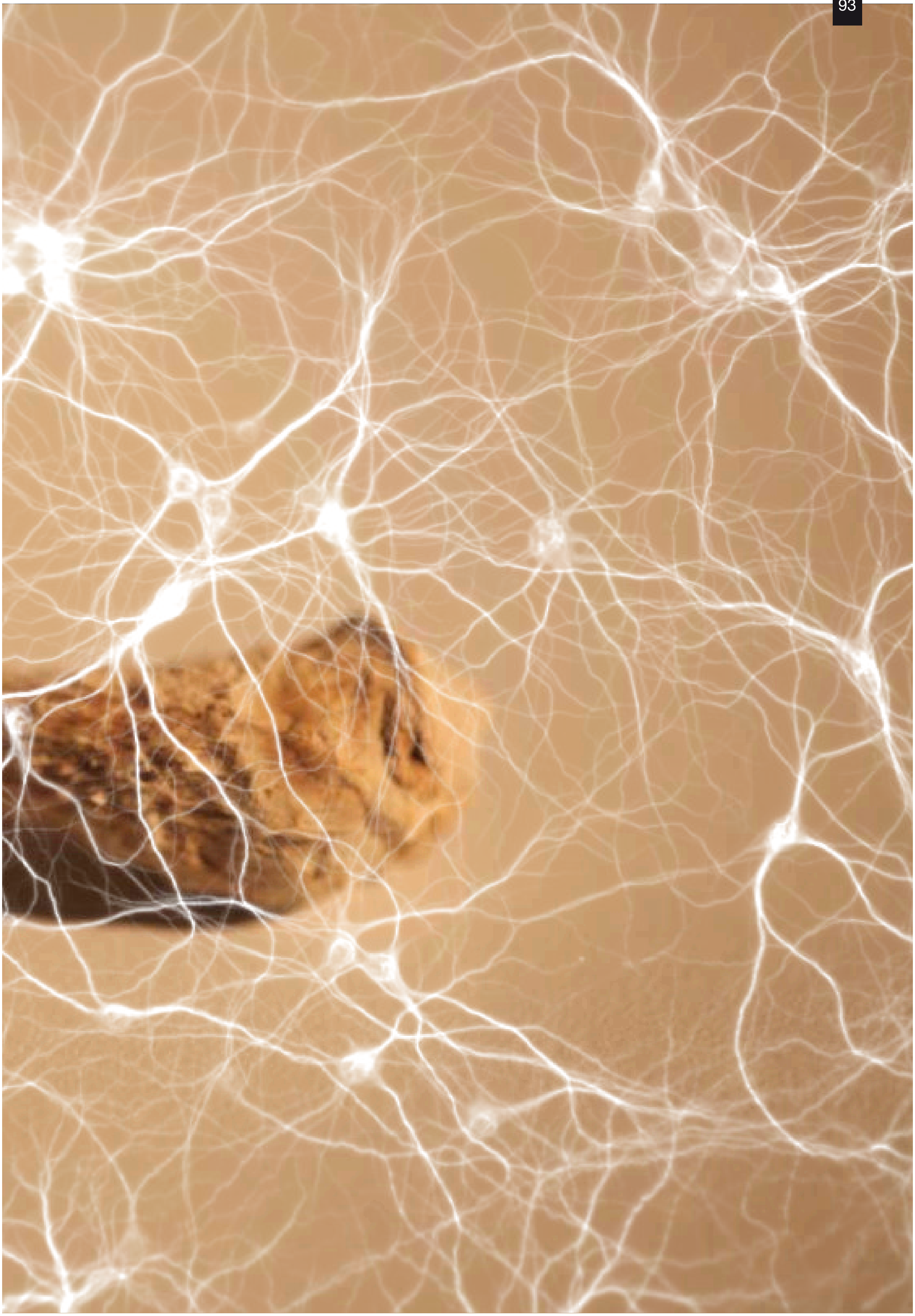
The subtle processes of chemical communication gives the fungal organs their shape and function, as well as ability to signal, attract (and repel), or feed other organisms. Can we enhance this type of embodied communication? What can we learn from the effects of fungi alkaloids on human physiology? Could fungi help us grow garments, objects, food and shelter, which are living with us, rather than for us? How would they let us know that they need water, or a particular cocktail of chemical nutrients? On the other hand, would they aks us for some of our blood and bone for dessert? Or would we maybe make horror movies based on the dreams of mind-controlling fungi?

HUMAN FUNGI POLLINATION

While humans grow, reproduce and often continue living, many fungi go through a vegetative phase, in which they grow, then move into a reproductive phase, that may destroy the parent organism, for the benefit of the procreation of the species. In this sense, fungi cannot be seen as individualists, they have not developed the selfishness evident in much of our global society. How would we reconcile our drive to become unique individuals, or separate entities living in a community, with that of the fungi being the community, connected though kilometres of roots and soil? In a Human-Fungus hybrid – what would constitute the parts and what would be the whole – could we viscerally experience ourselves as a part of the world?

An HFI could reveal possible futures where interactions between humans and fungi moves from consumption, nutrition and competition, towards a fertile, symbiotic entanglement...


Culture is the ability to percieve the hidden connections between phenomena...
- Vàclav Havel -



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- Maurizio Montalti -

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