MAKE BUILDINGS BREATHE

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Acknowledgments

I wish to express my sincere thanks to my tutor, whose unwavering support and patience guided me through the intricate process of crafting this dissertation.

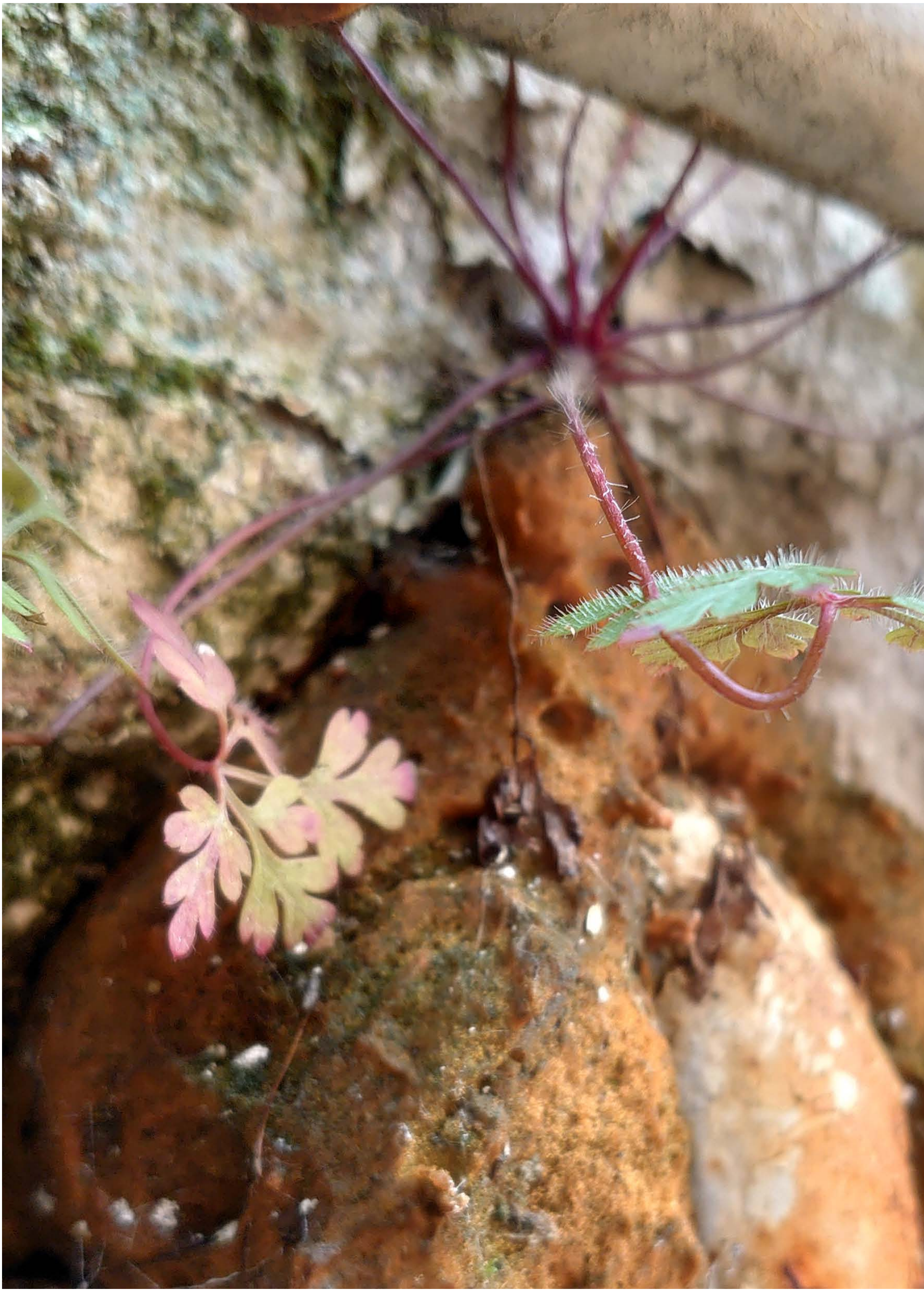


Figure 1: Nature reclaiming urban surfaces, Bermondsey, C. Hallman, 2023

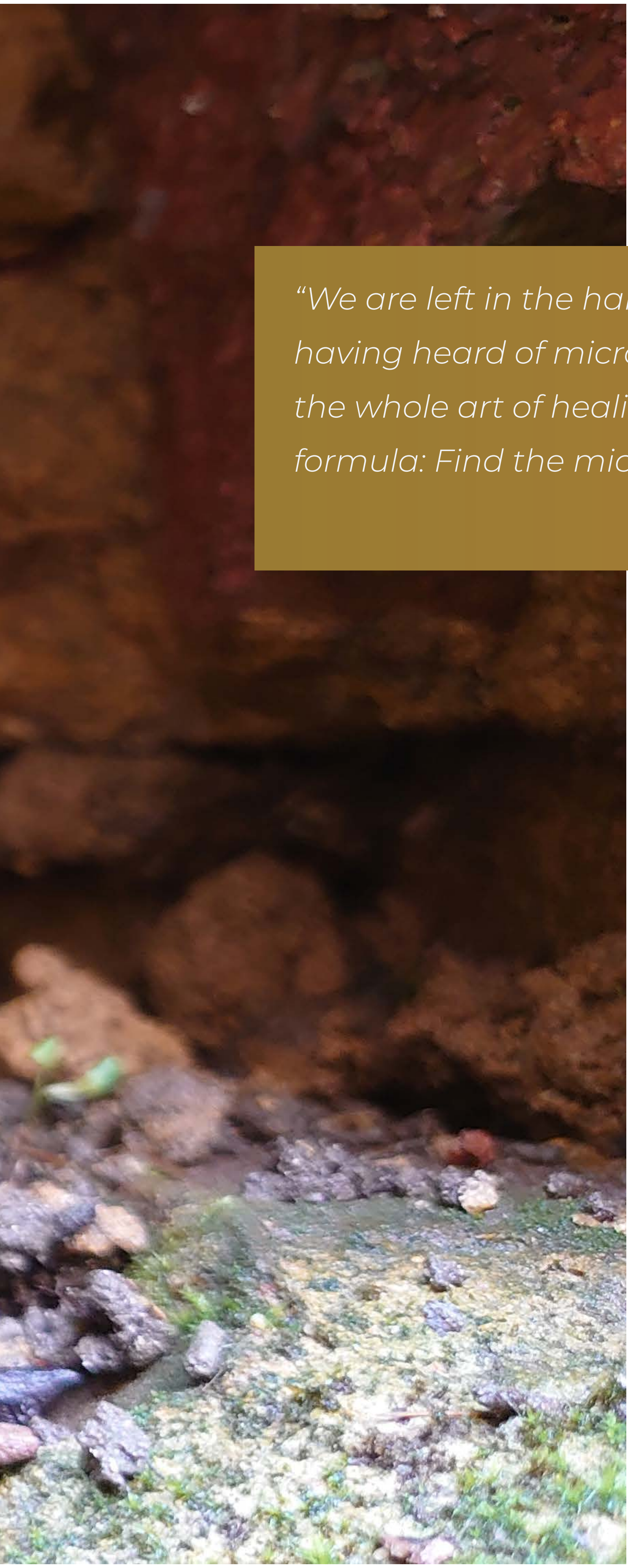
RATIONAL

A Posthuman built environment that moves and breathes – designing urban spaces where all can thrive

This dissertation explores the transformative potential of integrating nature, particularly living surfaces, into urban environments to address the pressing issues of air pollution, biodiversity loss, and the disconnection of citizens from nature.

It seeks to inspire a paradigm shift in urban planning, emphasizing the symbiotic relationship between architecture, ecology, and public health. Through analysis of social policies and shifting design trends, it calls for an urgent reconsideration of our approach to urban development towards a healthier and more vibrant urban future.


Figure 2: Nature reclaiming urban surfaces , Bermondsey, C. Hallman, 2023



"We are left in the hands of the generations which, having heard of microbes...suddenly concluded that the whole art of healing could be summed up in the formula: Find the microbe and kill it".

-George Bernard Shaw

INTRODUCTION

Figure 3: Created with DALLE-3, Promt: Nature reclaiming the interior of an old English industrial building. C. Hallman, 2024

The posthuman built environment that moves and breaths -Reimagining urban spaces for all to thrive.

Today, it is commonly recognised that our connection to nature has a significant influence on both our physical and mental well-being. Urban landscapes have incorporated beautifully manicured parks and tree-lined streets, yet they still struggle with poor air quality, declining biodiversity, and a disconnect with nature for their citizens.

A key but often overlooked contributor to this challenge is the critical role of healthy topsoil. Topsoil stands as the second largest carbon sink on our planet, following the oceans. Additionally, posthumanism theory, the concept of "One Health", which posits that human health is interlinked with the health of animals and the planet with microbes at the centre, leads us to reevaluate the importance of soil in our everyday lives.

However, rapid urbanization has led to the near-complete depletion of this invaluable resource, as it is relentlessly stripped away to make room for new buildings and infrastructure. Urbanization, while enabling modern life, has often led to environmental degradation, poor air quality, and a loss of biodiversity. In this context, the concept of making "buildings breathe" addresses the importance of a shift in the way we envision and construct our urban spaces.

This dissertation explores innovative building materials that draw inspiration not only from the forms found in nature but also from its architectural principles. Nature has been a source of inspiration for designers for centuries, and recent advancements in materials science allow us to translate its efficiency and sustainability into the construction industry. By examining materials that mimic the resilience, adaptability, and even the self-regulating systems observed in natural ecosystems, we can push the boundaries of sustainable architecture.

Architecture stands at the forefront of the challenge to harmonize human habitation with the natural world. This dissertation delves into the principles of biomimicry and post-human design, investigating how the possible infusion of soil and other living surfaces can play a pivotal role in improving air quality, supporting biodiversity, and promoting the well-being of all urban inhabitants.

As I explore the potential symbiosis of architecture, ecology, and human health, I am compelled to rethink our approach to the built environment, architectural practice, and our connection to the natural world.

1

THE MISSING LAYER -Topsoil

Figure 4: Carbon storage

Topsoil, constituting the upper layer of soil with a thickness ranging from 5 to 20 cm, stands as a vital component covering the Earth's surface. This intricate layer, composed of minerals, plant and animal residues, water, air, and living organisms, operates as a complex and efficient ecosystem at a miniature scale, playing an indispensable role in the environment and society.

Soil, containing approximately 60% carbon in its organic matter, is a crucial part of the global carbon cycle. Referencing the Commission's findings in 2011, the soil is identified as the second-largest active carbon store globally, boasting a vast reservoir of around 1,500 billion tonnes, surpassing both the atmosphere (760 billion tonnes) and vegetation (560 billion tonnes) combined.

However, the urban environment faces a detrimental depletion of soil due to infrastructure expansion, such as roads and concrete buildings.

Carbon, crucial in this ecosystem, undergoes continuous cycling between the soil and the atmosphere. This dynamic process involves plant absorption of CO2 through photosynthesis, organic compounds released into the soil via plant roots or decomposition, and soil respiration releasing some carbon as CO2.

The delicate balance between material addition and decomposition dictates the trajectory of soil organic matter, either increasing or declining. (Comission, 2011)

In the urban context, the health of soil is intricately linked to the wellbeing of trees. Unfortunately, tree roots are often ensnared by asphalt, causing soil degradation. Additionally, the removal of organic waste, like leaves, further exacerbates the challenge. The removal of this biomass deprives soil microorganisms of essential components needed to produce new organic matter. (Comission, 2011)

Addressing these issues becomes imperative in ensuring sustainable urban environments that prioritize the preservation and enhancement of this crucial natural resource.

The absence of soil in urban environments also exacerbates the Urban Heat Island (UHI) effect by diminishing the natural cooling capacity provided by soil moisture and vegetation. Healthy soil acts as a thermal regulator, absorbing and dissipating heat through processes like evaporation and transpiration.
Without sufficient soil cover, impervious surfaces dominate, leading to increased heat retention, higher surface temperatures, and elevated UHI intensities in urban areas. (MetLink, 2021)

Introducing soil and nature on a larger scale in our built environment is good on a global scale, but the impact would be greater on our own health and wellbeing. Humans instinctively respond to living things, and our wellbeing is intricately linked to our connection with nature. However, in constructing urban environments, we've often disconnected from nature, attempting to compensate by adding parks as substitutes for its presence. There are ample statistics to support this claim.

Human health is intricately linked to the well-being of animals, plants, and the environment. Soils play a pivotal role in this interconnected system, serving as a vital source and reservoir of pathogens, beneficial microorganisms, and overall microbial diversity across various organisms and ecosystems.

The soil microbiome performs functions that directly or indirectly contribute to the health of soil, plants, animals, and humans. It's increasingly evident that microorganisms are shared among different health compartments, and the microbiomes of soil, plants, and humans are more interconnected than previously assumed. Considering the impacts of dysbiosis and global change, it becomes evident that microbial diversity generally correlates positively with health outcomes. (Banerjee, 2023)

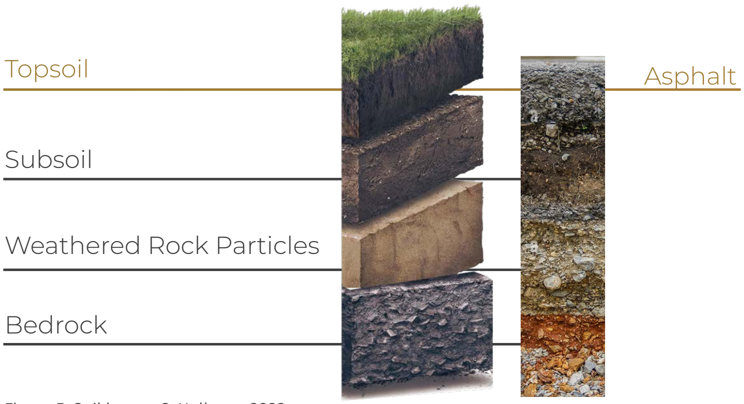


Figure 5: Soil layers, C. Hallman, 2023

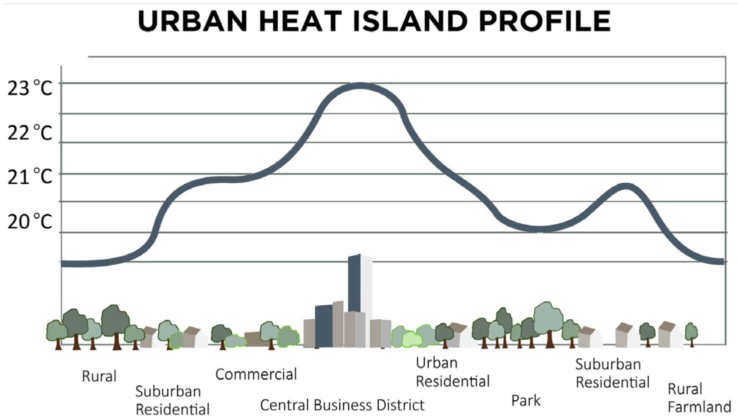


Figure 6: Diagram of UHI

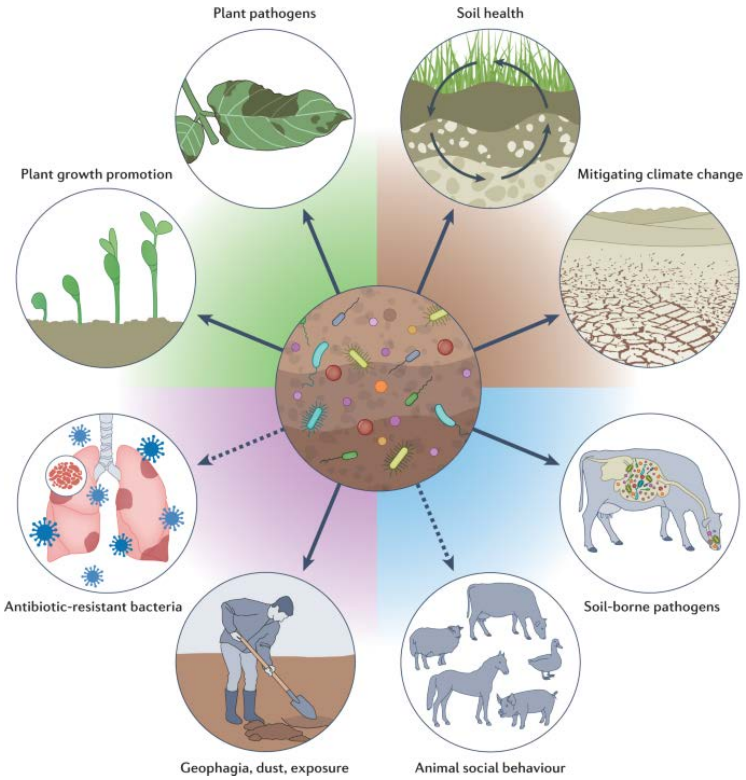
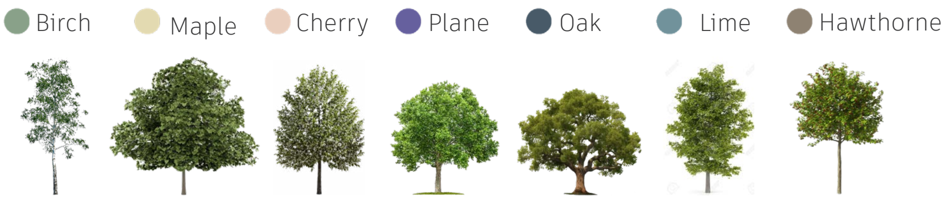


Figure 7: Soil microbiomes and one health

London is acknowledged as a vast urban forest with approximately 8.4 million trees. Nevertheless, it lacks the comprehensive attributes of a natural forest ecosystem. Challenges such as pollution, limited space for growth, and fragmented habitats impede the trees' ability to flourish and provide optimal ecosystem services.

This disparity is particularly evident between canopy and ground-level greenery.

Tree mapping Bermondessey



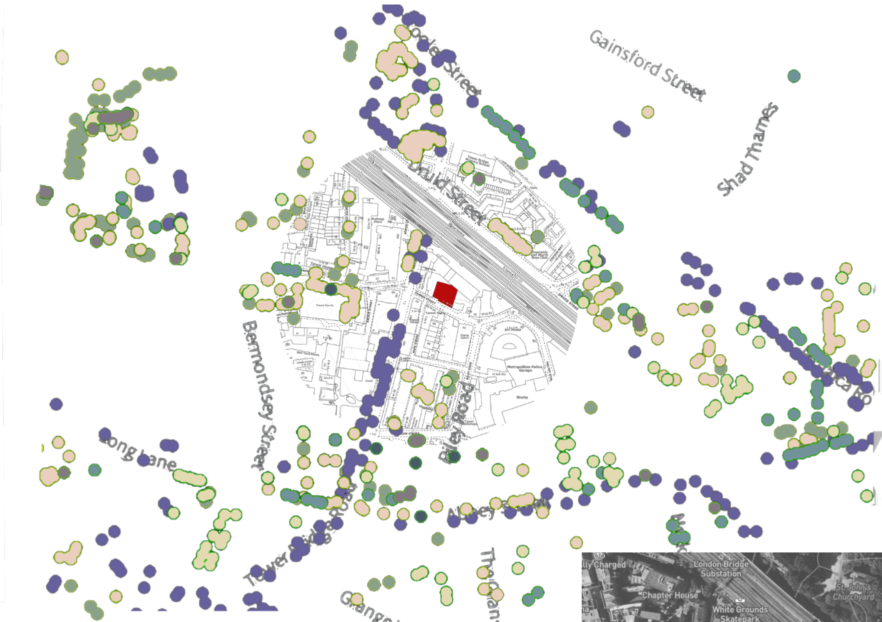


Figure 8: Tree mapping Bermondessey, C. Hallman, 2023

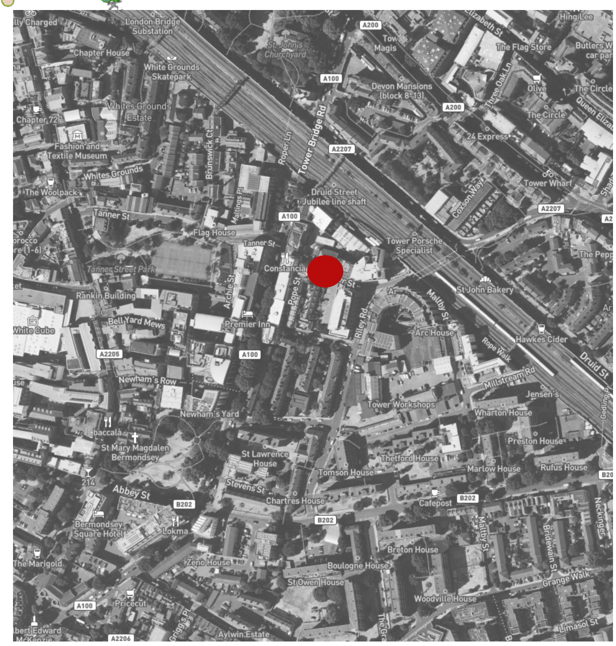


Figure 9: Urban Density Bermondessey

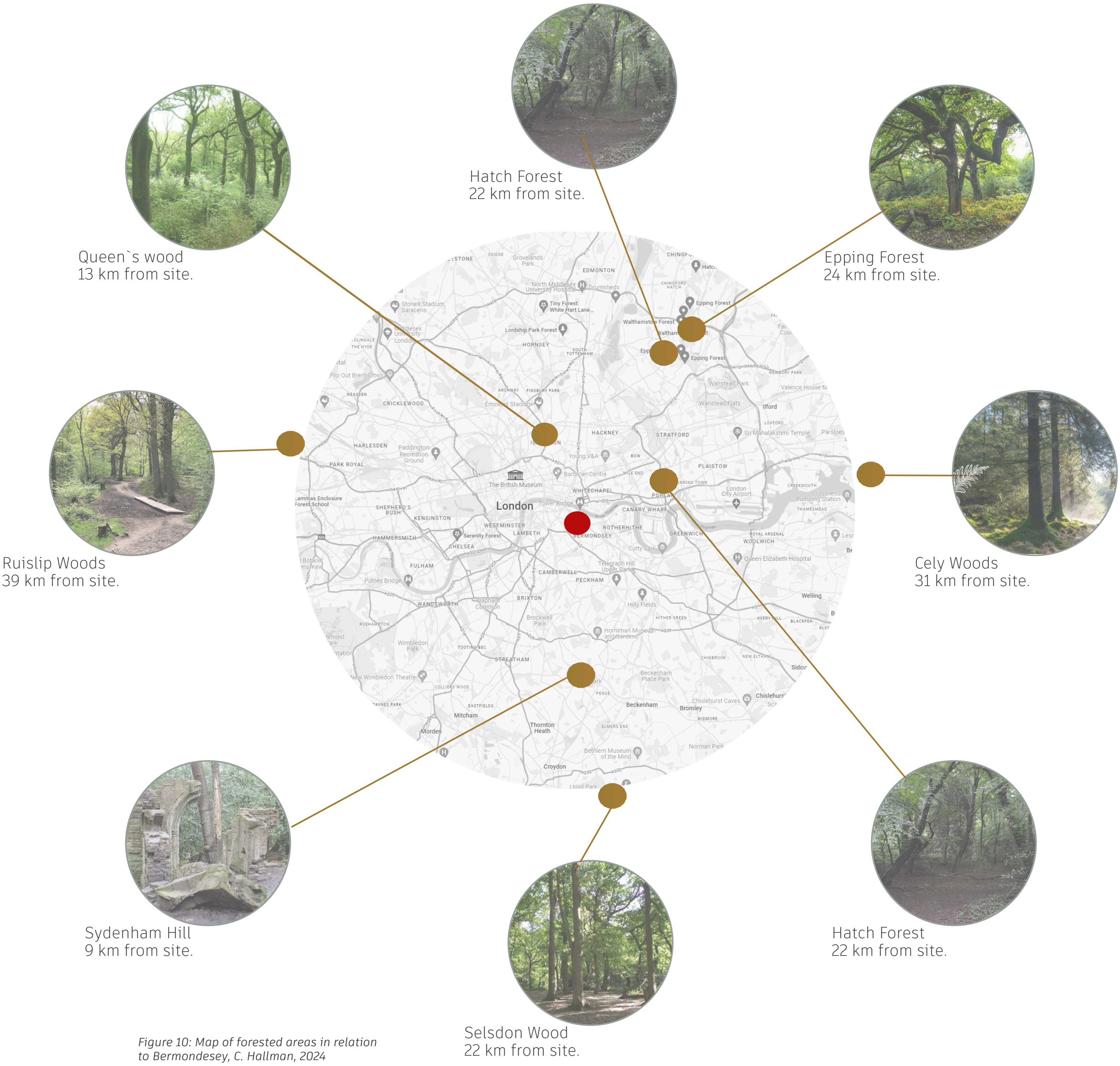


Figure 10: Map of forested areas in relation to Bermondesey, C. Hallman, 2024

Although there are several large parks and woodlands in inner London, they are typically contained and separate from adjacent neighborhoods. Through a more radical approach to urban planning and street design there is the potential to build a greater network of living surfaces across London.

Soil stands as an indispensable element in our lives, equivalent in importance to the water we drink and the air we breathe. However, in the urban environment, we find ourselves depleted of the third component of this vital trinity. Our historical aversion to what has been perceived as dirty, disgusting, and laden with germs has inadvertently led to detrimental consequences for our wellbeing. In our quest to sanitize and eliminate what we consider harmful, we have, paradoxically, made ourselves sicker.

It is imperative to embark on a journey of re-evaluation, not just of the soil beneath our feet but, equally importantly, our relationship with germs. The prevailing narrative surrounding microbes and dirt as solely negative entities needs to be reconsidered. Rather than viewing them as threats to be eradicated, there is a growing understanding of the essential role microbes play in maintaining our health. As we delve into this re-evaluation, we are confronted with the reality that our relentless pursuit of cleanliness has disrupted the delicate balance of microbial ecosystems, both within our bodies and in the environments we inhabit.

In envisioning a healthier future, we must acknowledge that microbes are not adversaries but integral participants in the intricate dance of life. It is time to design spaces that embrace, rather than shun, the microbial world. By fostering environments that encourage a diverse and balanced microbial presence, we can cultivate a symbiotic relationship with germs, ultimately contributing to a more resilient, vibrant, and healthier urban future. This paradigm shift calls for a holistic reimagining of our design principles, emphasizing the importance of coexisting with the microbial world for the benefit of both human and environmental health.

"We are on the brink of the transition towards nature-like construction: for the first time, it may be possible to design a true living, breathing building,"

-Rupert Soar

Figure 11: Vespignani, F. (2021) Meristem Wall, Italy

Figure 12: F, Staud, Termite Mound

LIVING, BREATHING, MOVING WALLS

2

In recent years, the concept of biophilic design has gained significant traction within architectural and design circles. This approach emphasizes the integration of natural elements and processes into the built environment, recognizing the inherent connection between humans and nature.

The growing popularity of biophilic design stems from a heightened awareness of nature's positive impact on human health and well-being, particularly its stress-reducing effects.

However, while biophilic design offers valuable insights into creating environments that promote mental and emotional well-being, there is a growing interest in exploring even deeper connections with nature through biomimicry design principles.

Biomimicry goes beyond simply incorporating natural elements into design, it seeks to emulate nature's strategies, processes, and systems to solve human challenges and enhance various aspects of our lives.

In this context, biomimicry presents an exciting opportunity to not only enhance our psychological well-being but also to improve our physical health.

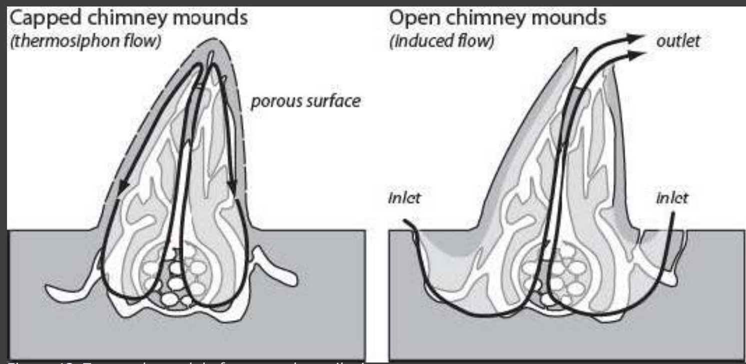


Figure 13: Two early models for mound ventilation

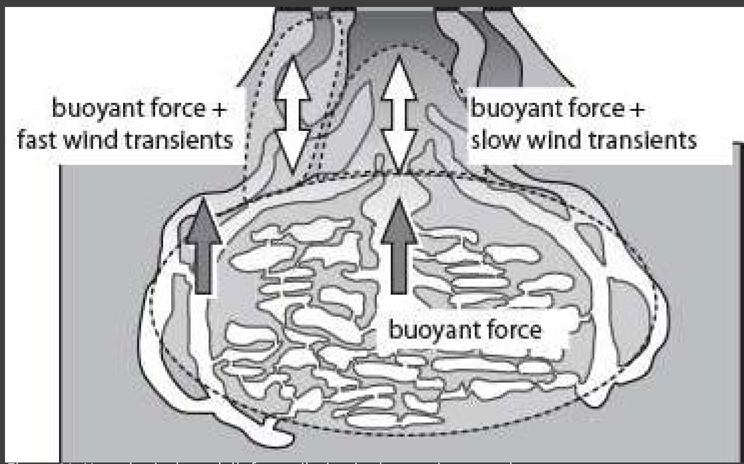


Figure 14: Hypothetical pendelluft ventilation in the termite mound nest

Termites

Termites in the Macrotermitinae subfamily construct expansive soil mounds above their colonies, integral to their physiology, serving as an extension of their physical form. The mound's architecture utilizes temperature differentials for ventilation. This intricate system not only controls airflow but also regulates humidity levels. Mound formation involves two building phases, where soil is either moved within the mound for expansion or deposited externally, and internal conduits can be modified without soil removal. (Turner, 2008)

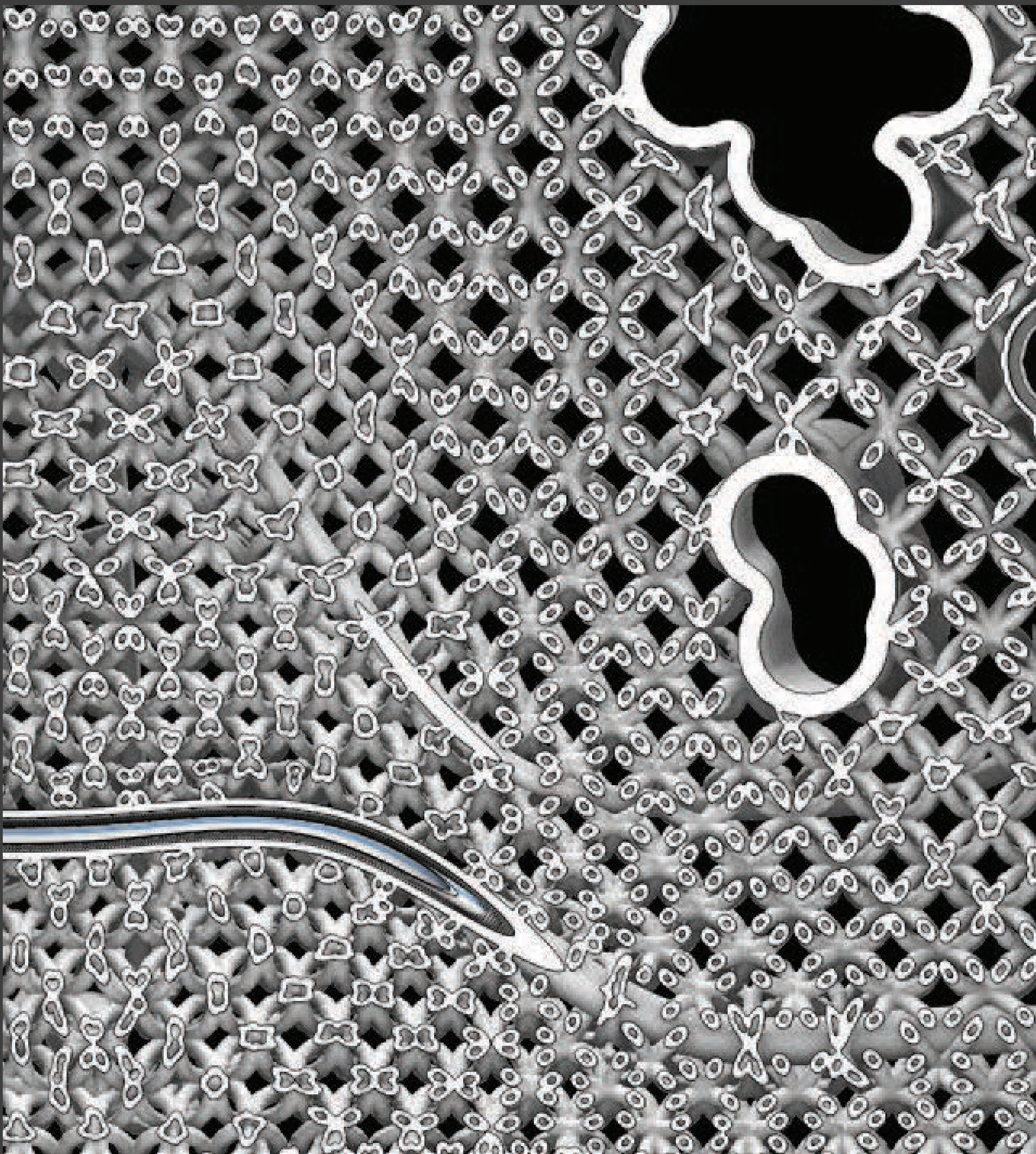


Figure 15: Meristem wall

The termite mound, including the subterranean nest and intricate tunnel network, functions as a complex system resembling a lung. Like the lung's multi-phase gas exchange, the termite mound incorporates subsidiary functions for colony gas exchange. Ventilation in the upper airways relies on forced convection, while gas exchange in the alveoli and alveolar ducts occurs through diffusion. This mixed-regime region, encompassing fine bronchi and bronchioles, parallels overall lung function control, highlighting the significance of understanding these complexities in biological systems. (Goidea, 2021)

Researchers from Lund University and Nottingham Trent University have explored the potential applications of termite mound design in architecture. The study focuses on the 'egress complex,' an intricate network of interconnected tunnels found in termite mounds, which promotes flows of air, heat, and moisture. By examining the mounds of Macrotermitinae termites, the researchers found that the egress complex facilitates oscillating flows that enhance ventilation. They suggest that integrating similar structures into building walls, using technologies like 3D printing, could allow for energy-efficient air movement, creating a true living, breathing building that balances comfort and ventilation. (Ionescu, 2023)

The Meristem Wall, a groundbreaking 3D-printed building envelope prototype, introduces a dynamic network of integrated air channels that foster a fluid and adaptive interaction between the interior and exterior environments. This innovative wall incorporates functional elements such as lighting, electricity, and windows. Fabricated through binder-jet sand 3D printing, the Meristem Wall represents a leap in climatically performative architecture, extending its inclusivity to nonhuman life in urban settings.

Building on previous research demonstrating airflow transfer in a branching network, the Meristem Wall's channels are controllable through embedded sensors and actuators, allowing selective heat and moisture transport.

The intricate design of the channels limits cross-drafts while offering a nested landscape on the outer part of the wall, creating an extensive biological habitat within the building itself.

This visionary project not only showcases the potential of 3D printing in the construction sector but also redefines our relationship with the natural and built environment, illustrating how technology can harmonize with ecological principles.

The computational design model, rooted in a parametric system, intricately defines the wall's volumetric and dynamic constraints, showcasing its adaptability and versatility. (Goidea, 2021)

Figure 16: Vespignani, F. (2021) Meristem Wall, Italy

"We imagine that building walls in the future, made with emerging technologies like powder bed printers, will contain networks similar to the egress complex. These will make it possible to move air around, through embedded sensors and actuators that require only tiny amounts of energy," -David Andréen

Figure 17: Vespignani, F. (2021) Meristem Wall, Italy

Scott Turner's remark on termite mounds being an integral extension of the insects' physiology prompts a thought-provoking comparison to human approaches. Humans tend to transform their spatial interiors as an expression of their personalities, yet the distinction lies in our tendency to eliminate the natural. Unlike termites, we rely on artificial elements for ventilation and well-being, sterilizing surfaces to eradicate bacteria and adding potted plants for a semblance of nature. Turner's insight urges us to reconsider, suggesting that true harmony with nature may require embracing it in its unadulterated form, recognizing its vital role in our overall well-being.

Figure 18: Tiles that inhabits microbes

Microbes

Associate Professor at The Bartlett School of Architecture, Richard Beckett, was awarded the 2020 Medal of the RIBA President's Awards for Research, for the creation of a wall tile designed to retain microbes and moisture, serving as a transformative element in indoor environments. Inspired by the principles of Japanese forest bathing, Beckett's approach aims to bring the numerous health benefits associated with nature directly into interior spaces.

"Exposure to microbes associated with natural environments plays a fundamental role in shaping immunoregulatory health. We're trying to develop biologically active materials for buildings, using a novel soil material rich in microbial communities that can 'rewild' the indoor environment – bringing microbial diversity associated with nature." - Richard Beckett

Urbanization, indoor lifestyles, and entrenched antibiotic attitudes are diminishing our exposure to a wide range of environmental microbes in our day-to-day lives. In the past, the threat of infection and pandemics was primarily associated with the presence or abundance of harmful microbes. However, contemporary medical understanding of the microbiome indicates a connection not with the presence, but rather with the absence of microbes from both our bodies and our surroundings. Evidence suggests that the divide between humans and the non-human world has been pushed to an extreme. It seems that to create healthy buildings and resilient cities, we require an increase in microbes, rather than a decrease. It's important to note that not all microbes are harmful; many are benign, and some are even essential for our well-being. (Beckett, Microbes are our friends, 2021)

Beckett`s research investigated the manipulation of microbes in buildings across air, water, and surfaces to become sources and sinks of beneficial microbes. It began with the development of hybrid living materials containing colonies of beneficial bacteria, exploring their design, fabrication, and sustainability over time without maintenance. A multidisciplinary team from UCL collaborated on the project across micro, meso, and macro scales. At the meso-scale, probiotic surfaces were designed and fabricated to transfer beneficial bacteria to occupants and other parts of the building, aiming to mitigate pathogen transmission. These surfaces, tested as wall tiles in an office, influenced the indoor microbiome, guided by computational simulations of air movement. The indoor microbiome was monitored in a controlled study using a before, during, and after installation approach employing both plating and DNA sequencing techniques. Results demonstrated a measurable effect on the microbiome of the space following installation. (Beckett, Probiotic design, 2021)

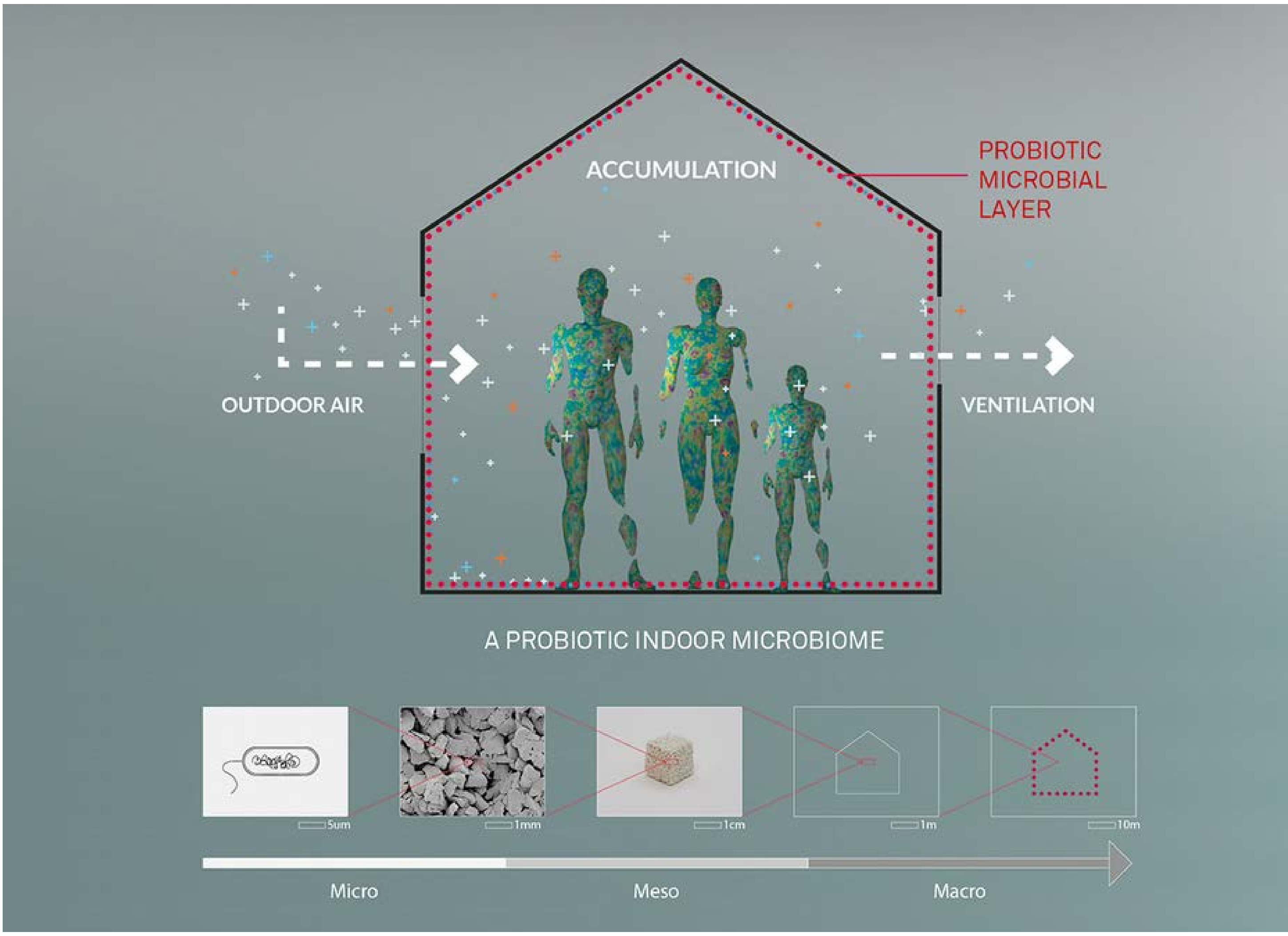


Figure 19: A probiotic Indoor microbiome approach using a multi scale design process

Figure 20: Meso Scale Design- Detail of probiotic surface

"As we learn more about the indoor microbiome, and what exactly constitutes healthy microbes, architects will need to work with experts from non-traditional fields including microbiologists, virologists and environmental engineers towards creating healthy and resilient buildings."

-Richard Beckett

By fostering a dynamic relationship between architecture and microbial life, these tiles not only contribute to the aesthetic appeal of interiors but also prioritize occupants' well-being. This approach to designing our future urban habitats is imperative, as it factors in our understanding of microbes and their impact on health, which holds significant implications for the future of architecture. This research introduces a refined strategy akin to an immune system for buildings: a living microbial layer capable of inhibiting the proliferation and transmission of harmful microbes, while also nurturing the presence of beneficial ones within architectural spaces. This experimental initiative offers an initial framework for embracing a living material and spatial-oriented approach to crafting healthier buildings, considering the indoor microbiome. Beckett terms this innovative approach 'probiotic architecture'.

3
THE CHALLENGES OF CO-EXISTENCE

Nature is remarkably resilient, often seeking to reclaim its existence even in the smallest cracks, which can pose challenges for our buildings and necessitate costly maintenance.
When left neglected, a building's façade can transform into a biodiverse universe of its own. In this state, new forms and textures emerge, marked by an untamed and wild appearance.

Figure 21: Nature reclaims urban surfaces , Bermondsey, C. Hallman, 2023

These areas illustrate the intricate dance between urban development and the persistent forces of nature attempting to reclaim their space, showcasing an ongoing dialogue between urban planning and the resilience of the natural environment.
Why not design surfaces that cater to both human and non-human species?

Figure 22 : Hallman, C. (2023) Dead fly, Bermondsey

Stop calling it climate change.
It's global warming.

Actually stop calling it global warming.
It's mass extinction.

Mass extinction.

-Timothy Morton

Feral

Environmental philosopher Timothy Morton proposes replacing the term 'climate change' with 'mass extinction', which he argues more accurately reflects the dire consequences of human impact on the environment. With the onset of the Anthropocene era, evidence mounts for Earth's sixth mass extinction event, with approximately half of the planet's two million identified species facing imminent extinction due to human-induced habitat loss and environmental degradation. This alarming trend includes what is often termed the 'insect apocalypse', with an estimated 75 percent decline in insect populations over the past five decades, posing a significant threat to terrestrial food webs. In response to these ecological challenges, Harrison Atelier is developing surfaces that incorporate habitats for insects, plants, and technology. (Harrison, 2024)

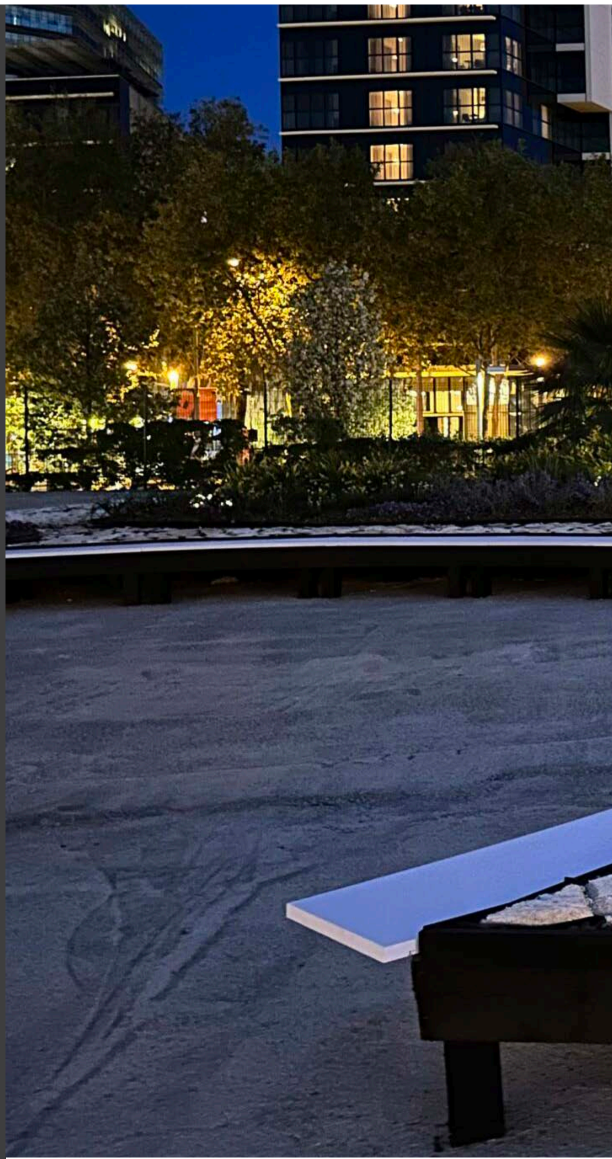
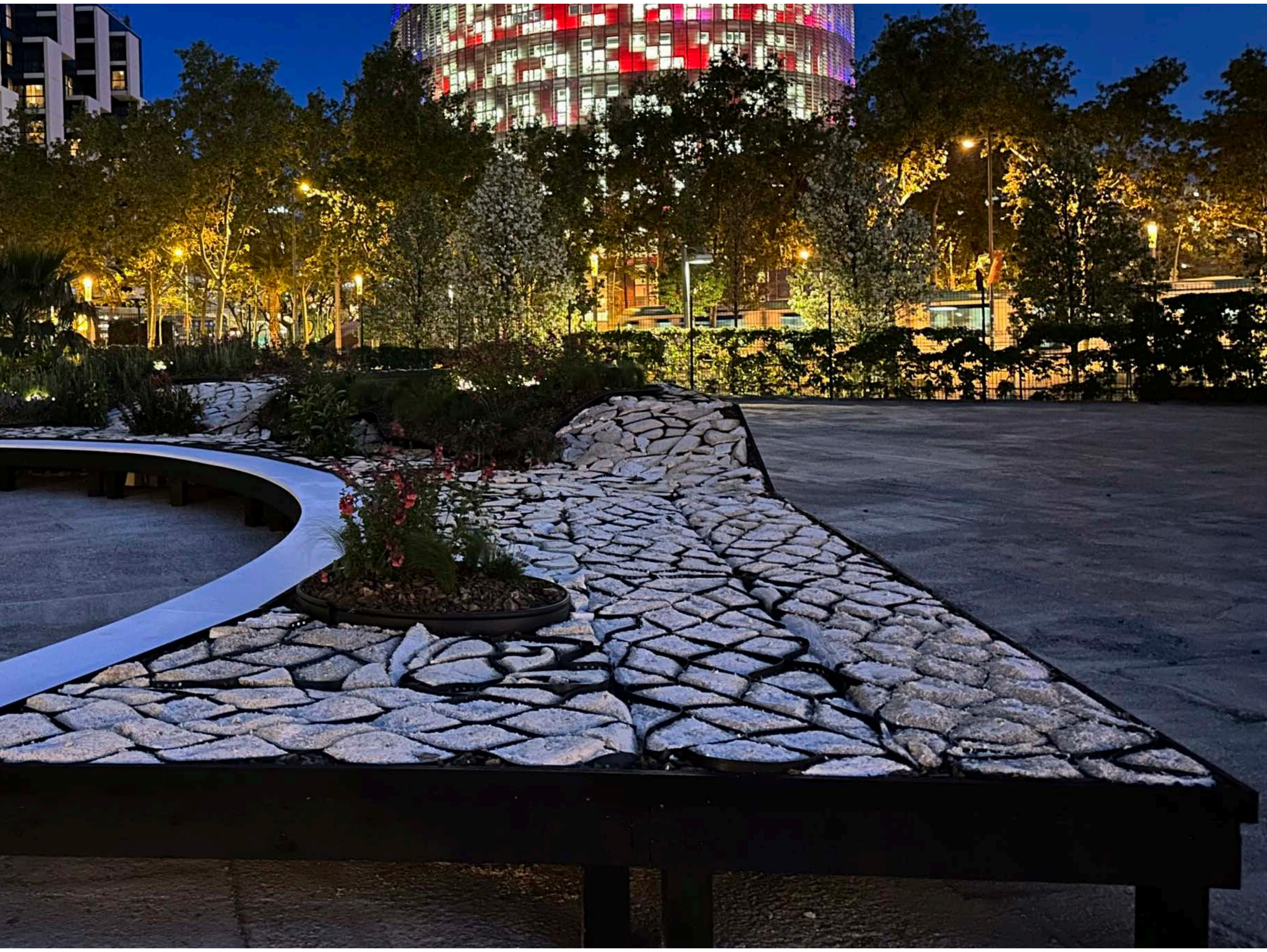


Figure 23: Feral Surfaces installation, Barcelona, 2023



The Feral Surfaces installation by Harrison Atelier was commissioned for the 2023 MODEL Barcelona Architectures Festival. It aimed to address the critical issue of habitat loss for native bees in urban, agricultural, and industrial landscapes. The installation featured native plants and over 2,000 mycelium panels, each serving as a habitat for solitary bees. These bees, which constitute 90% of the planet's bee species, play a crucial role in pollination but face threats due to habitat destruction. The minuscule nature of insect life often goes unnoticed by humans, to the extent that we can only approximate the significant decline in insect species, with only about 1 percent of them having been evaluated.

Despite their small size, insects play a crucial role in sustaining most terrestrial species. The installation, situated on a large concrete plaza, highlights the challenges in preserving the simple habitat of native bees—a hole in the ground—in our current urban environment, where the lack of suitable habitat poses a major threat to various species, including native bees. The installation features a landscape with native bee-friendly plants and over 2,000 mycelium panels designed as potential habitats for cavity-dwelling solitary bees, each equipped with a 10-centimeter diagonal tubular cavity and a one-centimetre diameter hole as the entrance. (Harrison, 2024)

Figure 24: Harrison atelier, Hempcrete Habitats Wall panels, New York

Figure 25: Nature reclaiming urban surfaces , Bermondsey, C. Hallman, 2023

Old building facades often serve as habitats for insects. Expanding on this concept could lead to the creation of a more symbiotic relationship between our species, while simultaneously generating beautifully textured and visually intriguing building skins.

Cookfox Architects have introduced a prototype of a ceramic multi-species facade system. This loadbearing terracotta facade consists of modular habitats that regulate themselves and are intended to encourage cohabitation with small birds, solitary bees, and other insects. The design emphasizes aerospatial habitonomics, incorporating openings and microclimates to attract New York City's local urban wildlife. Additionally, the hidden rear of the facade is engineered to provide shelter for nocturnal species. Leading the project is Spencer Lapp, the primary designer and beekeeper, who is experimenting with various modular scales, forms, colors, textures, and compositions to promote the coexistence of different species. As part of this ongoing effort, one module of the facade facilitates interactions with the diverse species of solitary bees that thrive in New York City, while another module, featuring a curved opening, offers nesting support for various small birds. The design approach is highly technical, taking into account factors such as ventilation, drainage, shading, and protection, as well as exploring techniques such as curvaceous slip casting and glazing. (Hutt, 2024)

Harrison states in an article for Architectural Design that throughout the history of architecture, the feral has been present in our cities. The fact that urban areas already serve as a substitute for wilderness deserves closer examination. As the human population grows and urbanization continues, habitat for other species will diminish unless our cities become resilient environments. Building surfaces not only provide the appearance but also the function of resilience by offering habitat. Unlike modern corporate towers or sleek residential complexes, the textured materials of older structures provided actual living spaces for non-human creatures. Working with ecologically conscious materials today could introduce new textures to accommodate non-human inhabitants on building surfaces. A feral envelope, neither smooth nor monolithic, embodies the qualities of wildness, growth, decay, and the cyclical processes of nature. (Harrison, 2024)

Figure 26: Ceramic multi species facade, New York, 2022

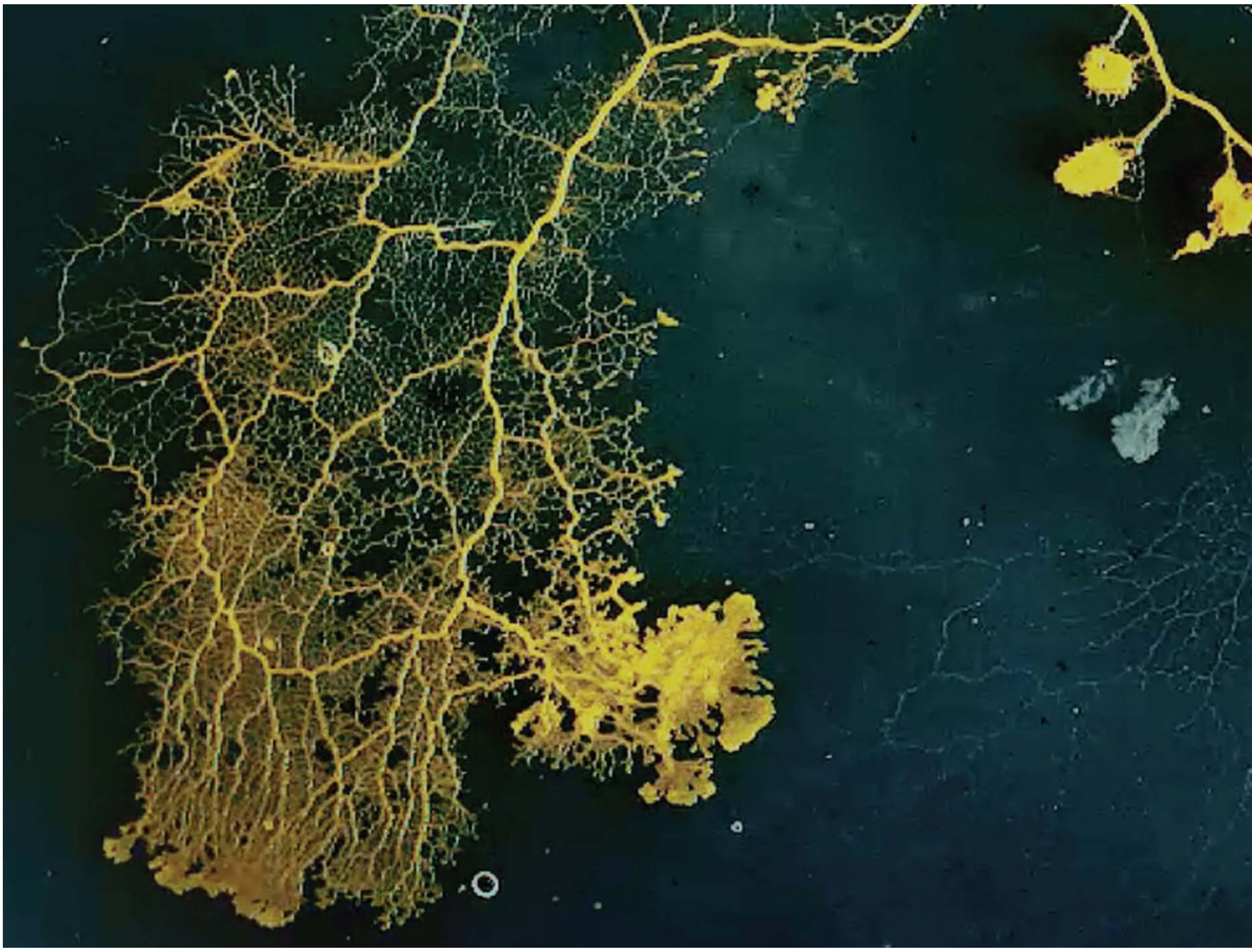
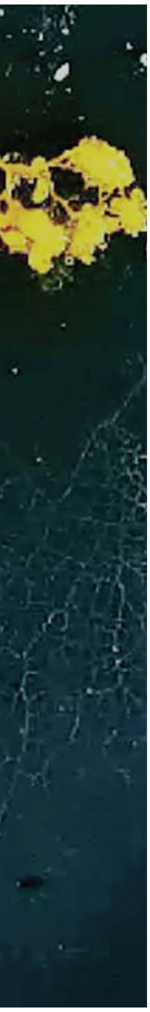


Figure 27: Redesign of the municipal waste collection networks, Guatemala City using an algorithm based on the behaviour of a slime mould.

Slime

In a recent article in Architectural Review, Mario Carpo, a prominent figure in architectural theory, highlights the significance of slime moulds in complexity and emergence studies, which are attracting attention from various academic disciplines and fields. The fascinating capabilities of slime moulds exhibit complex behaviors such as building cooperative networks and solving mazes in search of food despite lacking a central nervous system.



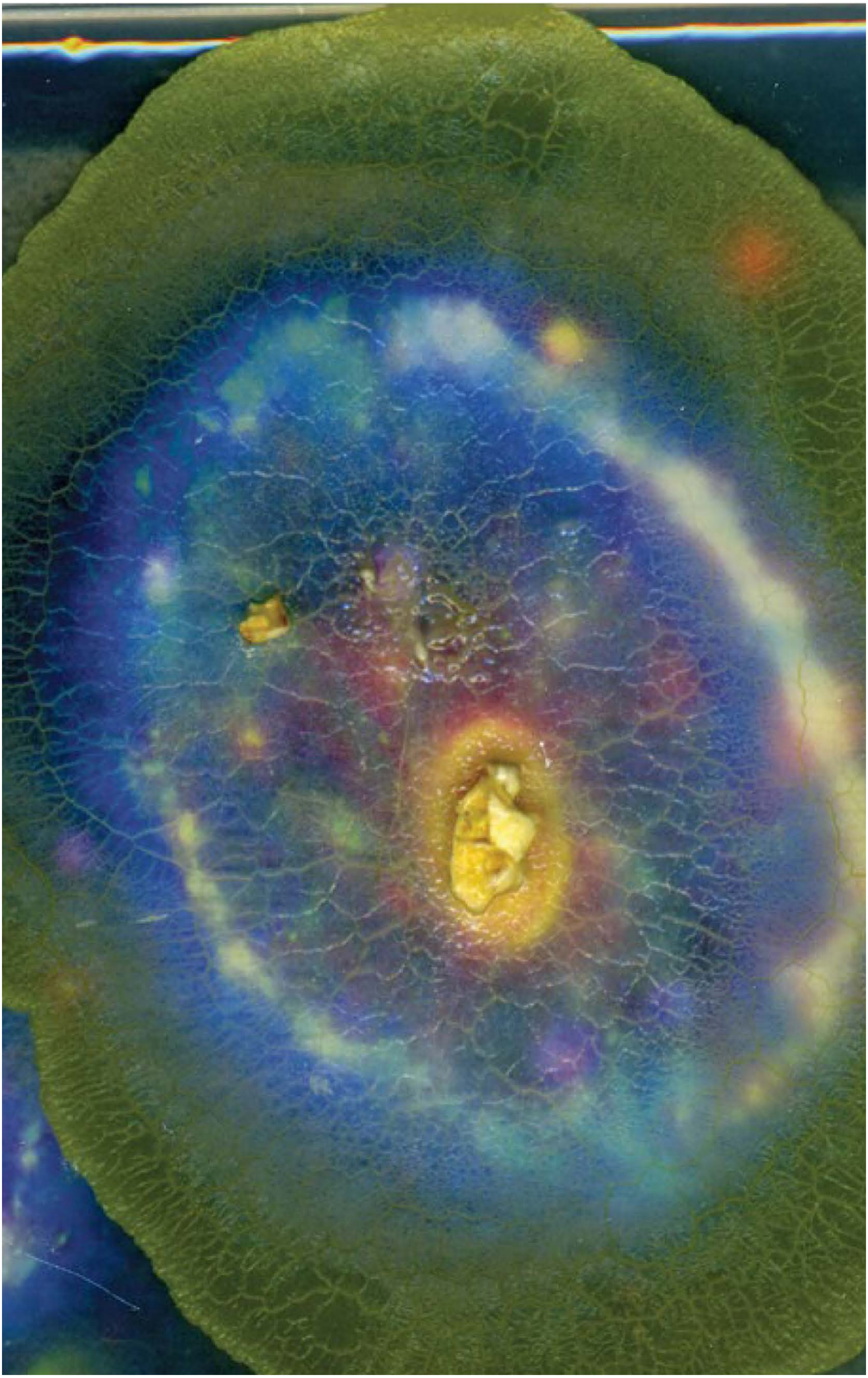


Figure 28: Slime Mould Gate, 2015

In a recent article in Architectural Review, Mario Carpo, a prominent figure in architectural theory, highlights the significance of slime moulds in complexity and emergence studies, which are attracting attention from various academic disciplines and fields. The fascinating capabilities of slime moulds exhibit complex behaviors such as building cooperative networks and solving mazes in search of food despite lacking a central nervous system.

Slime moulds, often regarded as a case study of biological self-organization, have intrigued scientists for their ability to transition between single-celled and multicellular forms based on environmental conditions. This phenomenon aligns with the concept of self-organization, a key aspect of complexity science. New research explores the potential applications of slime mould behavior in computational simulations and architectural design, drawing parallels between emergent behaviors observed in slime moulds and computational problem-solving strategies. (Carpo, 2024)

Despite their primitive nature, slime moulds exhibit problem-solving skills reminiscent of artificial intelligence algorithms, shedding light on the interconnectedness between organic and artificial intelligence. The attributes of slime moulds as scientific models, including emergent self-organization and computational machine learning, are embodied by two distinct species: cellular slime moulds and plasmodial slime moulds. While emergence and self-organization align with certain ideological views, computational problem-solving represents a pragmatic technological approach. (Carpo, 2024)

Despite their differences, slime moulds serve as a common reference point in machine learning and complexity science, highlighting shared characteristics with nature and artificial intelligence. Unlike humans, slime moulds lack the capacity for deliberate design or planning, relying instead on reactive behaviors for survival. This distinction underscores the limitations of trial-and-error learning in both natural and artificial systems, contrasting with the more nuanced learning mechanisms available to humans. (Carpo, 2024)

"Humans, can learn both by experience and by schooling; Slime moulds do not have that choice. But humans that choose to learn by trial and error when the transmission of accumulated knowledge is otherwise available are neither pre-human nor posthuman; they are wasteful fools."

-Mario Carpo

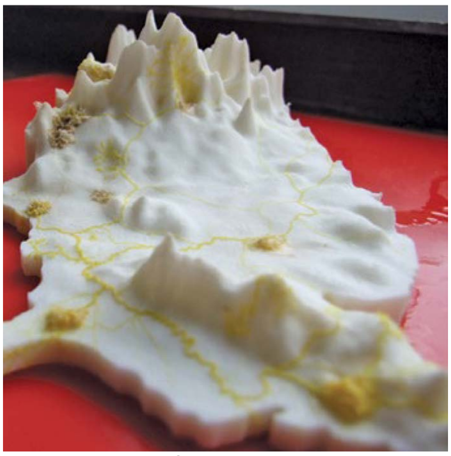


Figure 29: Slime mold, foraging on a three-dimensional nylon model of the USA, mimics migratory routes between Mexico and the US. Migratory paths formed on a flat substrate might represent air transportation, whereas routes on three-dimensional terrain signify ground transportation.

The study of slime moulds and their behaviors may help architects and designers rethink how buildings and cities can be designed more efficiently and creatively. For example, architects might look at how slime moulds can find the most efficient paths through mazes and apply that idea to designing efficient layouts for buildings or transportation systems. Also, slime moulds can teach us about self-organization, which is useful for designing buildings that can adapt to changes in their environment or usage over time. Studying slime moulds can inspire architects to think differently about how they design spaces, making them more efficient, adaptable, as well as aesthetically pleasing.

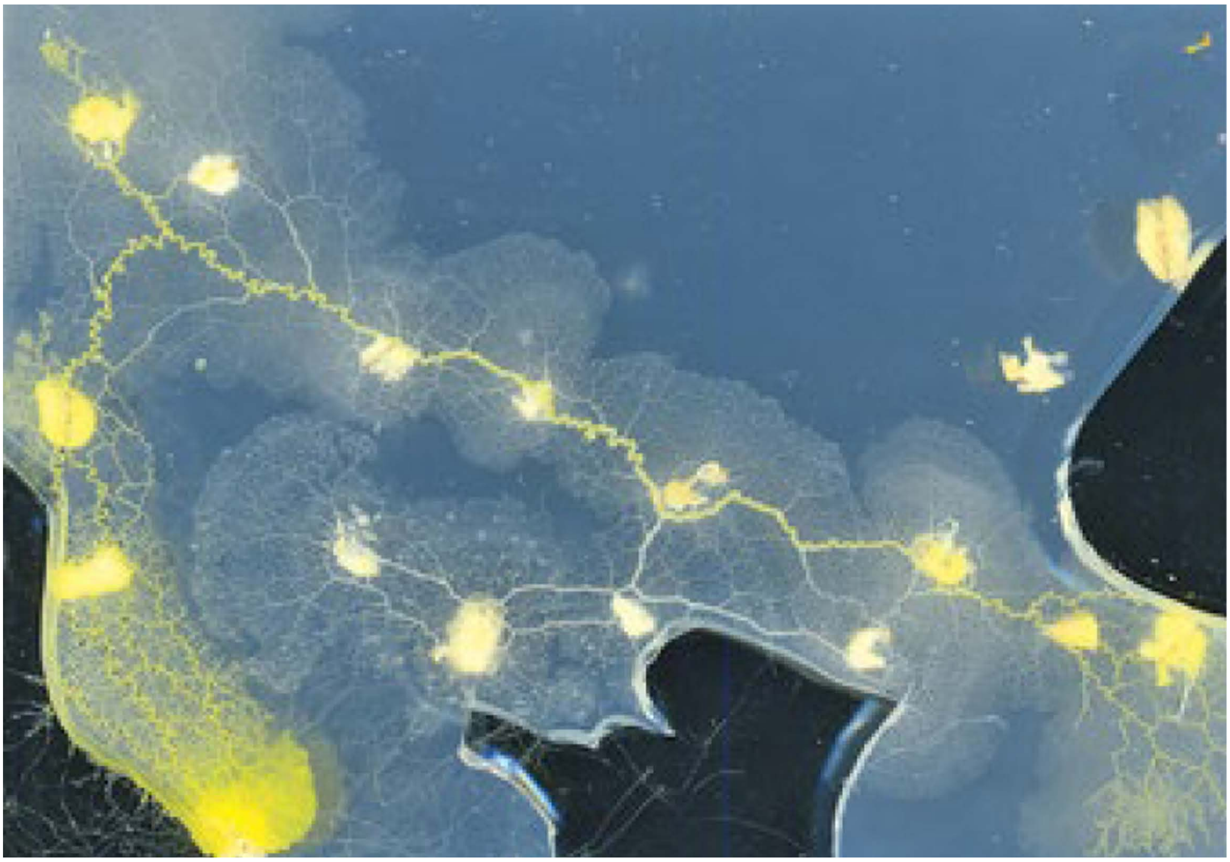


Figure 30: Slime mold foraging on a topographical map of the Balkans, with food placed where major settlements were located in the Roman era, reconstructs the historical pattern of Roman roads..

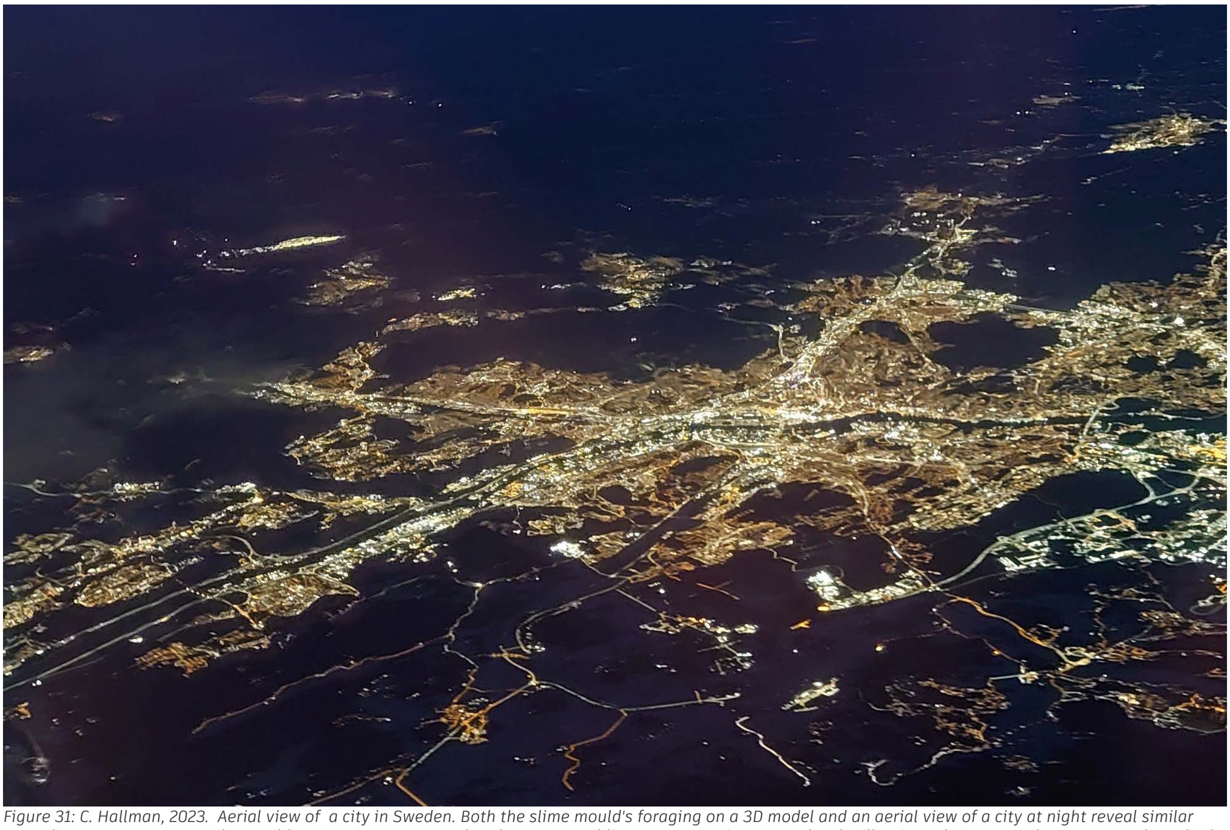


Figure 31: C. Hallman, 2023. Aerial view of a city in Sweden. Both the slime mould's foraging on a 3D model and an aerial view of a city at night reveal similar spreading patterns. Just as the mould creates interconnected pathways resembling transportation networks, the illuminated cityscape showcases roads and urban sprawl connecting various areas. This highlights how both biological and human-made systems exhibit comparable organizational patterns when viewed on a larger scale

4

LIVING WITH DIRT

Reintroducing nature into our living spaces would involve fostering cohabitation with microbes, insects, and elements often categorized as dirt.

How might inhabitants respond to this transition? Would they embrace it, or might there be expressions of disgust?

“Darwin identified disgust as a powerful emotion that's thought to be a human universal and counted it as one of the six basic human emotions.“

Curtis defines hygiene as a set of behaviors aimed at avoiding infection. He states that hygiene has deep roots in evolutionary history and is widespread among animals, including humans. In humans, the emotion of disgust plays a significant role in motivating these behaviors. According to his research findings, an inherent sense of disgust may drive individuals to avoid feces, vomit, and individuals who could potentially be contagious. He suggests that disgust serves as one of the mechanisms evolved through natural selection to aid in maintaining a safe distance from contagion, and that disgust can be likened to intuitive microbiology, providing a rationale for our instinctual aversion to objects that have come into contact with repulsive substances. He believes contrary to some assumptions that hygiene behaviors and disgust precede culture and cannot be solely attributed to cultural influence. Understanding the history of disease ideas requires a perspective that incorporates biology, as hygiene is fundamentally an aspect of animal behavior. (Curtis, 2001)

In his research, he uncovered the significant importance of hygiene across all subjects he studied. He identified disgust as a fundamental aspect of our psychological makeup, noting that certain stimuli are more prone to evoke disgust than others. However, he observed that the specific objects, acts, and events triggering disgust can vary between different places and individuals, suggesting a degree of variability influenced by social learning. Moreover, he observed that hygienic behaviour is often driven from a desire to avoid or eliminate things that are perceived as disgusting. (Curtis, 2001)

Lucy Pickering and Philippa Wiseman examined the significant role of dirt and its management in the process of civilization. They present a specific type of history concerning European interactions with dirt.

This history portrays dirt not only as a marker of distinction but also as a subject of increasing avoidance, particularly regarding bodily waste. By juxtaposing this narrative with another history concerning European perceptions of dirt in relation to illness and contagion, they analysed the functions of discourses surrounding dirt. They found evidence that both narratives involve processes of "Othering," whereby individuals or groups define what is considered dirty. They observe narratives that illustrate dirt as a locus of power, wielded by those who designate certain entities as unclean to subjugate them.

Philosopher Olli Lagerspetz believes that ontology plays a part in our perception of dirt. He noted a significant shift during the European Renaissance in how dirt was perceived due to the rise of experimental science. This era introduced a distinction between nature as an objective reality and subjective human perceptions of the world. Lagerspetz argues that dirt, being inherently social, varies in its definition across different societies, historical periods, genders, classes, and even individuals within a society. Therefore, it cannot exist independently of human perception. (Lucy Pickering, 2019)

Mary Douglas's famous quote, "Matter out of Place," succinctly encapsulates the essence of dirt. It raises the fundamental question of who determines what qualifies as matter out of place. Douglas asserts that the concept of dirt encompasses two aspects: concern for hygiene and adherence to social conventions. She argues that religious beliefs and rituals influence the definition of what is considered dirty. These rituals often originate from past experiences aimed at avoiding contagion. While the criteria for hygiene may evolve over time, religious justifications tend to remain conservative and uphold traditional norms. (Douglas, 1966)

“Matter out of place”

-Mary Douglas

My research indicates that our aversion to dirt is deeply ingrained in both biological and cultural factors. Biologically, this aversion seems hardwired as a mechanism to ensure our safety. However, culturally, there are two distinct aspects to consider: one based on rational and logical reasoning derived from modern science and current societal conditions, and the other stems from learned behaviors influenced by current societal norms, historical events, religious teachings, and past reactions to what is considered dirt, that may no longer be relevant today. I believe that the cultural aspect of this aversion, particularly the learned behaviors, can be unlearned and reshaped through education and awareness.

The central theme connecting these arguments is the concept of defining and removing what is considered dirt. Mary Douglas's perspective on dirt as "matter out of place" highlights the subjective nature of cleanliness and the societal norms that dictate what is deemed acceptable or unacceptable. Curtis's exploration of our biological instinct to remove what doesn't belong aligns with Douglas's notion, suggesting that our disgust to dirt is deeply ingrained and instinctual. Lucy's argument adds another layer by proposing that the definition of dirt evolves over time to exclude and marginalize certain groups within society, reflecting broader power dynamics and social hierarchies.

CHANGING SKIN

LONDON

Figure 32: , Bermondsey, C. Hallman, 2023

Figure 33: Barbican Center. C.Hallman, 2023

Barbican

In the heart of London, The Barbican emerges as a distinct urban marvel, a product of post-war visionaries striving to redefine city living. Designed and constructed in the 1960s and completed in 1982, Barbican stands as a utopian enclave within the bustling metropolis. A departure from the conventional, Barbican was conceived to be more than a residential complex; it was a comprehensive urban ecosystem, integrating living, culture, and recreation. (Kenyon, 2022)

Barbicans' utopian aspirations are etched into its very architecture. An expansive residential complex, it encompasses high-rise apartments surrounded by verdant landscapes and elevated walkways.

The design sought to foster a sense of community, encouraging interaction among residents while providing an escape from the urban hustle. The incorporation of cultural venues, including the Barbican Arts Centre, further enriched this utopian vision, offering a diverse array of experiences within arm's reach.

The utopian essence of The Barbican extended beyond physical design to its ethos —aiming to redefine the urban experience. The elevated walkways, inspired by the concept of 'streets in the sky,' aimed to promote pedestrian-friendly living. The architects envisioned an interconnected environment that seamlessly blended private and public spaces, fostering a harmonious coexistence. (Kenyon, 2022)

Figure 34: Barbican Center C.Hallman, 2023

Figure 35: Barbican Center. C.Hallman, 2023

"Amidst the architectural symphony of The Barbican, even the fish in the pond sway to the muted tones, a subtle reminder of the greyscale allure that defines this concrete utopia."

Figure 36: Barbican Center. C.Hallman, 2023

Figure 37: Barbican Center. C.Hallm

man, 2023

While the design champions communal living, a noticeable gap emerges between the lush green spaces and the residential dwellings. The Roof Garden and the central pond in the main square stand out as thriving hubs, magnets for community interaction. Contrastingly, the meticulously tiled squares echo with emptiness, resembling lifeless expanses that fail to engage the residents.

The acclaimed Roof Garden, a haven amidst the concrete jungle, becomes a focal point of vitality, drawing people seeking solace in nature. Simultaneously, the meticulously tiled squares seem barren and lifeless, raising questions about the effectiveness of such expanses in fostering community life.

The material choices, while beautiful, present an ironic contrast—a juxtaposition of lifeless concrete against the green aspirations of the utopian ideal.

The allure of The Barbican is undeniable, but beneath the surface, the material choices reveal a certain lifelessness. The concrete-dominated landscape, while visually striking, lacks the vitality one might expect in a utopian setting. The depletion of soil is palpable, emphasizing that a utopia should not only be about the absence of cars but, crucially, about our connection with the living—nurturing not just the architectural spaces but the very soil from which life springs.

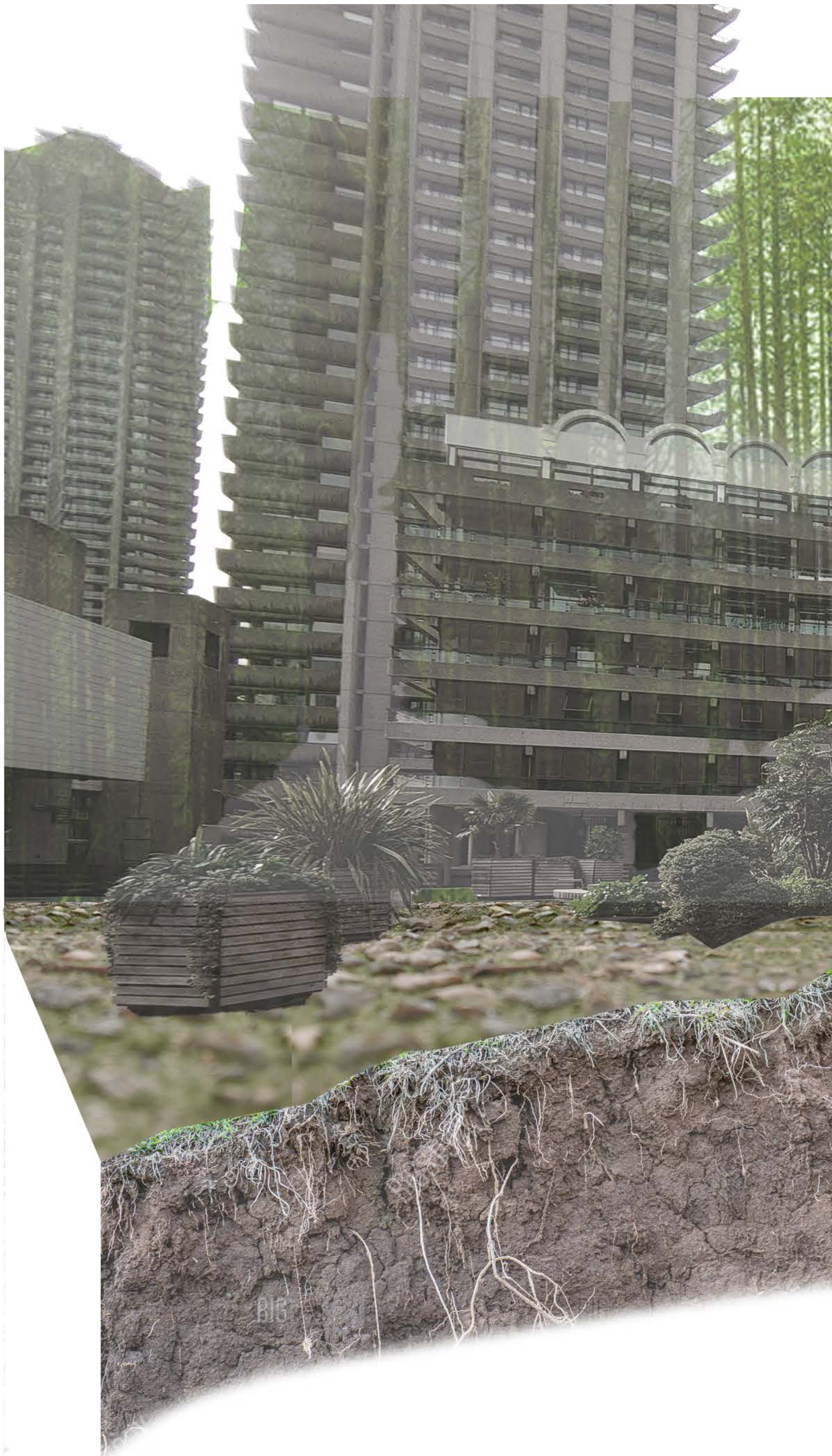


Figure 38: Nature reclaiming Barbican. C.Hallman, 2023

The Barbican, for all its architectural grandeur, tells us to reconsider the essence of utopia. It urges reflection on whether the design, while visually arresting, truly aligns with the core principle of fostering a vibrant, living community. The critical eye unveils a discord between the concrete aesthetic and the utopian dream, compelling us to redefine the parameters that constitute an urban utopia—a place not just aesthetically pleasing but one intricately connected to the living elements that breathe life into the architectural vision.

Figure 39: Hampstead Garden Suburb. C.Hallman, 2024

From the Barbican to Hampstead Garden Suburb: A radical alternative to the times

Henrietta Barnett founded the Hampstead Garden Suburb in 1907 with the vision of creating a social experiment that would provide a beautiful and healthy living environment for people of all classes. She envisioned the suburb as resembling a rural town, prioritizing the countryside aspect over urban elements, aiming to demonstrate how people from diverse backgrounds could coexist harmoniously through neighbourly interaction. She intended for every part of the suburb to offer pleasing views of the surrounding countryside. The suburb aimed to foster neighbourliness and preserve natural habitats.

The plans included spacious roads, ample greenery, and common areas accessible to all tenants. Overcoming the challenges of established urban development practices, the Hampstead Garden Suburb Act of 1906 laid the foundation for innovative residential planning.
Architect Raymond Unwin emphasized integrating buildings harmoniously with the surrounding landscape, drawing from 18th-century landscape garden principles. The suburb exemplified an early attempt to address the housing problem by offering working people cottages with gardens near central London. (Historical Background, 2015)

Figure 40: Hampstead Garden Suburb. C.Hallman, 2024

Figure 41:Hampstead Garden Suburb. C.Hallman, 2024

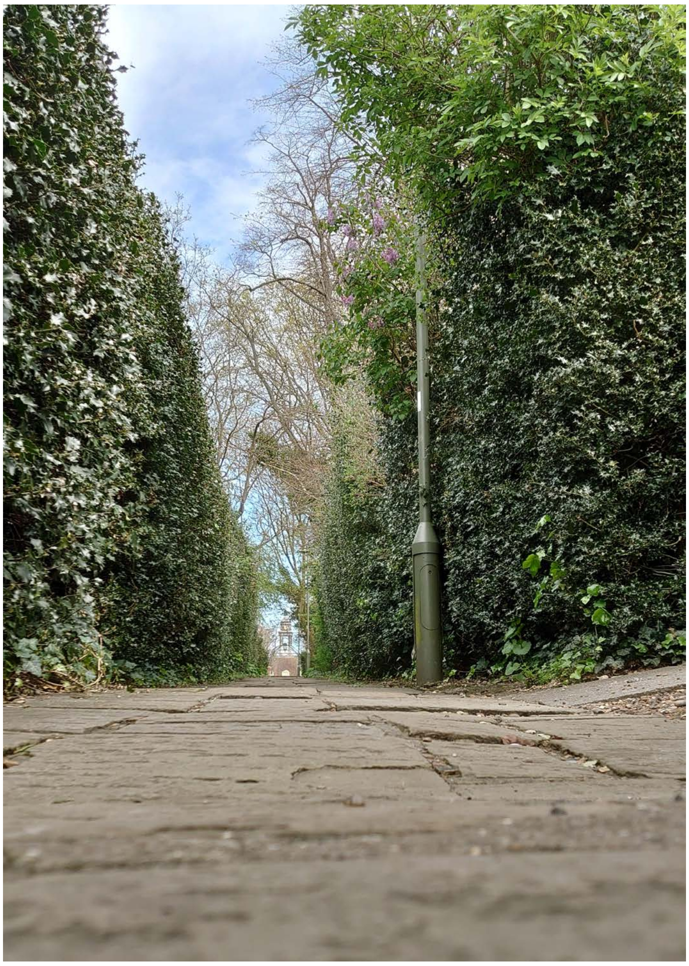


Figure 42: Hampstead Garden Suburb. C.Hallman, 2024

Hampstead Garden is a verdant oasis, a sanctuary where every breath is infused with the fragrant whispers of spring.
As you stroll along its meandering pathways of natural stone, adorned with verdant pergolas and embracing hedges, you're enveloped in a symphony of scents and sights.

The absence of walls between plots makes each garden seamlessly blend into the next, fostering a sense of unity and connection of the area.

In Hampstead Garden, nature isn't just a backdrop; it's woven into its very fabric. It's a place where the boundaries between urban and rural blur, where the gentle embrace of greenery offers solace and rejuvenation to all who call it home.

The challenge lies in our limited space to embrace such a lifestyle. While it may seem more feasible in expansive rural areas, there's a valuable lesson to glean from Barnett's approach. Her innovative ideas hold potential for adaptation even in densely populated urban settings.

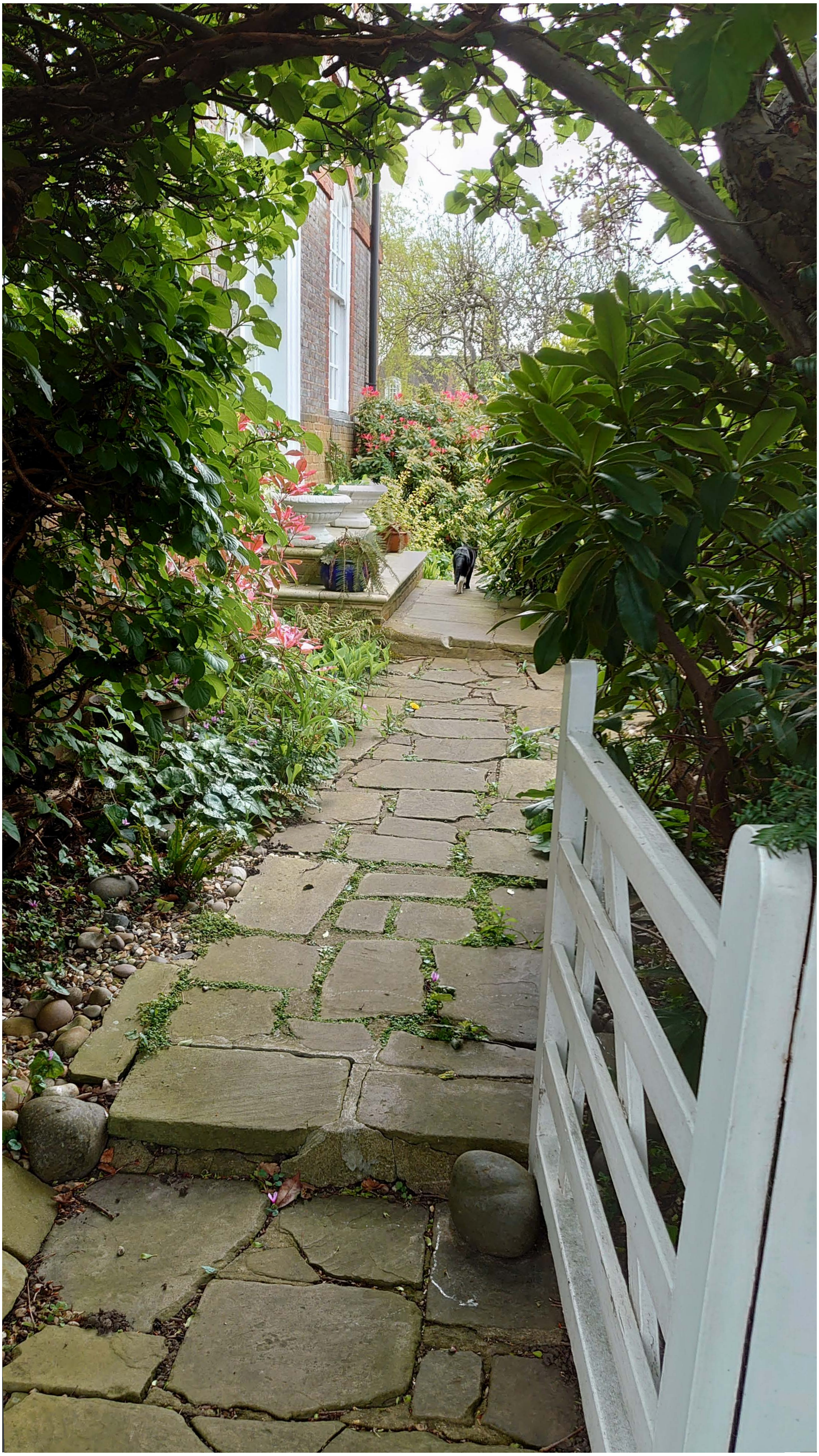


Figure 43:Hampstead Garden Suburb. C.Hallman, 2024

Figure 44: Hampstead Garden Suburb Stilt houses collage.
C.Hallman, 2024

A proposal for elevating domestic dwellings from ground level to allow for living surfaces to exist beneath each residential dwelling.
Additionally, it involves creating living walls and shared spaces between dwellings, along with private terraces for residents, to evoke a rural ambiance.

Figure 45: Hampstead Garden Suburb Stilt houses collage.
C.Hallman, 2024

Figure 47: Barbican Stilt houses collage. *C.Hallman, 2024*

A careful group orientation of stilt houses is crucial to ensure that ample light can reach the living layer on the ground level beneath each structure.

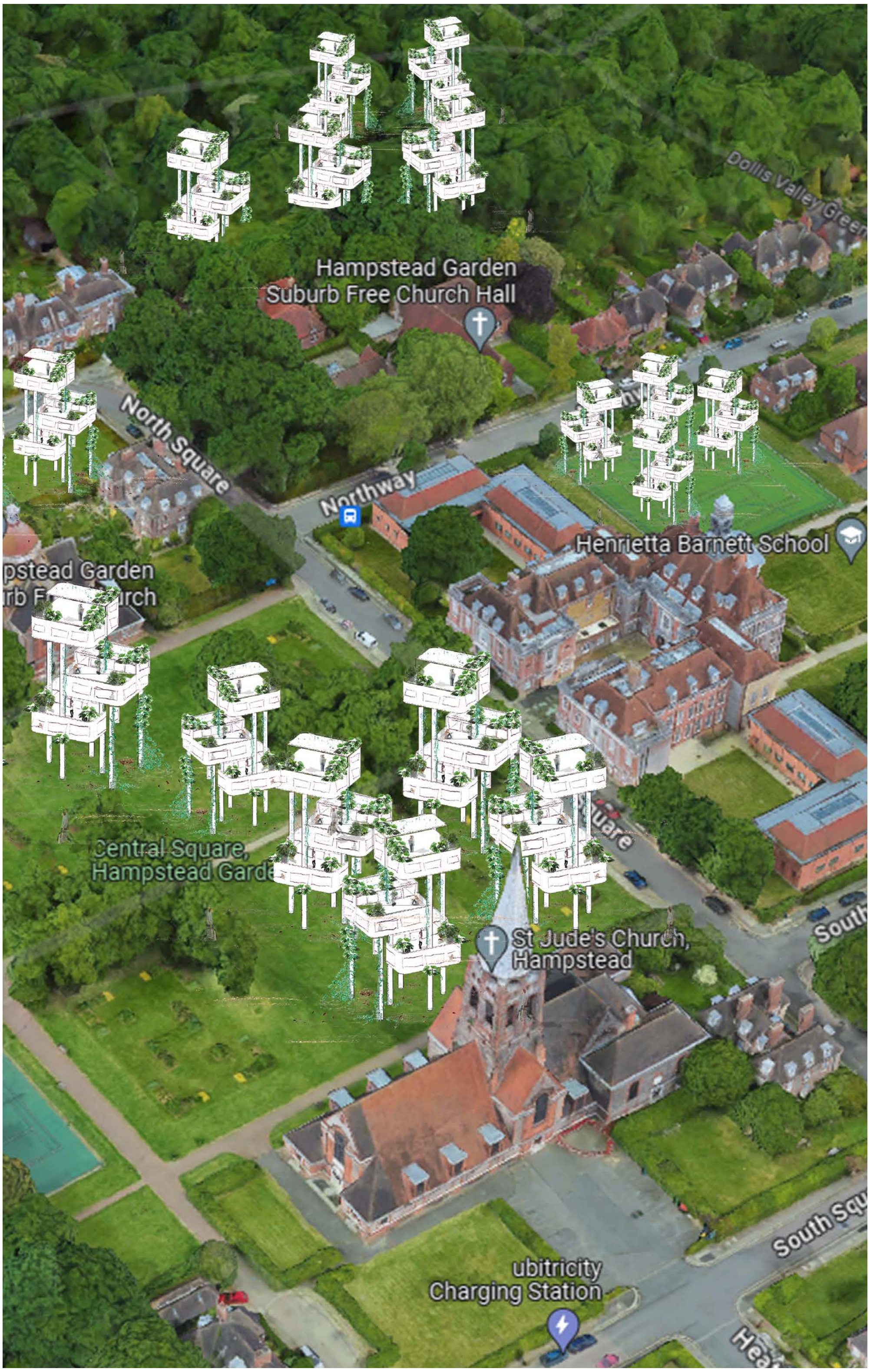


Figure 46: Hampstead Garden Suburb Stilt houses collage.
C.Hallman, 2024

CONCLUSION

This dissertation underscores the urgent need to reimagine our urban environments as vibrant, interconnected spaces that breathe with vitality. By nurturing urban forests and infusing living surfaces into our architectural designs, we stand on the threshold of creating spaces that transcend conventional limitations of city planning. This vision goes beyond mere convenience or aesthetics, it recognizes that true urban utopia lies in our ability to reconnect with nature.

Soil emerges as a fundamental pillar of human existence, equally important to the air we breathe and the water we drink. However, within urban landscapes, we witness a depletion of this crucial component, a consequence of our historical aversion to dirt and germs. Paradoxically, our pursuit of cleanliness has led to detrimental impacts on our well-being, disrupting the delicate balance of microbial ecosystems vital to our health.

It is imperative that we embark on a journey of re-evaluation, not only of the soil beneath our feet but also of our relationship with germs. We must challenge the prevailing narrative that portrays microbes and dirt solely as threats to be eradicated and instead recognize their integral role in sustaining life. By fostering environments that embrace the microbial world, we can cultivate a symbiotic relationship with microbes.

Through the implementation of biomimicry and post-human design principles, we can breathe new life into our urban spaces, both literally and metaphorically. Not only can we purify the air we breathe, but we can also build healthier, more harmonious habitats for both humans and the diverse wildlife that shares our cities. In this paradigm shift, architecture becomes a means to foster our well-being and stewardship of the planet. It offers a framework for crafting healthier buildings by harnessing the benefits of living microbial layers. Moreover, addressing the cultural aspects of our aversion to dirt through education and awareness can reshape societal norms, paving the way for a more inclusive and holistic approach to cleanliness.

The central theme of defining and removing what is considered dirt underscores the subjective nature of cleanliness and its societal implications. As we strive to create urban utopias, it is essential to redefine our parameters to encompass not just aesthetic appeal but also the intricate connections with the living elements that breathe life into our architectural visions.

The ongoing dialogue between urban development and the forces of nature highlights the need for design solutions that cater to both human and non-human species. By embracing nature-based design strategies and reimagining our relationship with the microbial world, we can create urban environments that thrive as ecosystems, fostering a harmonious coexistence between humans and the natural world.

As interior designers, we have a responsibility not only to prioritize sustainability through material choices and building practices but also to provoke thought and conversation through our designs. By reimagining the role of microbes within our habitat, this dissertation aims to start a dialogue about the importance of holistic health and environmental stewardship, positively impacting society and fostering a sense of connection to both each other and the natural world.

The ambition of this dissertation extends beyond the physical space it occupies. It seeks to inspire a paradigm shift, challenging conventional notions of urban design and advocating for a more symbiotic relationship between humans and the natural world. Through collective effort and visionary thinking, we can create cities that thrive as ecosystems, where every living organism contributes to the well-being of the whole.

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Figure 28: Adamatzky, A (2015). Slime Mould Gates, Roads and sensors [Photograph] Available from: doi:https://doi.org/10.1002/ad.3013. [Accessed April 2024].

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BIBLIOGRAPHY

Akemi, F., Keiji, T., Norikoshi, K., Kobayashi, T., & Oriyama , S. (2019, january 23). *A comparative study of the physiological.* Retrieved from Environmental Health and Preventive Medicine: https://doi.org/10.1186/s12199-019-0800-1

Banerjee, S. (2023, 01 01). Soil microbiomes and one health. *Nature Reviews Microbiology*, 21(1), 6-20. Retrieved 03 25, 2024, from https://doi.org/10.1038/s41579-022-00779-w

Bardunias, P., Calovi, D., Erin Carey, N., & Scott, T. (2020, July). *The extension of internal humidity levels beyond the soil surface facilitates mound expansion in Macrotermes*. Retrieved from ResearchGate: https://www.researchgate.net/publication/342785893_The_extension_of_internal_humidity_levels_beyond_the_soil_surface_facilitates_mound_expansion_in_Macrotermes

Beckett, R. (2021, January 19). *Microbes are our friends.* Retrieved from RIBAJ: The RIBA Journal: https://www.ribaj.com/intelligence/presidents-awards-for-research-medal-winner-probiotic-design-microbes-in-buildings-for-health

Beckett, R. (2021, 02 17). Probiotic design. The Journal of Architecture, 26, 1-26. doi:10.1080/13602365.2021.1880822

Carpo, M. (2024, January/Febuary). On the Posthuman Charm of Slime and Mould. *Architectural Design,* 94(1), pp. 46-51. doi:https://doi.org/10.1002/ad.3013

Comission, E. (2011). *Soil: the hidden part of the climate cycle*. Luxembourg: Publications Offi ce of the European Union.

Curtis, V. &. (2001). Dirt, Disgust, and Disease: Is Hygiene in Our Genes. *Perspectives in biology and medicine.*, 44. 17-31. doi:10.1353/pbm.2001.0001.

Douglas, M. (1966). *Purity and Danger: An analasis of the concepts of pollution and taboo*. London: Routledge.

Fransen, B. (2022, May 17). *The Art of Forest Bathing*. Retrieved from Eco Matcher: https://www.ecomatcher.com/the-art-of-forest-bathing/

Giddings, J. 2023. Can Building with Timber Save the Planet?. AJ x Rocca Event, 9 November 2023, Rocca London Gallery.

Goidea, A. P. (2021). Meristem Wall: An Exploration of 3d-printed Architecture. *PROCEEDINGS OF THE 41ST ANNUAL CONFERENCE OF THE ASSOCIATION FOR COMPUTER AIDED DESIGN IN ARCHITECTURE* (pp. 438-443). Association for Computer Aided Design in Architecture (ACADIA). Retrieved from https://doi.org/10.52842/conf.acadia.2021.438

Harrison, A. L. (2024, January/Febuary). Feral Surfaces: Building Envelopes as Intelligent Multi-species Habitats. *Architectural Design*, 94(1), pp. 38-45. doi:https://doi.org/10.1002/ad.3012

Historical Background. (2015). Retrieved from Hampstead Garden Suburb Heritage: https://hgsheritage.org.uk/Detail/collections/H120

Hutt, S. (2024, January/Febuary). Flying Feral: Posthuman Architectures, Enclosures and Open-Loop Interface Designs. *Architectural Design,* 94(1), pp. 84-93. doi:https://doi.org/10.1002/ad.3018

Ionescu, A. (2023, May 27). *Termite mounds could inspire “living and breathing” buildings*. Retrieved from Earth.com: https://www.earth.com/news/termite-mounds-could-inspire-living-and-breathing-buildings/

Kenyon, N. (2022). *Building Utopia: The Barbican Centre* (edition ed.). London: Batsford.

Lucy Pickering, P. W. (2019). Dirty scholarship and dirty lives: Explorations in bodies and belonging. *The Sociological Review*, 67(4), 746-765. doi: https://doi.org/10.1177/0038026119854244

Menezes, K., de Oliveria-Smith, P., & A. Vernon, W. (2022). *Programming for Health and Wellbeing in Architecture* (edition ed.). New York: Routledge.

MetLink. (2021). *Urban Heat Islands*. Retrieved from MetLink Royal Meteorological Society: https://www.metlink.org/fieldwork-resource/urban-heat-island-introduction/

Singh, K., Muljadi, B. P., Raeini, A. Q., Jost, C., Vandeginste, V., Blunt, M. J., . . . Degond, P. (22, Mars 2019). *The architectural design of smart ventilation and drainage systems in termite nests*. Retrieved from Science Advances: https://www.science.org/doi/10.1126/sciadv.aat8520

Small Spaces in the City: Rethinking Inside the Box (2023) [Rocca London Gallery]. London. September 9, 2023 - January 27, 2024.

Smith, C., & Topham, S. (2022). *Houses that can save the world*. London: Thameson & Hudson.

Turner, S. (2008, January). *Beyond biomimicry: What termites can tell us about realizing the living building*. Retrieved from ResearchGate: https://www.researchgate.net/publication/255650482_Beyond_biomimicry_What_termites_can_tell_us_about_realizing_the_living_building

Yudina, A. (2017). *Garden City: Supergreen Buildings, Urban Skyscapes and the new planted space* (edition ed.). London: Thames & Hudson Ltd.

SITE VISITS

The Barbican
EC2Y London, UK
7 October 2023

79 & Park
115 28 Stockholm, Sweden
24 January 2024

Brandbergen
136 64 Haninge, Sweden
25 January 2024

Hampstead Garden Suburb
NW1 London, UK
8 April 2024