

ENMESHED SELVES

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Abstract

My research-creation dissertation investigates the ways we are all enmeshed in the world, as well as how we can productively imagine ways to live together. I approach this research through “thinking-with,” a concept proposed by Donna Haraway. Throughout this text and my dissertation exhibition I think-with many partners including microbial life, Lake Ontario, mud, the field of bio art, and other researchers. My dissertation exhibition provides an opportunity for viewers to encounter microbial life. In the creation of this body of work, I have collected mud from Lake Ontario and placed it, along with nutrients that encourage microbial growth, in clear sculptural prisms. When exposed to light, the microorganisms already present begin to flourish, becoming visible in the form of vibrant marbling. In this text I discuss how my thinking partners have shaped my research, which takes the form of writing, artworks, and workshops. I go on to engage geographic borders, such as those between land and water, or between Canada and the United States of America; biologic borders that we use to distinguish one organism from another; and the borders that are drawn around disciplines or types of knowledge. I argue that working across divides is essential to forging a more sustainable future. I also explore different forms of collaboration that have become critical in the way I conduct research: collaborating with scientists, with non-humans, and with the public. Throughout the text I argue for the value of thinking-with, working across borders, and forging meaningful collaborations. I argue that working together is an important strategy for deeper understanding, as well as responsible action in the face of ecological crisis.

Dedication

To all of my thinking partners.

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Preface

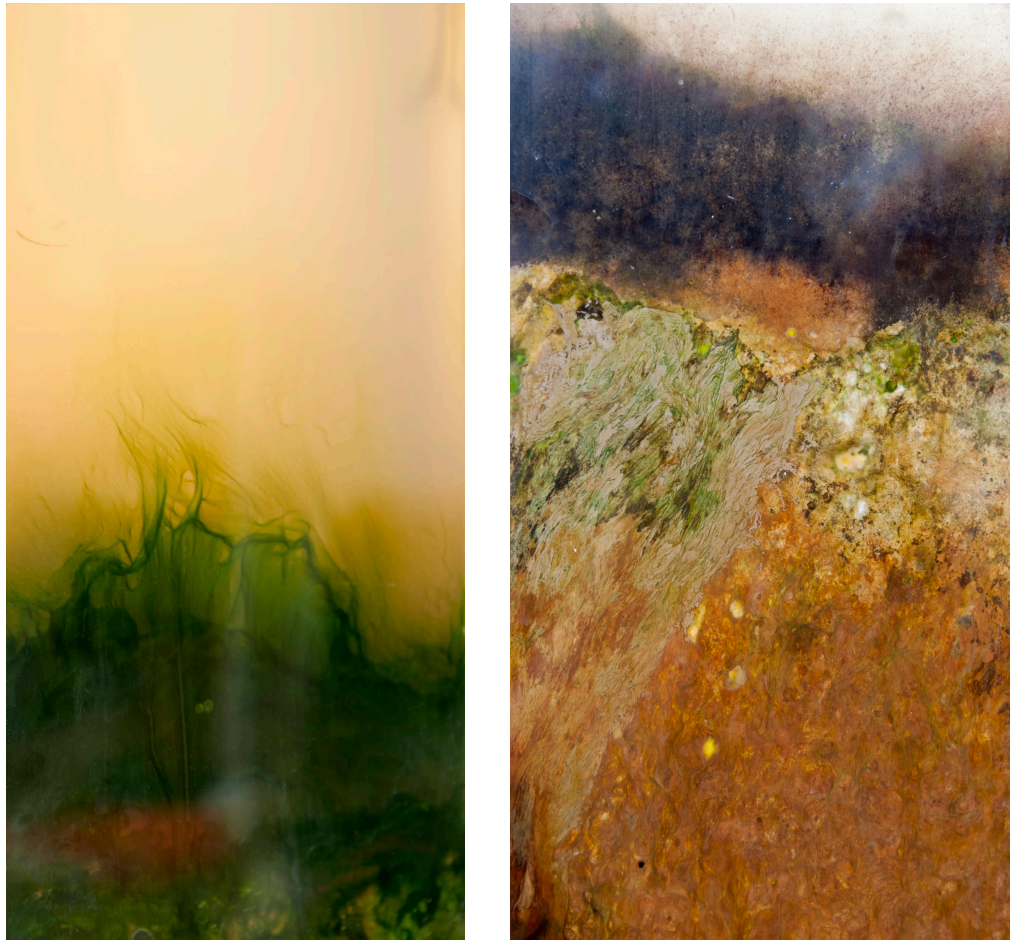
I work with mud from Lake Ontario and the microbes that live in it to explore the enmeshed nature of life. Microbes – organisms invisible to the naked eye – form vast, complex communities around, on, and within our bodies. Microbial life passes in and out of us, permeating what we perceive to be the barrier between ourselves and everything else. This community of microbes supports our growth, helps us to eat, protects us from pathogens, produces vitamins, and much more we do not fully understand.¹ Traits that we previously believed belonged to individuals are actually the result of a complex negotiation between host and microorganisms. According to Dr. Julie Segre, senior investigator for the Human Microbiome Project (HMP), “We just happen to look human because our human cells are much larger than bacterial cells ... no matter how you look at it, it’s high time we acknowledge that part of being human is being microbial.”² I was immediately fascinated and repulsed when I became aware that the microbial cells in my body outnumber my human cells, and that without them I would not be able to survive. Since then, I have been grappling with my relationship to microbes and webs of connections that extend far beyond my body.

I began working with microbial life in my artwork; first in drawings, then on agar, and now in mud. I collect mud and place it, along with nutrients that encourage microbial growth, in clear sculptural prisms. When exposed to light, the microorganisms already present begin to flourish, becoming visible in the form of vibrant marbling. These

¹ Ed Yong, *I Contain Multitudes: The Microbes Within Us and a Grander View of Life* (New York: Harper Collins Publishers, 2016).

² The Eden Project, “Invisible You: The Human Microbiome” (Cornwall: The Wellcome Trust, 2015).

microbial colonies are capable of growing to the point that they can be seen without a microscope. Their visual presence in turn draws attention to their constant invisible presence around, on, and within our bodies. I am interested in the capacity for microbes to connect us in a very literal way to each other and our environment. Microbes reveal that our boundaries are indistinct and can prompt us to think about the many ties that enmesh us.



Figures 1 & 2: Detail images of microbial growth in *Mud (Lake Ontario)*, 2017-present. Photo and artwork by the author.

To exist is to be enmeshed. From the moment we are born our microbial symbionts – microbes that closely interact with our bodies – begin their complex relationship with us. Transferred from our mothers, microbes enter our gut and enable us to digest our first meal.³ These ties are always there, even when we are not conscious of them. As author, scholar, and philosopher Donna Haraway describes, “beings do not pre-exist their relatings.”⁴ ‘Enmeshed’ is the term I have come to use to describe these connections. To be enmeshed is to be woven in an intricate, interdependent web where bodies have unclear and permeable boundaries.⁵ Although the term evokes a sense of connection, it is not intended to romanticise notions of being together. When we are enmeshed we cannot disentangle, even when the connections become uncomfortable or harmful. Despite the damage that can be done, we do have the capacity to try to forge meaningful ways of being in the mud together.

I have chosen to “think-with” microbial life, a concept proposed by Donna Haraway, to understand the connections microbes form. Theorist Maria Puig de la Bellacasa, inspired by the thinking-with of Haraway, described this method as, “a relational way of thinking ... [that] creates new patterns out of previous multiplicities, intervening by adding layers of meaning rather than merely deconstructing or conforming to ready-made categories.”⁶ This form of thought encourages researchers to consider

³ The University of Utah, “Your Changing Microbiome,” Learn.Genetics (blog), accessed March 4, 2018, <http://learn.genetics.utah.edu/>.

⁴ Donna Haraway, *The Companion Species Manifesto: Dogs, People, and Significant Otherness* (Chicago: Prickly Paradigm Press, 2003): 6.

⁵ “Enmesh,” in *Oxford Dictionary* (Oxford University Press, 2018), <https://en.oxforddictionaries.com/definition/enmesh>.

⁶ Maria Puig de la Bellacasa, *Matters of Care: Speculative Ethics in More Than Human Worlds* (Minneapolis: The University of Minnesota Press, 2017): 71.

many voices when conducting their work in order to understand the world more expansively.

Theorists and artists have chosen a diverse array of non-humans⁷ to think-with: Anna Lowenhaupt Tsing and matsutake mushrooms; Donna Haraway and her dog Cayenne; Eduardo Kohn and the forests of Ávila; Marta de Menezes and butterflies; Viviane Despret and lab rats; Aganetha Dyck and honeybees; Karen Barad and quantum particles; Jakob von Uexküll and ticks; María Puig de la Bellacasa and soil.⁸ Thinking-with non-human companions is an exercise in extending kinship outward, allowing space for diverse way to foster more equitable methods of being together.⁹

In this text, I explore various connections that thinking-with microbial life has enabled me to make. In “Chapter 1, Being Enmeshed”, I discuss how my thinking partners – mud, microbes, the Winogradsky column, and Lake Ontario – have shaped my research as well as my understanding of what it means to be enmeshed. I elaborate on coming to know each of them through a diversity of perspectives including through the work of artists and scientists. Finally, I discuss how my material journey through art making, alongside these thinking partners, has informed my dissertation exhibition.

In “Chapter 2: Borders Unbound”, I discuss the act of border making and the porous nature of borders. I describe the physical – both geographic and political – borders that intersect Lake Ontario, how those borders have impacted my own research, as well

⁷ I have chosen to use the imperfect term non-human in my text. Although it does have the problem of possibly implying humans are set apart from the world, it also encompasses all matter including living things and what we may think of as not living things such as mud. I will do the work in this paper to make clear that humans are very much entangled in our world and in no way should we assume a hierarchical relationship to it.

⁸ This is a short and incomplete list, but it conveys the diversity of companions to think-with. The ways we are connected are innumerable and so are the companions we choose.

⁹ Donna Haraway, *The Companion Species Manifesto: Dogs, People, and Significant Otherness* (Chicago: Prickly Paradigm Press, 2003).

as other bodies. I consider borders as well as the significance of place in relation to site-specific art and land art. Through this lens I contemplate the act of removing material from Lake Ontario to be displayed in a gallery and how the site of the lake is still present in the artwork. I also discuss the biologic borders we draw around individuals, arguing that one individual is much more difficult to define than we might assume. Finally, I describe the borders that are placed between disciplines. I argue that blurring disciplinary divides, such as we see in the field of bio art, is an essential strategy for deeper understanding and envisioning more sustainable futures together.

In “Chapter 3: Collaboration”, I examine the potential of art and science collaborations, as well as my own experience working with scientists at the Coalesce Bio Art Lab at the University at Buffalo. I argue that although these relationships can be fraught, there is also generative potential when all collaborators enter the partnership willing to be impacted by each other. I then grapple with the concept of calling my work with microbial life – and other researchers’ work with non-humans – collaborative. I analyze human/non-human collaborations through the lens of caring about as well as caring for. Finally, I discuss my collaborative work with the public; describing a series of workshops I have given as part of my research creation, the motivations behind these workshops and conversations that have emerged from them.

I am not alone in writing this text. While thinking-with mud, microbes and Lake Ontario I am also thinking-with other artists, theorists, and researchers of all kinds. This includes thinking from my own experiences as an artist, brought up through the visual arts doing my Bachelor of Fine Arts, Masters of Fine Arts, and now Doctorate, with a focus on sculpture. The art historical contexts that I am thinking from as well as with are

also important to note. In this text I will think-with research from the fields of site-specific art, land art, and bio art. To contextualize these examples, it is important to give the reader a general understanding of how they are situated within contemporary art.

The site specific art movement emerged in the 1960's as artists began to critically consider artwork's relation to site beyond a physical location. Theorist Nick Kaye states site specific artwork could "define itself through properties, qualities or meanings produced in specific relationships between an 'object' or 'event' and a position it occupies."¹⁰ Site specific artists reacted against the modernist desire to create a self-contained artwork. As curator and researcher Miwon Kwon argues:

If modernist sculpture absorbed its pedestal/base to sever its connection to or express its indifference to the site, rendering itself more autonomous and self-referential, and thus transportable, placeless, and nomadic, then site-specific works, as they first emerged in the wake of Minimalism in the late 1960s and early 1970s, forced a dramatic reversal of this modernist paradigm. Antithetical to the claim "If you have to change a sculpture for a site there is something wrong with the sculpture," site-specific art, whether interruptive or assimilative, gave itself up to its environmental context, being formally determined or directed by it.¹¹

While reacting against modernism, site specific artists were drawing on concepts from minimalism. Minimalist artists aimed to direct viewers' attention back onto themselves, their environment and the act of looking.¹² Kwon articulates that site-specific artwork was "informed by the contextual thinking of minimalism"¹³ going on to say the artwork "challenged the 'innocence' of space and the accompanying presupposition of a universal

¹⁰ Nick Kaye, *Site-Specific Art* (New York: Routledge, 2000): 1.

¹¹ Miwon Kwon, "One Place after Another: Notes on Site Specificity," *October* 80, no. Spring (1997): 85-110.

¹² Nick Kaye, *Site-Specific Art* (New York: Routledge, 2000): 1.

¹³ Miwon Kwon, *One Place After Another: Site Specific Art and Locational Identity* (Cambridge: The MIT Press, 2002):13.

viewing subject ... as espoused in the phenomenological model.”¹⁴ Bringing attention to the gallery as a space also questioned its position as a neutral location to look at art objects. This engagement with the physical space of the gallery as well as the viewers’ presence in the gallery were an important aspect of site specific artists’ exploration of place.

Site specific art is also characterized by “the (neo-avant-gardist) aesthetic aspiration to exceed the limitations of traditional media, like painting and sculpture, as well as their institutional setting...”¹⁵ Artists working in this area employed materials and methods typically used in other fields such as construction, architecture, or landscaping. Kwon argues that site specific artists began to employ “deaestheticization” alongside “dematerialization” of the site as well as the artwork.¹⁶

Going against the grain of institutional habits and desires, and continuing the resist the commodification of art in/for that marketplace, site-specific art adopts strategies that are either aggressively anti-visual – informational, textual, expository, didactic – or immaterial altogether – gestures, events, or performances bracketed by temporal boundaries. The ‘work’ no longer seeks to be a noun/object but a verb/process, provoking the viewer’s *critical* (not just physical) acuity regarding the ideological conditions of their viewing.¹⁷

The active artwork that Kwon describes also developed as a result of the artists’ consideration of the bodily experience of the viewer. The public engaging the artwork were no longer understood to be simply viewing the work, but experiencing it with all of

¹⁴ Miwon Kwon, *One Place After Another: Site Specific Art and Locational Identity* (Cambridge: The MIT Press, 2002):13.

¹⁵ Ibid: 12.

¹⁶ Ibid: 24.

¹⁷ Ibid.

their senses. Site specific artworks aimed for “the radical restructuring of the subject from an old Cartesian model to a phenomenological one of lived body experience.”¹⁸

Site specific artwork gave way to the field of land art that began to develop alongside it in the 1960’s and 1970’s. Also described as earth art or eco art, land art typically engaged specific sites beyond the gallery, built out of the land and in it. However, this work still “frequently played on the gallery as a vantage point from which the viewer might look *out* toward designated, mapped locations” as Kay describes.¹⁹

Like site-specific art, earth art pushed beyond what would be considered typical art materials, often working with what was available at the site itself or directed by the materiality of the site. Art theorist Amanda Boetzkes in her text *The Ethics of Earth Art* argues, “The artists’ evasion of traditional media and institutions demanded a theorization that would give precedence to new spaces of experience in lieu of a formal analysis of the artists’ mastery of a particular medium.”²⁰ Land artist Robert Smithson echoes this sentiment, stating that artists aimed to work with “processes that have not been idealised, or differentiated into “objective” meanings.”²¹ Working with atypical materials enabled artists to begin a dialogue with the site, stripped from some of the conceptual or art historical weight of materials such as paint, or bronze.

Just as in site specific artwork, the embodied experience of land art became essential. Boetzkes articulates that artists were inspired by the philosophical movement of phenomenology – a theory explored by French philosopher Maurice Merleau-Ponty –

¹⁸ Miwon Kwon, *One Place After Another: Site Specific Art and Locational Identity* (Cambridge: The MIT Press, 2002): 12.

¹⁹ Nick Kaye, *Site-Specific Art* (New York: Routledge, 2000): 91.

²⁰ Amanda Boetzkes, *The Ethics of Earth Art* (University Of Minnesota Press, 2010): 26.

²¹ Robert Smithson, “A Sedimentation of the Mind: Earth Projects,” in *The Collected Writings*, ed. Jack Flam (New York, 1979): 101.

which studied conscious experience as a state involving the whole body and its senses, rather than purely the mind.²² The artworks of earth art “rooted the aesthetic experience in bodily perception.”²³ The act of going out to a site to view earth art was another aspect of the embodied experiences that artists were fostering.

However, due to the often remote location, or temporal quality of the artwork, land artists frequently developed not only the artwork “out there” but also media representations of it. These representations included photography, sketches, textual descriptions, and video works. The artworks that could be viewed in the gallery were either considered to be lesser representations of the “real” artwork, or as works of art in themselves that aligned with the artwork installed in the landscape. Kwon and fellow curator Philipp Kaiser of the *Ends of the Earth: Land Art to 1974* at the Museum of Contemporary Art in New York City (2012), wrote in the exhibition’s catalogue:

This disunity stems from two different views about media’s function: as re-presentation or as relay. For artists who adhere to an idealist, even modernist, view of Land art as offering an unmediated, pure aesthetic experience, photographs, videos, films, texts, models, drawings, and the like are conceived as unacceptable substitutes. ...For other artists, media is conceived not so much as a representational surrogate for “the work,” but as a relay or extension of it.²⁴

Each interpretation of the use of media persisted, becoming a part of the dialogue surrounding *Ends of the Earth: Land Art to 1974* (2012) as well as the field of land art more broadly.

²² David Woodruff Smith, “Phenomenology,” in *The Stanford Encyclopedia of Philosophy* (Stanford University Press, 2013).

²³ Amanda Boetzkes, *The Ethics of Earth Art* (University Of Minnesota Press, 2010): 27.

²⁴ Philipp Kaiser and Miwon Kwon, “Ends of the Earth and Back: Exhibition Catalogue” (Museum of Contemporary Art, 2012).

The use of media itself is important to note as new media such as video and television became more prominent in the 1960's and 70's. Artists began employing these technologies in their artwork in the form of documentation, an investigation into the technology itself, or as a medium. The field of media art, or new media art, focused on the capacity for digital technologies since the late 1980's to help produce artwork as well as distribute it.²⁵ Media artists began to foreground technology in their practices, developing a new wave of artworks engaging these emerging digital technologies including video, computer art, and net art.

Artists have a long tradition of adapting both emerging technologies and scientific advancements. Pointillist painters in the 1880's were influenced by new discoveries about the way our eyes communicate with our brain to optically mix colour, technologies such as mold making were developed by industry then adapted by artists, as were digital technologies. The field of bio art which emerged in the 1990's can be viewed as another step along this trajectory.²⁶ Bio artists use biological matter as artistic medium, effectively using the medium of life to discuss life. As biotechnology became more prominent and visible to the general public in the 1990's artists began engaging the field conceptually as well as materially.

Although the use of living biologic matter in the creation of artwork has often been described as a distinct break from previous forms of art making, bio artist Eduardo Kac argues that it is aligned with the development of visual art. Kac states, "I use the media of my time to make art, as Nam June Paik used video, Laszlo' Moholy- Nagy used

²⁵ Tate Modern, "New Media," Art Museum, Tate Modern Art Term, accessed February 20, 2020, <https://www.tate.org.uk/art/art-terms/n/new-media>.

²⁶ Treva Michelle Legassie, "Keepers of the Bio Art Laboratory: Mangling Methods and Curating Critically," *Canadian Art Review* 43, no. 2 (2018): 73–88.

the photogram and the Impressionists used new paints in tubes. It will be obvious in about one hundred years, or even fifty or . . . when the novelty wears off and the artwork stands on its own.”²⁷ As media studies theorist Jens Hauser argues, bio art can be understood as an extension of new media art into another kind of media that brings together the biologic and technologic. Robert Mitchell links bio art to both a scientific viewpoint and media theory:

On the one hand, bioart draws on the more familiar sense of ‘medium’ as a material means through which thoughts, information, images, sounds, colors, and textures are stored and transmitted from one place or time to another. [...] On the other hand, bioart also draws on the sense of ‘media’ that is used by biologists, for whom the term refers to fluids or solids that are employed to keep living cells developing, dividing, and transforming during the course of an experiment. Bioart links these two conceptions of media by situating biological media and technologies within a milieu — namely, the art gallery — that has traditionally been associated with the sense of media as a means for storage and communication.²⁸

Bio artists employ a diverse range of techniques in the creation of their artwork, united by the use of living matter as medium. Bio artists “have re-contextualized their biomaterials as an aesthetic object.”²⁹ Hauser describes strategies of what he calls “organic media-art” as “biomediality”, stating:

these include life enabling milieus (i.e. biological media that turn biological systems into something), technical means (i.e. biomedial through which biological systems make something) and instances of measurement (i.e. media of biology that do something with biological systems). This kind of art shows how, under the influence of the natural scientific disciplines, the focus of the concept of mediality of the humanities

²⁷ Anne Byerley and Derrick Chong, “Biotech Aesthetics: Exploring the Practice of Bio Art,” *Culture and Organization* 21, no. 2 (2015): 208.

²⁸ Robert E. Mitchell, *Bioart and the Vitality of Media* (Washington: University of Washington Press, 2010): 11.

²⁹ Annick Bureau, Roger F. Malina, and Louise Whiteley, eds., *Meta-Life: Biotechnologies, Synthetic Biology, ALife and the Arts* (Leonardo, 2014): 7100.

themselves is expanded. For when the technology of media changes, so too changes our concept of what a medium is.³⁰

Artists in the field of bio art are working with a medium that had not necessarily been considered a material for art before. Through their engagement with living matter, bio artists are bringing about shifts in what can be a medium for art, like media artists, land artists, and site specific artists did before them.

Bio artists Ionat Zurr and Oron Catts have grappled throughout their research with whether to employ biotechnology more obviously or more subtly in their work. Zurr and Catts established their collective Tissue Culture & Art Project (TC&A) in 1996. The collective's work was at the forefront of the bio art field and continues to have a prominent presence. They describe their work as an:

...on-going research and development project examining the use of tissue technologies to create Semi-Living sculptures. We are using constructed biodegradable/bio-absorbable polymers in a desired shape, and seeding them with living cells from complex organisms. We use technologies and procedures developed by tissue engineers. Tissue engineering deals with constructing artificial support systems (with the use of bio-materials) to direct and control the growth of tissue in a desired shape in order to replace or support the function of defective or injured body parts. It is a multi-disciplinary field that involves biologists, chemists, engineers, medical practitioners and now, artists.³¹

TC&A articulate how their early artworks did not feel alive to viewers because they lacked the "aesthetics of care"³²

³⁰ Jens Hauser, "Biomediality and Art," in *Recomposing Art and Science*, ed. Irene Hediger and Jill Scott (Berlin, Boston: Walter de Gruyter, 2016):203.

³¹ Ionat Zurr and Oron Catts, "An Emergence of the Semi-Living" (The Aesthetics of Care? The artistic, social and scientific implications of the use of biological/medical technologies for artistic purposes., *SymbioticA: The Art and Science Collaborative Research Laboratory & The Institute of Advanced Studies*, University of Western Australia: SymbioticA, 2002): 67.

³² Ibid.

We wanted to have life in the gallery, but even if it is there, would anyone notice? We wanted to emphasize the notion of care as an indicator for the liveness of our sculptures. The solution was to construct a fully functioning tissue-culture laboratory in the gallery space, in which the procedures needed to sustain the entities alive were performed.³³

For their early tissue culture work, TC&A adopted the format of digital collages of the images of tissue growth over objects, in the spirit of media representations of the real thing as described above. They then chose to create a grander structure so as to make the technological mechanisms of caring for their artwork more apparent in a gallery setting. These apparatuses, whether recreations of the laboratory or incubators on their own, do the work of signaling an aesthetic of care through making obvious the need to tend to, and care for, their bio art projects. As I will discuss further in Chapter 2, not all bio art employs this strategy or brings technology to the forefront of their artwork.

Bio art also seriously considers the embodied experience of the viewer. Bio artists create a space to encounter artwork in “an embodied sense ... by using living beings – or by revealing ways in which spectators are bound, beyond their control, to other forms of life – bioart frames spectators as themselves media for the transformative powers of life.”³⁴ The presence of the bio art body as well as the viewers’ bodies become important in the act of engaging bio art.

Throughout this text I will think-with these concepts, as well as from my position as an artist creating work that employs living material in this contemporary art context. My concepts are informed by and contextualized throughout this dissertation by many voices. The thoughts in the dissertation are – like their writer – enmeshed. In alignment

³³ Oron Catts, “Not Moving - Living,” *Leonardo* 48, no. 2 (2015): 170.

³⁴ Robert E. Mitchell, *Bioart and the Vitality of Media* (Washington: University of Washington Press, 2010): 11.

with this method, in this text my use of the term ‘me’ refers to myself and microbes, ‘we’ refers to us and microbes.

Research Questions

Throughout this text and my practice-based research more broadly I ask:

- How do we understand our relationship with microbial life? What are the possible implications of coming to know our enmeshed existence?
- How can collaborations across disciplinary boundaries, as well as human/non-human divides work toward building a more sustainable future?
- How can we come to understand our relationship to a broader ecology through interacting with mud from Lake Ontario? Can the act of caring for microbes become a model for extending responsibility more broadly?
- What is the relationship between thinking ecologically, thinking scientifically, and thinking through practice-based research?

Methodology

I work with the conceptual and physical processes involved in practice-based research to explore my research questions. Research is the act of formulating questions and coming to meaningful understandings with the hope of expanding what we know. Artists engage in research through gathering information, developing new methods of interpreting the world, increasing understanding of existing research, and critically analyzing contemporary discourse. Currently, there is no universally agreed upon definition of practice-based research. I see this ambiguity as an asset that encourages diverse approaches.

In my research, I employ methodological pluralism, where multiple forms of research methods are used simultaneously.³⁵ This allows me to construct the method that is most appropriate at the time in relation to the task at hand. My methods – drawn primarily from the fields of visual art and biology – include gathering data, collecting mud, text-based research, recording and transcribing interviews, training on scientific equipment, workshop development, building sculptural forms, microbial identification, and material testing. Erin Manning in her text “Ten Propositions for Research-Creation” argues that “Research-creation generates new forms of experience; it situates what often seem like disparate practices, giving them a conduit for collective expression.”³⁶ In my research, I engage seemingly disparate fields such as microbiology, practice-based research, theoretical biology, and art theory.

³⁵ As exemplified by: Biggs and Büchler, 2013; Hannula, et al. 2005; O’Riley 2011.

³⁶ Erin Manning, “Ten Propositions for Research-Creation,” in *Collaboration in Performance Practice*, ed. N. Colin and S. Sachsenmaier (London: Palgrave Macmillan, 2016), 131.

My practice-based research takes the form of writings, artworks, and workshops. Inspired by art theorist Natalie S. Loveless's approach, I consider writing to be a medium that should be applied when appropriate to the idea. Through her negotiation of the differences between art-based and text-based research Loveless "discovered the importance of speaking with difference and dissent."³⁷ In doing so, Loveless carves out a place for each kind of dissemination in her practice. In my research, writing is the appropriate medium to communicate particular ideas in a precise manner, pose and respond to research questions, and textually engage the thoughts of myself as well as other researchers. The text works alongside the artwork, however, any attempt to explain the artwork could complement, but never recreate the actual experience of it. As theorist Kathrin Busch argues in her text "Artistic Research and the Poetics of Knowledge":

...art seems to be able to refer to that which cannot be articulated within the respective fields of knowledge... This different knowledge, one that questions the tight limitations of modern rationality by articulating – in contrast to objective, absolute, consistent scientific knowledge – knowledge that is equally ambivalent, incommensurable, and singular.³⁸

Busch attests that art is capable of accessing and communicating aspects of life that are impossible, or at very least much more difficult to access and communicate using any other medium.

Another essential aspect of my methodology is diffractive research and thinking-with. As described previously, thinking-with is a concept introduced by Donna Haraway that involves bringing together many human and non-human voices in order to explore

³⁷ Natalie S. Loveless, "Practice in the Flesh of Theory: Art, Research, and the Fine Arts PhD," *Canadian Journal of Communication* 37 (2012): 100.

³⁸ Kathrin Busch, "Artistic Research and the Poetics of Knowledge," *Art & Research* 2, no. 2 (2009): 4.

the topic at hand. Similarly, a diffractive methodology – proposed by theoretical physicist and feminist theorist Karen Barad – aims to consider topics from many points of view, as well as from diverse research perspectives. As Bellacasa describes, “thinking-with thick populated worlds is an acknowledgement of multiplicity, but also an effort to actually foster multiplication – creating a *diffraction* rather than a reflection of the ‘same.’”³⁹

Diffractive thinking in my dissertation has led me to engage the research of many scholars from various perspectives to explore my research questions. This includes looking at microbes from the perspective of a sculptor, through the lens of microbiology, theoretical biology, bio art, popular science, soil science, poetry, the humanities, and anthropology. This diversity of approaches to microbes comes together to give a more holistic understanding of what microbial life can be or mean in our contemporary context.

According to Barad, a diffractive reading looks for generative aspects of difference, rather than simply identifying differences: “Rather than employing a hierarchical methodology that would put different texts, theories, and strands of thought against one another, diffractively engaging with texts and intellectual traditions means that they are dialogically read “through one another” to engender creative, and unexpected outcomes.”⁴⁰ By employing both thinking-with as well as diffractive reading, my aim is to show where diverse thinking can intersect and lead to new understandings of our enmeshed state, microbial life, as well as working together.

³⁹ Maria Puig de la Bellacasa, *Matters of Care: Speculative Ethics in More Than Human Worlds* (Minneapolis: The University of Minnesota Press, 2017): 72.

⁴⁰ Evelien Geerts and Iris van der Tuin, “Diffraction and Reading Diffractively,” *New Materialism: How Matter Comes to Matter* (2018) <https://newmaterialism.eu/>.

Chapter One: Being Enmeshed

Our entanglements endure. We are all exposed, but not equally. Escape is not an option, especially for many who are most commonly exposed. Our endurance must be an active one that sees beyond what is to what is becoming. For me, I need new narratives to begin reimagining what still could be. Denied the luxury of disengagement, how do we become *more* materially entangled in ways that are of *this* (molecular) world and not an imagined past one? How do we tell stories in which becoming less toxic means becoming *with* rather than *without*?

– Jody Roberts, *Narrating a Past for New Futures*

mesh

noun 1. Material made of a network of wire or thread. 2. An interlaced structure. Verb 1. (of the teeth of a gearwheel) lock together or be engaged with another gearwheel. 2. Represent (a geometric object) as a set of finite elements for computational analysis or modeling.

– Oxford English Dictionary

enmesh

verb 1. (usually to be enmeshed in) Cause to be entangled in something. 2. Involve (someone) in a difficult situation from which it is hard to escape.

– Oxford English Dictionary

Through thinking-with many companions I have become more attuned to our enmeshed existence. What does it mean to be enmeshed? In psychology, enmeshment describes a variety of relationships where boundaries are unclear and individuals become overtly psychologically dependent on each other.⁴¹ In this state, people become attached to the point that “they cannot separate or individuate from one another without experiencing tremendous anxiety, anger, or other forms of emotional distress.”⁴² It is clear that interconnectivity is not simply beneficial. As Science and Technology Studies

⁴¹ Stephen Ludwig and Anthony Rostain, “Family Function and Dysfunction,” in *Developmental-Behavioral Pediatrics*, Fourth (Elsevier Academic Press, 2009).

⁴² *Ibid*: 115.

(STS) researcher Jody Roberts expresses, being enmeshed is not a choice, we do not have “the luxury of disengagement.”⁴³ We are caught in the meshes of connections that build and destroy: the microbes that support our lives now will also decompose our bodies when we die, the water that we drink to sustain us also pollutes our bodies. Our interconnectivity cannot be denied. In the face of catastrophic climate change our past and present actions must be contended with. ‘Enmeshed’ and all of its connotations forces me to confront the difficulties of working together responsibly, enabling me to “stay with the trouble” as Donna Haraway stresses, in an attempt to work and think-together.⁴⁴ “Staying with the trouble” implores us to not turn away from the difficulties of living together on a damaged Earth, but to contend with them.⁴⁵ To be enmeshed is to be connected with responsibility and consequence.

One way that I have chosen to discuss my thinking partners in this chapter is through a scientific lens and this needs to be contextualized. The predominant understanding of science is as a formal activity that produces knowledge through the rigors of the scientific method. STS teaches us that this simplified picture of science is highly constructed. Science, like all other fields of human production, is a social activity. As STS scholar Sergio Sismondo describes in *An Introduction to Science and Technology Studies*:

Neither science nor technology is a natural kind, having simple properties that define it once and for all. The sources of knowledge and artifacts are complex and various: claims, theories, facts, and objects may have very different meanings to different audiences. For STS, then, science and technology are active processes and should be studied as such. The field

⁴³ Jody Roberts, “Narrating a Past for New Futures,” <http://www.toxicsymposium.org/conversations-1/>.

⁴⁴ Donna Haraway, *Staying with the Trouble: Making Kin in the Chthulucene (Experimental Futures)* (New York: Duke University Press, 2016).

⁴⁵ Ibid.

investigates how scientific knowledge and technological artifacts are *constructed*. Knowledge and artifacts are human products, and marked by the circumstances of their production. ... scientists and engineers *use* the material world in their work; it is not merely translated into knowledge and objects by a mechanical process.⁴⁶

Rather than as an objective activity producing absolute knowledge, science should be viewed as an ongoing process that is shaped by context. In looking at my thinking partners through a scientific lens I aim to contend with science as a field that my practice-based research is engaged with. I do not intend to add to the authority of science, but in some respects to humanize it. I try to do this work by first bringing attention to the false perception of scientific knowledge as objective, as well as through discussing scientific topics such as microbes from diverse perspectives that include a scientific lens as well as from my own perspective as an artist. Placing many perspectives equally enables a more equitable understanding of scientific knowledge. As Sismondo argues “the humanization of science and technology undermines some sources of scientific and technical authority.”⁴⁷

I also acknowledge that the scientific stories I am telling, such as the origin of the microscope, or our early relationships with microbes, are socially constructed. Historic scientific discoveries are often described as concise movements from point A to point B. These stories are highly revisionist as they are told from a contemporary point of view. As Sismondo argues, “discoveries are not events by themselves, but are rather events retrospectively recognized as origins.”⁴⁸ To illustrate this Sismondo describes how the

⁴⁶ Sergio Sismondo, “The Prehistory of Science and Technology Studies,” in *An Introduction to Science and Technology Studies* (John Wiley & Sons, 2009): 11.

⁴⁷ Ibid: 168.

⁴⁸ Ibid: 59.

discovery of the laws of genetics is a social construction. Gregor Mendel has been attributed with the discovery of genetic inheritance. However, at the time, Mendel's research was published in an obscure journal and neither Mendel nor the scientific community seemed to recognize its importance. It was not until 1900 that Carl Correns read Mendel's paper and labeled the research 'Mendel's Law.' As Sismondo puts it, "Mendel discovered his eponymous laws in 1866, but only as a result of the events of 1900."⁴⁹ The story of the first microscope is similarly told retrospectively from a contemporary perspective. However, as long as this social context is kept in mind, the story is still a useful way to come to an understanding of our relationship with microbial life. Scientific stories are not absolute truth, instead they are situated in social and material spaces.⁵⁰ They are simply one way to interpret the world.

Throughout this chapter I will grapple with what it means to be enmeshed and how we can imagine living together productively. We cannot remove ourselves, but we can attempt to build more equitable connections. I will work through this by expanding on my thinking partners: mud, the Winogradsky column, microbial life, and Lake Ontario.

⁴⁹ Sergio Sismondo, "The Prehistory of Science and Technology Studies," in *An Introduction to Science and Technology Studies* (John Wiley & Sons, 2009): 59.

⁵⁰ Sergio Sismondo, "Political Economies of Knowledge," in *An Introduction to Science and Technology Studies* (John Wiley & Sons, 2009): 204.

Mud

In sum, mud and mudstones are the most widespread and abundant deposits on the Earth's surface both today and in most of the past and deserve full attention.

– P.E. Potter, J.B. Maynard, and P.J. Depetris,
Mud and Mudstones

Conceiving soils as communities of kin.

– Maria Puig de la Bellacasa, *Matters of
Care: Speculative Ethics in More Than
Human Worlds*

Mud is a thinking companion that has shaped my research. This earthy material is incredibly alive, containing “more individual organisms than the total number of human beings that have ever lived.”⁵¹ Yet, despite its vitality, mud is often thought of as lifeless as well as undesirable. Mud forms when water becomes woven into the small pores of soil particles.⁵² Each of these elements are generally appreciated – clear, cool water; fresh, aromatic soil – but when combined, they become off-putting. In his poem *Unfinished Ode to Mud* (1942), Francis Ponge portrays society's general distaste for mud and his personal admiration of it:

Mud pleases the noble of heart because it is constantly scorned.
Our mind reviles it, our feet and wheels squelch it. It makes walking
hard and us dirty; there's what we can forgive it.
Filth! We say of people we despise, or self-serving, mud-slinging
insults. Not caring about the blame we inflict on it, how we wrong it.
Who needs such constant humiliation? Atrocious persistence.
Despised mud, I love you. I love you because people scorn you.
May my writing, literal mud, splash the faces of those who disparage
you!

⁵¹ I.M. Young and J.W. Crawford, “Interactions and Self- Organization in the Soil-Microbe Complex,” *Science* 304, no. 5677 (2004): 1634.

⁵² J. Lipiec et al., “Soil Porosity and Water Infiltration as Influenced by Tillage Methods,” *Soil and Tillage Research* 89, no. 2 (2006): 220.

...

Oh, how attached to you it is! More than you wish, you say. Not me. Its attachment touches me. I happily forgive it. I'd rather slog through mud than indifference, rather come home mud-splattered than pin-pricked and deflated; as if I didn't exist for the ground I crossed ... I love the way it slows my footsteps, I'm grateful for the detours it makes me take.

No matter what, it won't let go of my socks; it'd rather dry there. It dies or it sticks. Like a kind of mineral ivy. No brushing it off. You must scrape it with a knife. Till it turns back to dust – like all carbohydrates (you included) – print it with your foot, it puts its seal on you. The reciprocal mark ...⁵³

Ponge expressively describes the many ways mud is often disparaged as well as the seemingly negative impact it has on our movements. The slowness of moving through mud can be inconvenient, but it forces a shift of attention to what is around us. Theorist Lutz Koepnick argues that slowness enables us to recognize the present as “a site charged with multiple durations, pasts, and possible futures.”⁵⁴ Slowing down movement through space, even temporarily, can help us pay attention to where we are, not just where we are going.

Despite its viscosity, mud is a material constantly in flux. When it dries out, mud returns back to water and soil. Even the mud lining waterbeds gradually forms sedimentary rock over geologic time.⁵⁵ These mudstones preserve traces from the past, inextricably enmeshed with human activity and the contaminants it produces.⁵⁶

Mudstones are so strongly influenced by particle contaminants that they are used as key

⁵³ Francis Ponge, “Unfinished Ode to Mud”, trans. Beverley Bie Brahic (CB Editions, 2008).

⁵⁴ Lutz Koepnick, *On Slowness: Toward an Aesthetic of the Contemporary* (New York: Columbia University Press, 2014): 12.

⁵⁵ P.E. Potter, J.B. Maynard, and P.J. Depetris, *Mud and Mudstones* (New York: Springer, 2004): 1.

⁵⁶ Ibid.

indicators of past atmospheric conditions.⁵⁷ These mudstones continue to change, eventually eroding to become the granules that form mud again.

The mud inside my sculptures is also constantly shifting. It is slowly compacting down into the prisms, as well as changing composition as the microbial life inside lives and dies. Although often considered a passive habitat, mud is an active participant in our ecology. Soil scientists Ian Young and John Crawford described soils as “the most diverse and important ecosystem on the planet.”⁵⁸ The essential role that mud plays is in part due to what Young and Crawford call the “soil-microbe complex.”⁵⁹ This term describes the ongoing regenerative actions of microbial life within soil. Mud and soil microbes have such an intricate relationship that the way we define soil has begun to include microorganisms:

We would include the phrase ‘with its living organisms’ in the general definition of soil. Thus, from our viewpoint soil is alive and is composed of living and nonliving components having many interactions. It is part of that larger unit, the terrestrial ecosystem, that soil must be studied and conserved. The interdependence of terrestrial vegetation and animals, soils, atmosphere and hydrosphere is complex, with many feedback mechanisms. When we view the soil system as an environment for organisms, we must remember that the biota have been involved in its creation, as well as adapting to life within it.⁶⁰

⁵⁷ Dan Ma, Haibo Bai, and Hai Pu, “Effect of Particle Mixture on Seepage Properties of Crushed Mudstones,” *Transport in Porous Media* 108, no. 2 (June 2015): 257–77.

⁵⁸ I.M. Young and J.W. Crawford, “Interactions and Self- Organization in the Soil-Microbe Complex,” *Science* 304, no. 5677 (2004): 1637.

⁵⁹ *Ibid.*

⁶⁰ David C. Coleman, Jr. D.A Crossley, and Paul F. Hendric, *Fundamentals of Soil Ecology*, vol. 2 (New York: Elsevier Academic Press, 2004): xvi.

The division between mud and microorganism is indistinct. This level of interconnection means that many soil microbes cannot be grown outside of mud; because of this, some are deemed “extremely difficult” to study in a lab.⁶¹ The microbes resist isolation.

Working with mud over the course of my research has given me a new appreciation for it. When I collect mud, I reveal different layers of varying composition and colour. The mud sticks to me and sometimes restricts my movements along the shore. I am always left with traces of it on my clothes and body. It gives off the earthy smell of soil, as well as lake, debris, and contaminants. The mud I have encountered includes an array of sandy mud, clay-based mud, and mud filled with detritus. I have noticed through spending time with it, that the older the mud the better it smells, like compost slowly breaking down.



Figures 3 & 4: Mud collected from the shore of Lake Ontario, 2017. Photo by the author.

⁶¹ Noah Fierer, Scientists Peek Inside The “Black Box” Of Soil Microbes to Learn Their Secrets, interview by Dan Charles, All Things Considered, NPR, January 18, 2018, <https://www.npr.org/sections/thesalt/2018/01/18/578924748/scientists-peek-inside-the-black-box-of-soil-microbes-to-learn-their-secrets>.

We are all connected to mud through our dependence on it as the biomaterial that makes most vegetation possible. Without mud, soils, or dirt, most life on earth would not be possible. However, as practice-based researchers Alana Bartol and Amanda White aptly note, “much of what is known about soils (and their resident communities of microorganisms) is based on the economic value of soil as an agricultural commodity.”⁶² In the face of this human centric approach to understanding soil, Bartol and White founded the Deep Earth Treatment Centre (DETC) with the aim of exploring a different kind of relationship:

At the Deep Earth Treatment Centre we are similarly critical of human-centered world views and seek alternatives to the often one-sided flow of understanding as an approach to the exploration of, not just what we don’t know, but also how we might be of benefit to soils. At the DETC, the subjects of our work are both humans and soils, and the “treatments” are a kind of mediation tending to this relationship through physical, affective, and sensory explorations.⁶³

As a participant at the “Life in Soil” conference hosted by Alana Bartol, Amanda White, and bio artist Jennifer Willet (2017), I experienced one of the DETC’s “treatments.” A large raised bed of soil was placed in the center of a gallery space during the conference, providing the opportunity for individuals to encounter the dirt. As Bartol and White describe:

Human participants were invited to create actions in response to the soil over the three days: artist and Reiki practitioner Kacey Auffret performed a Reiki treatment for the bed; Alana Bartol slept overnight on it; I buried

⁶² Amanda White and Alana Bartol, “Notes from the Deep Earth Treatment Centre,” in *Naturally Postnatural, Catalyst: Jennifer Willet*, ed. Ted Hiebert (Canada: Noxious Sector Press, 2017): 168.

⁶³ Ibid: 172.

myself up to my belly in the bed and read a children's story to my then unborn baby, to name a few examples.⁶⁴

The presence of soil enabled various interactions that encouraged thoughtful considerations of the material.



Figure 5: Deep Earth Treatment Centre, *Soil Bed*, 2017. Installation view. Photo by Shallen Chen.

During the conference I also presented my research on microbes in mud, arguing that revealing the liveliness of mud – that it is not an inert material – can help foster a deeper sense of empathy with the material and our ecology more broadly.

In my work, when I interact with mud I am reminded of its vitality as well as the webs of connections it forms. Handling soil can enhance our liveliness as well: contact

⁶⁴ Amanda White and Alana Bartol, “Notes from the Deep Earth Treatment Centre,” in *Naturally Postnatural*, Catalyst: Jennifer Willet, ed. Ted Hiebert (Canada: Noxious Sector Press, 2017), 177.

with earth, and in particular soil microbes, may decrease anxiety, enhance the ability to learn new tasks, and help to form a healthy immune system.⁶⁵ In many ways I am impacting the mud and microbial life I work with, while at the same time they are also impacting me.

Winogradsky Column

The method for investigation of actual processes mediated by microbes in nature should be based on the study of microbial communities as a whole, in nature, rather than on the study of species isolated from nature.

– Sergi Winogradsky, 1952

Mud and microbes were also the thinking companions of Russian scientist Sergei Winogradsky. His work studying specific microorganisms led to a deeper understanding of how sulfur and nitrogen are fixed in soils; revealing one of the key roles that microbes play in our ecosystem.⁶⁶ Despite beginning his scientific career isolating species, Winogradsky has become known as the first microbial ecologist for his work with bacterial communities. Winogradsky began to develop a more “ecological perspective” as he became interested in a less mediated way to work with microbial life.⁶⁷ He outlined his “direct method” in four elements:

1. Avoid on principle working with stock cultures. Use for experiments strains freshly isolated from the soil by a method as short and direct as possible.

⁶⁵ Dorothy M. Matthews and Susan M. Jenks, “Ingestion of *Mycobacterium Vaccae* Decreases Anxiety-Related Behavior and Improves Learning in Mice,” *Behavioral Processes* 96 (June 2013).

⁶⁶ Martin Dworkin, “Sergei Winogradsky: A Founder of Modern Microbiology and the First Microbial Ecologist,” Blackwell Publishing, *FEMS Microbiology Reviews*, no. 36 (2012).

⁶⁷ Lloyd Ackert, *Sergei Vinogradskii and the Cycle of Life: From the Thermodynamics of Life to Ecological Microbiology: 1850-1950* (New York: Springer, 2012): 99.

2. Supply them with nutrients that can be supposed to be utilized by them in the soil.
3. Make a special point of studying the reactions of the soil population as a whole, as the competition between its components is the principal determinant of their individual functions.
4. Where solid media was to be used to study the soil population, the use of silica gel media was recommended, to be inoculated with fine particles of soil.⁶⁸

Winogradsky understood that interactions between microbes in a community were essential to understanding them as individuals. He began to view soil as “...a living environment as a collective entity that possessed the characteristic functions of a living organism.”⁶⁹ The direct method formed the methodological basis of the Winogradsky column.

In a Winogradsky column, soil, water, and nutrients – typically sulphur, calcium carbonate, and cellulose – are combined in a clear container exposed to sunlight. Over time, an oxygen gradient and a sulfide gradient form in the column. Due to the resulting increased input of energy the microbial life inside is able to grow in such numbers that they can be seen without a microscope. The colonies develop in different locations depending on their needs. For example, algae and cyanobacteria will grow near the top of the column where they get the most oxygen, while anaerobic sulfate reducing bacteria will grow near the bottom of the column where there is a concentration of sulfides. The colour of the colony in addition to their location in the column can be used to identify the type of microbe.

⁶⁸ Martin Dworkin, “Sergei Winogradsky: A Founder of Modern Microbiology and the First Microbial Ecologist,” Blackwell Publishing, FEMS Microbiology Reviews, no. 36 (2012): 376.

⁶⁹ Ibid.

Winogradsky wrote that his column would enable access to “microscopic landscapes’ ... of the soil” and allow him to “investigate a microbe’s vital function, that is, its role in the cycle of life.”⁷⁰ Winogradsky’s culturing method is still widely used today both within the scientific research community – often to study microbial population compositions – and as an educational tool to teach students about the interconnected relationships of microbial communities.

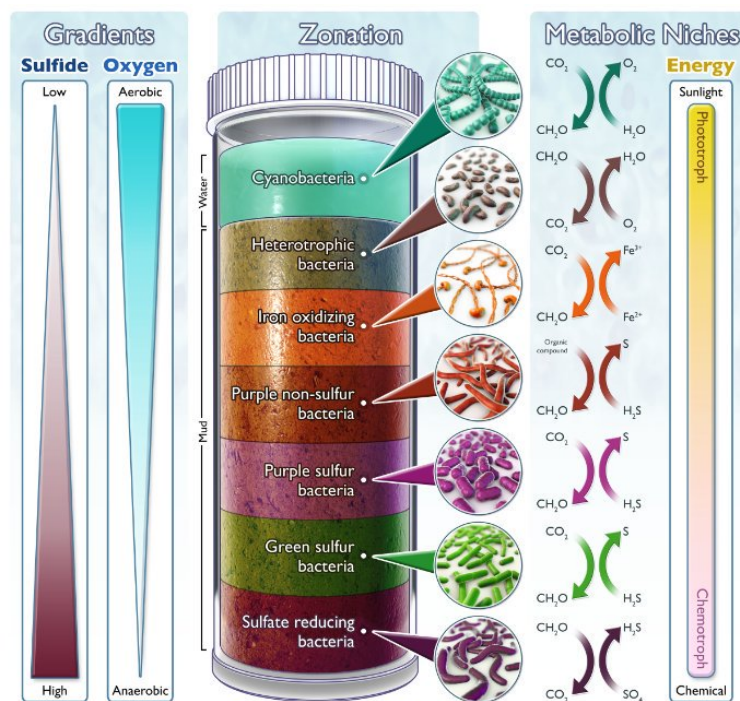


Figure 6: “Winogradsky Column—Microbial Evolution in a Bottle”, Poster by the Howard Hughes Medical Institute, 2012

⁷⁰ Lloyd Ackert, *Sergei Vinogradskii and the Cycle of Life: From the Thermodynamics of Life to Ecological Microbiology, 1850-1950* (New York: Springer, 2012): 113.

I first came across the Winogradsky column while researching how to safely work with microorganisms outside of a laboratory. The column became the starting point for my work with mud and microbes, not just due to its accessibility, but also because the method places emphasis on community, contextual thinking, and connections. Although inspired by it, my sculptures extend and expand in different directions than the scientific method. The artwork is not a tool used to discern what microbes are growing where, or to grow them in enough abundance to conduct experiments with them. Instead, brought into an art context, the use of Winogradsky's methods can start dialogue about many different topics including the ways we are enmeshed with microbial life and the liveliness of our connections.⁷¹

Microbial Life

It's a fact of our lives we move through unseen legions: bacteria, viruses, protists, fungi, so we wash, we disinfect, we keep the inside out, but our individual insides, they aren't individual at all. What is human in our bodies is outnumbered by trillions of strangers. You're like a wild island, a forgotten rainforest and so am I, and we're not just ambulant hotels, we're communities with gate keepers, janitors, nurses, farmers, builders, drones. Our newborn safety, our chemical balance, our ability to eat, it all relies on our tiny collaborators, their happy accommodation, their ability to reproduce in us. So when I say it's a pleasure to meet you, I mean it's a pleasure for us to meet all of you, and to know that we are both as wonderful and crowded as we sometimes feel. How do you do?

—A. L. Kennedy, *Invisible You Catalogue*

There has never been any natural animal or plant free of microorganisms.

—Ilana Zilber-Rosenberg and Eugene Rosenberg, "Role of Microorganisms in the Evolution of Animals and Plants"

⁷¹ The impact of art/science work is discussed in greater detail in "Chapter 3, Collaborating with Scientists."

Microbes are the constant companions of all ecosystems and the bodies that inhabit them. Microorganisms drive planetary cycles of carbon, nitrogen, sulphur, and phosphorus as they enrich soils and breakdown waste.⁷² Photosynthetic bacteria consume sunlight and release oxygen, making the air breathable for aerobic life. Inside clouds, microbes form the seeds for raindrops; inside bodies, they protect, nourish, and sustain. We are just beginning to gain a deeper understanding of the multifaceted roles these organisms play.

Before humans could see microbial life, they could only be sensed through the infections they caused. Although we are beginning to understand microorganisms as more than simply a threat, microbes are still most often associated with illness. As popular science writer Ed Yong describes in his book, *I Contain Multitudes* (2016), our early relationship with microbial life left a “cultural scar,” going on to say that “microbes are now so commonly associated with dirt and disease that if you show someone the multitudes that live in their mouth, they will probably recoil in disgust.”⁷³

This prejudice was not yet established when microbes were first magnified to the point they could be seen. In 1676 Dutch cloth merchant Antony van Leeuwenhoek used a powerful, singled-lensed microscope that he invented to look at a drop of lake water. He observed in the water “little animals” in “vast quantities.”⁷⁴

And the motion of most of these little animals in the water was so swift, and so various, upwards, downwards, and round about, that ‘twas wonderful to see: and I judge that some of these little creatures were

⁷² Paul G. Falkowski, Tom Fenchel, and Edward F. Delong, “The Microbial Engines That Drive Earth’s Biogeochemical Cycles,” *Science* 320, no. 5879 (2008): 1034–39.

⁷³ Ed Yong, *I Contain Multitudes: The Microbes Within Us and a Grander View of Life* (New York: Harper Collins Publishers, 2016).

⁷⁴ Antony van Leeuwenhoek, “Letter to the Royal Society of London,” October 9, 1676.

above a thousand times smaller than the smallest ones I have ever yet seen, upon the rind of cheese.⁷⁵

The bacteria that Leeuwenhoek would have seen were 200 times smaller than the smallest known creatures at the time, cheese mites.⁷⁶ After this discovery, Leeuwenhoek continued to explore using his microscope, becoming the first documented person to see his own microbes. He described looking at his tooth plaque under the microscope in a letter to the Royal Society of London (1683):

I then most always saw, with great wonder, that in the said matter there were many very little living animalcules, very prettily a-moving ... All the people living in our United Netherlands are not as many as the living animals that I carry in my own mouth this very day.⁷⁷

The warmth and excitement conveyed by Leeuwenhoek when writing about microbes is striking from a 21st century perspective. He marveled at the “animalcules” that lived inside him and was fascinated by their movement in rainwater and wine.⁷⁸

Leeuwenhoek’s observation was initially met with skepticism from his peers who argued “...tis not credible that so great a many of these little animalcules can be comprehended in the compass of a sand-grain.”⁷⁹ His research was not fully accepted by the Royal Society until another one of their members, Robert Hooke, was able to reconstruct a sufficiently powerful microscope to see the “little animals” himself.⁸⁰

⁷⁵ Antony van Leeuwenhoek, “Letter to the Royal Society of London,” October 9, 1676.

⁷⁶ The average cheese mite is 320–460 μm (μm ; micrometer or millionths of a meter), the average protozoa is only 2 - 50 μm , and the average bacterium is 2 μm (Melnik, et.al., 2010; Carolina Biologic, 2006; Katz et.al., 2003).

⁷⁷ Antony van Leeuwenhoek, “Letter to the Royal Society of London,” September 17, 1683.

⁷⁸ Douglas Anderson, “Lens on Leeuwenhoek,” Research Page, Lens on Leeuwenhoek, June 19, 2018, <http://lensonleeuwenhoek.net>.

⁷⁹ Ibid.

⁸⁰ Robert Hooke, “Letter to the Royal Society of London,” October 5, 1677.

Hooke described the creatures as: “...so exceedingly small, that millions of millions might be contained in one drop of water. I was very much surprised at this so wonderful a spectacle.”⁸¹ The microscope then became recognized as a valid scientific tool.

The predominant attitude toward microbes changed in the second half of the 19th century when Louis Pasteur, Robert Koch, Joseph Lister, and others, demonstrated that microbes are the cause of many human diseases.⁸² Their work on the germ theory of disease led to the identification of pathogens, development of vaccines, sterilization of medical equipment, and the practice of regular hand washing.⁸³ The germ theory has been the basis of ongoing research into protecting humans from microbes. Although it is clear that taking precautions against pathogens is important, Leeuwenhoek and his contemporaries’ awe was not simply naïve: we have recently discovered that only 1% of microbes are known to cause disease in humans.⁸⁴ The vast majority are either uninterested in us, or beneficial to our lives. For example, consider the thousands of species of bacteria that make up human skin flora, or that live symbiotically in the human gut.

The focus of microbial research has expanded beyond eradication of threatening microbes, with initiatives such as the National Institute of Health’s Human Microbiome Project, the International Human Microbiome Consortium, the European Union’s MetaHIT project, and the Earth Microbiome Project. These projects mark what has been described as a “renaissance” in microbiology, as the complex role of microbial life has

⁸¹ Robert Hooke, “Letter to the Royal Society of London,” October 5, 1677.

⁸² Robert Gaynes, *Germ Theory: Medical Pioneers in Infectious Diseases* (ProQuest eBook Central: ASM Press, 2011), <https://ebookcentral-proquest-com.ezproxy.library.uvic.ca/lib/uvic/detail.action?docID=1039538>.

⁸³ Ibid.

⁸⁴ “Microbiology by Numbers,” *Nature Reviews Microbiology* 9 (August 12, 2011): 628.

become easier to study with the advancement of fast DNA sequencing.⁸⁵ Mass spectrometry has enabled researchers to look at the genome of microbes without culturing them individually in a lab. This has meant soil microbes that could not be grown independently can now be researched more easily.

The Earth Microbiome Project (EMP), founded in 2010, consolidates the information from DNA sequences in an attempt to “characterize microbial life on this planet.”⁸⁶ The project statement invites researchers from around the world to use the EMP’s standardized method for collecting samples, preparing DNA to be sequenced, and running it through mass spectrometry.⁸⁷ The EMP then uses this data to “understand patterns in microbial ecology across the biomes and habitats of our planet.”⁸⁸ The focus of the project is to better understand the immense diversity of microbial life on Earth, and what roles they play in the environment. Many of the microbes being discovered have never been studied before. Thousands of previously unknown species have been identified in soil alone.⁸⁹

A more complex view of microbes has started to emerge not only in scientific research, but also in popular knowledge. Epitomic of the shift towards a greater understanding of microorganisms is the rise of probiotics in North America. As people have become more conscious of the human microbiome, and the vital role microbes play

⁸⁵ “Renaissance,” *Nature Microbiology* 1 (January 11, 2016): 15022.

⁸⁶ “Earth Microbiome Project,” Scientific Research Initiative, accessed June 20, 2018, <http://www.earthmicrobiome.org/>.

⁸⁷ I used the EMP’s method to sequence the microbial life present in my sculptures. This process is described in “Chapter 3, Collaborating with Scientists.”

⁸⁸ “Earth Microbiome Project,” Scientific Research Initiative, accessed June 20, 2018, <http://www.earthmicrobiome.org/>.

⁸⁹ Baliyarsingh B., Nayak S.K., and Mishra B.B., “Soil Microbial Diversity: An Ecophysiological Study and Role in Plant Productivity,” in *Advances in Soil Microbiology: Recent Trends and Future Prospects*, ed. Adhya T. et al., vol. 4, *Microorganisms for Sustainability* (Singapore: Springer, 2017).

in gut health, many have actively sought foods and supplements that are probiotic.⁹⁰ The company Renew Life markets a chewable probiotic tablet for children:

Keep your child's tummy in tip-top spirits every day with Ultimate Flora Kids Probiotic 3 Billion. This daily chewable probiotic is made with 6 scientifically studied *Lactobacillus* and *Bifidobacterium* strains to ease occasional tummy trouble and support digestive and immune health.⁹¹

It is unclear yet if pills like these actually support a healthy community of gut microbes,⁹² but their existence, and our willingness to consume “billions of live cultures” marks a clear shift in how we think about some bacteria.⁹³

STS scholar Heather Paxson has studied this shift in general attitudes toward microbes. Paxton coined the term “microbiopolitics” to describe “the creation of categories of microscopic biological agents; the anthropocentric evaluation of such agents; and the elaboration of appropriate human behaviors vis-à-vis microorganisms engaged in infection, inoculation, and digestion.”⁹⁴ Paxson states that since the work of Louis Pasteur microbes have been treated as threats to the human body. She argues that this understanding has started to change in the past two decades, yet appreciation is still tempered, with an emphasis on microbes considered beneficial to humans. Paxson uses the example of artisan cheese to illustrate the nuances of the microbial turn:

⁹⁰ “Probiotics Market Growth: Industry Size, Share Research 2018-2024” (Cleveland: Global Market Insights, April 2018).

⁹¹ Renew Life, Commercial Web Site, “Ultimate Flora”, accessed June 19, 2018, <http://www.renewlife.ca/products/ultimate-flora-kids-probiotic/>.

⁹² Nancy Toedter Williams, “Probiotics,” *American Journal of Health-System Pharmacy* 67, no. 6 (March 2010): 449–58.

⁹³ Renew Life, Commercial Web Site, “Ultimate Flora”, accessed June 19, 2018, <http://www.renewlife.ca/products/ultimate-flora-kids-probiotic/>.

⁹⁴ Heather Paxson, “Post-Pasteurian Cultures: The Microbiopolitics of Raw-Milk Cheese in the United States.,” *Cultural Anthropology* 23, no. 1 (2008): 15.

In countering Pasteurian dreams of microbial control, post-Pasteurian fantasies of microbial flourishing are not indiscriminate in their passion. We refer to raw-milk cheesemaking as *post*-Pasteurian rather than *anti*-Pasteurian because it recognizes risk and guards against infection through hygienic practice, while it moves beyond Pasteurianism in recruiting ‘good’ microbes as friends and allies in this effort. Joining a wider movement against the industrial standardization of food, post-Pasteurians say that pasteurization is less an obligatory passage point to cheese safety than a sledgehammer squashing the potential benefits of microbial abundance.⁹⁵

The tight regulation of non-pasteurized cheese demonstrates that the public is still skeptical of microbial life, but it is clear that some progress is being made. In the article “The Perils and Promises of Microbial Abundance,” Paxton in collaboration with STS scholar Stefan Helmreich aptly describe the current micropolitical climate:

To be sure, that deployment of microbial life – as promise rather than peril – is in part a function of a broader environmentalist vision. No longer are we in a modernist Cold War world in which enemies are everywhere, even unto the microbial realm; that was the ambient ethos surrounding both the 1949 supremacy of pasteurized American cheese and the 1960 enunciation of exobiology as the defense of Earth against microbes from outer space. Rather, microbes have now become models for apprehending biotic nature, both in the sense of serving as representatives of dynamics that suffuse the organic world in general, but also in the sense of standing as promising tokens for reimagining nature as it could or should be. It is worth pointing out that this optimistic vision of microbes has been enabled precisely by the fact that the Pasteurian project has been so successful; microbes can be promising for those people who no longer have to worry about smallpox, polio, cholera, and other agents of infectious disease.⁹⁶

Humanity’s relationship with microbial life is complex and there is still much to be done to forge a deeper understanding of our microbial companions. Our appreciation for

⁹⁵ Heather Paxson and Stefan Helmreich, “The Perils and Promises of Microbial Abundance: Novel Natures and Model Ecosystems, from Artisanal Cheese to Alien Seas,” *Social Studies of Science* 44, no. 2 (2014):173.

⁹⁶ *Ibid*: 183.

microbes is largely based in their use-value for humans, with little consideration for their liveliness. This is demonstrated in part by the language applied to discussions of microorganisms.

It is common in microbiology – and other sciences – to use machine or war-based metaphors to describe life. Cells are compared to tiny machines, organelles to factory workers, viruses become hackers, and DNA is as a code to be executed. As Donna Haraway emphasizes, “...it matters what stories tell stories, it matters what thoughts think thoughts.”⁹⁷ Using the machine as a metaphor “highlight[s] specific aspects of the functioning of living beings while at the same time hiding others, such as evolutionary change and interdependencies” argues anaesthesiologist and scientific researcher Joachim Boldt.⁹⁸ This kind of thinking can lead to objectification of the microbial world, a concept that Stefan Helmreich touches on in his book *Alien Oceans* (2009). In the text, Helmreich describes a conversation he had with microbiologist Jim Holden. Helmreich asks Holden how he thinks about his relationship to microbial life and Holden replies:

I’m just an observer and manipulator. I don’t feel any oneness with them. Obviously, we share metabolic capabilities, but I don’t have an attachment to them. That makes it easier to take a kilogram of them and grind them up. It’s like being a farmer who raises pigs or cows. They are what they are. I am what I am. But I do see them as part of the handiwork of the Creator. We both have metabolism, which makes us alive. But we humans have something beyond metabolism, something that makes us special.⁹⁹

⁹⁷ Donna Haraway, “Anthropocene, Capitalocene, Chthulucene: Staying with the Trouble” (Lecture, Anthropocene: Arts of Living on a Damaged Planet, University of California, Santa Cruz, 2014), <http://opentranscripts.org/transcript/anthropocene-capitalocene-chthulucene/>.

⁹⁸ J. Boldt, “Machine Metaphors and Ethics in Synthetic Biology,” *Life Sciences, Society, and Policy* 14, no. 12 (2018).

⁹⁹ Stefan Helmreich, *Alien Ocean: Anthropological Voyages in Microbial Seas* (Los Angeles: University of California Press, 2009): 238.

The way Holden thinks of microbes allows him to separate his way of being in the world from theirs. As Helmreich states, “the language of observation he uses to describe his relation to microbes operates in a different register than immersion, in the idiom of objectification rather than subjectification of cells.”¹⁰⁰ Objectification separates ‘us’ from ‘them’, whereas subjectification can help foster empathy and recognition of the interdependence inherent to life. By subjectifying cells, like microbes, we are able to appreciate their liveliness as well as their intrinsic value.

In an act of subjectification, microbiologist Takeo Kasabo built a monument in Kyoto in 1981 to the microbes that enabled his research, with a plaque that reads:

To the innumerable souls of Microbes Who have dedicated and sacrificed
For the existence of Humans,
We pay our deepest respect.
Here we hold a Memorial Service For their soul’s rest and condolence,
Building a Microbe Mound.¹⁰¹

Kasabo announced at the founding of the site:

Thanks to recent remarkable progress in bacteriology, new kinds of enzymes have been developed in succession, and have been playing important roles in many fields. But how selfish of human beings to have been too indifferent to the victimization of trillions of little lives, in the shade of these glorious technological achievements, to pay attention to the sacrifices offered by them! Deploing this deeply, I set up the Microbe Mound in the holy precinct of the auspicious Manshuin Temple at the western foot of Mt. Hiei.¹⁰²

¹⁰⁰ Stefan Helmreich, *Alien Ocean: Anthropological Voyages in Microbial Seas* (Los Angeles: University of California Press, 2009): 188.

¹⁰¹ Ibid: 138.

¹⁰² Ibid.

The microbe mound adapts an anthropocentric ritual to honor the deaths of microbes. In doing so, Kasabo considers their liveliness in their capacity to die, even to sacrifice, for research.

Another way that we can begin to consider the subjectivity of microbes is through microbial life's ability to collaborate. Microorganisms can communicate by releasing and receiving "signal molecules" called autoinducers.¹⁰³ Their "elaborate chemical signaling systems"¹⁰⁴ enable microbes to work together as a "multicellular organism"¹⁰⁵ on tasks that are "critical for survival,"¹⁰⁶ but impossible for a microbe to perform alone. Microbes use this method, called quorum sensing, to collaborate in the production of antibiotics, to become virulent at the right time inside a host, to form biofilms that can protect communities in harsh conditions, to reproduce quickly, and to emit bioluminescence strong enough to become visible to other creatures.¹⁰⁷ Microbes can communicate within and across species – meaning that completely different species of microbes can collaborate on the same tasks.¹⁰⁸ Inside our mouths, bacteria cooperate with fungi to create mixed biofilm.¹⁰⁹ These biofilms form plaque, yet they also help maintain a healthy community of microbes by protecting from pathogens.¹¹⁰ This kind of cross-

¹⁰³ Robert Hine and Elizabeth Martin, eds., "Quorum Sensing," in *A Dictionary of Biology* (New York: Oxford University Press, 2016).

¹⁰⁴ Michael J. Federle and Bonnie L. Bassler, "Interspecies Communication in Bacteria," *The Journal For Clinical Investigation* 112, no. 9 (November 1, 2003): 1291.

¹⁰⁵ Mahendra Kumar Prajapat and Supreet Saini, "Logic of Two Antagonizing Intra-Species Quorum Sensing Systems in Bacteria," *Biosystems* 165 (March 2018): 89.

¹⁰⁶ Wai-Leung Ng and Bonnie Bassler, "Bacterial Quorum-Sensing Network Architectures," *The Annual Review of Genetics* 43 (2009): 197.

¹⁰⁷ Michael J. Federle and Bonnie L. Bassler, "Interspecies Communication in Bacteria," *The Journal For Clinical Investigation* 112, no. 9 (November 1, 2003): 1291.

¹⁰⁸ Mahendra Kumar Prajapat and Supreet Saini, "Logic of Two Antagonizing Intra-Species Quorum Sensing Systems in Bacteria," *Biosystems* 165 (March 2018): 88.

¹⁰⁹ Sivan Elias and Ehud Banin, "Multi-species Biofilms: Living with Friendly Neighbors," *FEMS Microbiology Reviews*, January 2012, <https://onlinelibrary-wiley-com.ezproxy.library.uvic.ca/doi/full/10.1111/j.1574-6976.2012.00325.x>.

¹¹⁰ *Ibid.*

species collaboration in making biofilm is not rare. In fact, it is much more common than single species biofilms.¹¹¹

Microbial life's capacity to communicate across species inspired bio artist Anna Dumitriu to work with quorum sensing microbes to conduct bacterial-human communication. In her performance piece *Cybernetic Bacteria 1* (2008), Dumitriu planted a large, open, plastic tube filled with agar in the ground outside the Brighton Media Centre. Over time soil bacteria grew up the tube. Dumitriu then introduced a small amount of Homoserine Lactone – one of the autoinducers bacteria use in quorum sensing – to the tube. By doing this, Dumitriu announced her presence to the microbes, which then (theoretically) passed on the message through complex webs all the way around the globe.¹¹² She describes *Cybernetic Bacteria 1* as a way to be “absolutely connected, through the sublime, vast, complex, cybernetic networks of bacterial communication, which constantly flow around us, in us and through us.”¹¹³ Although the precise signal that the artist may be sending to the microbes is unknown – and I would argue this message matters – the artwork still fosters awareness of the incredible communication capacity of microorganisms. Microbial life links us, as Dumitriu expresses, to a deeply enmeshed web. Recognizing these connections may help us extend our empathy and become more accountable to the ecosystem we are a part of.

In her text, “Posthuman Critical Theory” (2016), feminist theorist Rosi Bradotti argues that to be accountable to a larger collective is to be posthuman:

¹¹¹ Sivan Elias and Ehud Banin, “Multi-species Biofilms: Living with Friendly Neighbors,” *FEMS Microbiology Reviews*, January 2012, <https://onlinelibrary-wiley-com.ezproxy.library.uvic.ca/doi/full/10.1111/j.1574-6976.2012.00325.x>.

¹¹² Anna Dumitriu, “Cybernetic Bacteria 2.0: Investigating the Sublime in Bacterial and Digital Communication,” *Technoetic Arts: A Journal of Speculative Research* 11, no. 1 (2013).

¹¹³ Ibid.

To be posthuman does not mean to be indifferent to the humans, or to be dehumanized. On the contrary, it rather implies a new way of combining ethical values with the well-being of an enlarged sense of community, which includes one's territorial or environmental inter-connections ¹¹⁴

Microbial life connects all bodies through its presence, as well as through its ongoing role in evolutionary processes. Bradotti cites evolutionary theorist and biologist Lynn Margulis' theory of symbiogenesis as a way to acknowledge and care for a broader community. Bradotti argues that posthuman ethics can be "sustained by a vision of evolutionary processes as symbiotic modes of relation."¹¹⁵ Margulis came to her theory of symbiogenesis while looking for evidence of Darwinian evolution. Recounting what led her to seek more than the answers Neo-Darwinism¹¹⁶ could provide, Margulis asserted:

What you'd like to see is a good case for gradual change from one species to another in the field, in the laboratory, or in the fossil record—and preferably in all three. Darwin's big mystery was why there was no record at all before a specific point [dated to 542 million years ago by modern researchers], and then all of a sudden in the fossil record you get nearly all the major types of animals. The paleontologists Niles Eldredge and Stephen Jay Gould studied lakes in East Africa and on Caribbean islands looking for Darwin's gradual change from one species of trilobite or snail to another. What they found was lots of back-and-forth variation in the population and then—whoop—a whole new species. There is no gradualism in the fossil record.¹¹⁷

¹¹⁴ Rosi Braidotti, "Posthuman Critical Theory," in *Critical Posthumanism and Planetary Futures* (California: Springer, 2016): 26.

¹¹⁵ Ibid.

¹¹⁶ Neo-Darwinism, also known as modern evolutionary synthesis, refers to the integration of Charles Darwin's theory of evolution by natural selection, Gregor Mendel's theory of genetic inheritance and mathematical population genetics.

¹¹⁷ Dick Teresi, "Lynn Margulis Says She's Not Controversial, She's Right," *Discover Magazine*, June 17, 2011.

Margulis started looking for the cause of these incongruences by studying cells. She noticed that the mitochondria and chloroplasts in multicellular life looked a lot like bacteria. The research that resulted from this observation led to the publication of her controversial paper “On the Origin of Mitosing Cells” (1966). In it, Margulis outlines her serial endosymbiotic theory on the origin of eukaryotes or multi-cellular life. She describes how the Earth was once an anaerobic or low-oxygen environment dominated by microorganisms. When some microbes began using photosynthesis to produce energy, they created oxygen as a by-product, shifting the composition of the atmosphere. Life on Earth needed to adapt to oxygen or move to anaerobic environments (such as deep within the ocean). Margulis argues that around this time:

An aerobic prokaryotic microbe (i.e. the protomitochondrion) was ingested into the cytoplasm of a heterotrophic anaerobe. This endosymbiosis became obligate and resulted in the evolution of the first aerobic amitotic amoeboid organisms.¹¹⁸

The absorption of an aerobic microbe – already adapted to oxygen – into an anaerobe enabled both to survive in Earth’s oxygen rich atmosphere. Margulis contends that a series of symbiotic relationships such as this one eventually coalesced in the evolution of three different kinds of organelles – mitochondria, chloroplasts, and flagella – all integral aspects of the cells of eukaryotes (multi-cellular organisms).¹¹⁹

Margulis faced widespread criticism of her theory. At the time, most scientists believed that organelles had come from other parts of the cell through Darwinian

¹¹⁸ Lynn Sagan, “On the Origin of Mitosing Cells,” *Journal of Theoretical Biology* 14 (1967): 228.

¹¹⁹ *Ibid*, 227.

evolution.¹²⁰ German biologist Bill Martin recalls that, “[Endosymbiosis] was taboo, you had to sneak into a closet to whisper to yourself about it before coming out again.”¹²¹ In his book *The Vital Question* (2015), biochemist Nick Lane points out that it was not until the rise of molecular biology that Margulis could adequately prove her theory.¹²² Once the DNA of organelles inside cells could be sequenced, it became clear that “plainly, mitochondria and chloroplasts do derive from bacteria.”¹²³ The circumstances surrounding exactly how and why this occurred are still debated. However, it is now widely accepted that an archaeon¹²⁴ and a bacterium merged to form the basis for all multi-cellular life on Earth. Lane points out, “There must have been thousands or millions of these cases over evolutionary time, but they’ve got to find a way of getting along, of reconciling and co-adapting to each other ... that seems to be genuinely difficult.”¹²⁵ This serendipitous union has seemingly never happened again, but symbiosis continues to drive many relationships. “The creative force of symbiosis produced eukaryotic cells from bacteria. Hence all larger organisms—protists, fungi, animals, and plants—originated symbiogenetically,” Margulis states. “But creation of novelty by symbiosis did not end with the evolution of the earliest nucleated cells. Symbiosis still is everywhere.”¹²⁶

¹²⁰ Ed Yong, “The Unique Merger That Made You (and Ewe, and Yew): All Sophisticated Life on the Planet Earth May Owe Its Existence to One Freakish Event,” *Nautilus*, February 6, 2014.

¹²¹ *Ibid.*

¹²² Nick Lane, *The Vital Question: Why Is Life the Way It Is?* (London: Profile Books Ltd., 2015): 16.

¹²³ *Ibid.*

¹²⁴ Archaea (singular archaeon) are a single-celled microorganism genetically distinct from bacteria. Archaea are known for surviving in extreme environments such as the hydrothermal vents deep in the ocean.

¹²⁵ Ed Yong, “The Unique Merger That Made You (and Ewe, and Yew): All Sophisticated Life on the Planet Earth May Owe Its Existence to One Freakish Event,” *Nautilus*, February 6, 2014.

¹²⁶ Lynn Margulis and Dorion Sagan, *Acquiring Genomes: A Theory of the Origins of Species* (New York: Basic Books, 2002): 55-56.

Margulis developed these ideas into her theory of symbiogenesis. She argued that evolution is not purely based on competition; instead, many organisms evolved through collaboration. According to Margulis, Darwin's theory of evolution is not incorrect – it is just incomplete.¹²⁷ As she stated, “Life did not take over the globe by combat, but by networking.”¹²⁸ Margulis's theories support a more egalitarian approach to human/non-human relationships. “The evolutionary biologists believe the evolutionary pattern is a tree,” said Margulis. “It's not. The evolutionary pattern is a web—the branches fuse, like when algae and slugs¹²⁹ come together and stay together.”¹³⁰ Acknowledging the role of symbiosis in evolution – in particular the role of microbial life in human evolution– is humbling. Donna Haraway describes symbiogenesis as a way to “wound the primary narcissism of those who still dream of human exceptionalism.”¹³¹ Undeniably, our existence has been made possible by microbial life; from the very beginning we are inextricably enmeshed.

Being conscious of our microbial roots can help us understand we are always a part of “a relational web opening to non-Euclidean pasts, presents, and futures,” says Haraway. “These are also the cobblings together that give meaning to the ‘becoming with’ of companion species.”¹³² Companion species are not simply the animals we choose as our companions; they are non-humans that we attempt to become with. For Haraway,

¹²⁷ Dick Teresi, “Lynn Margulis Says She's Not Controversial, She's Right,” *Discover Magazine*, June 17, 2011.

¹²⁸ Lynn Margulis and Dorion Sagan, *Microcosmos: Four Billion Years of Evolution from Our Microbial Ancestors* (Los Angeles: University of California Press, 1997): 29.

¹²⁹ Margulis is referring to a juvenile slug that takes in algae chloroplasts to become photosynthetic.

¹³⁰ Dick Teresi, “Lynn Margulis Says She's Not Controversial, She's Right,” *Discover Magazine*, June 17, 2011.

¹³¹ Donna Haraway, *When Species Meet*. Vol. 3. *Posthumanities*. Minneapolis: University of Minnesota Press, 2008: 43.

¹³² *Ibid.*

this means fostering a relationship based on empathy in which we are interested in hearing what our companions have to say.¹³³ Becoming with is an active and ongoing negotiation that requires we remain aware of our place within a larger network; enmeshed with “a motley crowd of differentially situated species, including landscapes, animals, plants, microorganisms, people, and technologies.”¹³⁴ Through engaging and acknowledging her place within this community and becoming receptive to it, Haraway aims:

...to be worldly, to be in connection with significant otherness and signifying others, on many scales, in layers of locals and globals, in ramifying webs. I want to know how to live with the histories I am coming to know. Once one has been in touch, obligations and possibilities for response change.¹³⁵

Microbial life is a companion in the most intimate manner, present in, on, and around our bodies.¹³⁶ The connections they form put us in touch with each other, providing the opportunity to reflect on becoming with in a productive way.

The microbial life inside my sculptures have been, and continue to be, my companion species and thinking partners. The microbial community present is diverse – composed of cyanobacteria, heterotrophic bacteria, algae, iron oxidizing bacteria, purple sulphur bacteria, sulfate reducing bacteria, to name a few. These bacteria form complex relationships in negotiation with each other. Inside the prisms, cyanobacteria, as well as green and brown algae¹³⁷ gain energy from the sun via photosynthesis, producing oxygen

¹³³ Donna Haraway, *When Species Meet*. Vol. 3. *Posthumanities*. Minneapolis: University of Minnesota Press, 2008: 43.

¹³⁴ *Ibid*: 41.

¹³⁵ *Ibid*: 97.

¹³⁶ Pray, Pillsbury, and Tomayko, “The Human Microbiome, Diet and Health.” Washington: National Academies Press, 2013:1.

¹³⁷ Both green and brown algae contain chlorophyll, which gives them their green hue, but the brown algae also contain an additional brown pigment called fucoxanthin

as a by-product. Other bacterial species, such as clostridium, grow in anaerobic environments near the bottom of the sculpture. They break down the cellulose of detritus, plant matter, and the newspaper I introduced, fermenting it into glucose to gain energy.

Bacteria also run a sulphur cycle inside the sculpture. Sulphur-reducing bacteria consume sulphur and produce hydrogen sulfide gas as a waste product. The gas moves up the prism where it is used by green and purple sulphur bacteria. These bacteria are anaerobic photosynthetic bacteria, meaning that they gain their energy from light, but they use hydrogen sulfide to photosynthesize instead of water.¹³⁸ Through this process, the bacteria convert the hydrogen sulfide back into sulphur where it is consumed again by the sulphur-reducing bacteria.

The intricate web of relationships inside the prisms sustains the microbes in ongoing living and dying. It also reminds me that I – like the microbes inside my sculpture – am intimately enmeshed with other beings. Without these ties my existence would not be possible. Microbes bind us together. As Ed Yong said, “Through microbes, we find unity with our fellow creatures, despite our incredibly different lives.”¹³⁹

¹³⁸ Water is used in aerobic photosynthesis

¹³⁹ Ed Yong, *I Contain Multitudes: The Microbes Within Us and a Grander View of Life* (New York: HarperCollins Publishers, 2016): 4.

Lake Ontario

In early Middle English ‘to lake’ indicated an offering, a sacrifice, finally a gift.

–Barry Lopez and Debra Gwartney, *Home Ground: Language for an American Landscape*

Water is the element that, more than any other, ties human beings in to the world around them – from the oceans that surround us to the water that makes up most of our bodies.

– Astrida Neimanis, *Bodies of Water: Posthuman Feminist Phenomenology*

Bodies of water and living bodies are intimately connected. Just as microbial life creates ties, water also flows between us. We are composed of water, reliant on where it comes from, what it does, as well as where it goes.¹⁴⁰ Posthuman feminist thinker Astrida Neimanis talks about bodies as primarily “watery” as a way to break down the illusion of a cohesive body.¹⁴¹ She states, “For us humans, the flow and flush of waters sustain our own bodies, but also connect them to other bodies, to other worlds beyond our human selves. Indeed, bodies of water undo the idea that bodies are necessarily or only human.”¹⁴² Becoming attuned to our wateriness is “a means for cultivating better ways of living with water *now*.”¹⁴³ When we recognize how our body extends outward to meet others – including bodies of water – our responsibility to those bodies becomes apparent. The body of water that we call Lake Ontario is connected to my body and many others.

¹⁴⁰ Astrida Neimanis, *Bodies of Water: Posthuman Feminist Phenomenology* (New York: Bloomsbury Academic, 2017): 4.

¹⁴¹ Ibid.

¹⁴² Ibid.

¹⁴³ Ibid: 26.

When I first began my work with mud and microbes I decided to collaborate with Lake Ontario. Growing up and living in the Greater Toronto Area (GTA) I have had a relationship with the lake my entire life. However, I was initially tempted to include many more lakes in my project such as Balsam Lake where my grandparents lived, or potentially more of the Great Lakes, but I realized I would never be able to give enough time to develop a meaningful understanding of all these bodies of water. Instead, I have chosen to focus my research on a meaningful collaboration with Lake Ontario. As anthropologist Anna Lowenhaupt Tsing says, “landscapes and landscape knowledge develop in patches.”¹⁴⁴ I am still doing the work of developing my knowledge of Lake Ontario – its history and unfolding present.

Over 10000 years ago the Great Lakes basins were formed by the retreating Laurentide Ice Sheet, which covered most of Canada, and as far south as present-day Ohio.¹⁴⁵ As the glacier slowly moved the basin filled with melt-water. Initially this formed a much larger lake – that we refer to as Lake Iroquois – until the retreating ice released the trapped water through the St Lawrence River and into the Atlantic Ocean. The remaining water eventually settled into what is now called Lake Ontario. The lake is situated on Anishinaabe, Haudenosaunee, and Huron-Wendat first nation territories, straddling the province of Ontario and the state of New York.¹⁴⁶ This history of the lake is a geographic one, but as “natureculture” teaches us, it is inseparable from the lake’s cultural history. “Natureculture” is a term developed by Donna Haraway to describe that

¹⁴⁴ Anna Lowenhaupt Tsing, *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins* (Princeton: Princeton University Press, 2015).

¹⁴⁵ Anders E. Carlson et al., “Rapid Early Holocene Deglaciation of the Laurentide Ice Sheet,” *Nature Geoscience* 1 (August 31, 2008): 620.

¹⁴⁶ Michelle Murphy, “Alterlife and Decolonial Chemical Relations,” *Cultural Anthropology* 32, no. 4 (2017): 494–503.

nature and culture are never separate entities.¹⁴⁷ There is no pure nature, or pure culture, but always an intermingling of the two. The separation of nature from cultural activities leads to dangerous understandings about the pristine, or untouched landscape, as pure nature that is disassociated from humans. The term begins the work of breaking down the dichotomy of nature and culture that has been particularly violent toward Indigenous peoples whose presence on the land was attempted to be erased with settlers coming to wild, untouched nature.¹⁴⁸ The name Lake Ontario itself provides insight into its natureculture history. ‘Ontario’ was taken from the Indigenous Huron word for shining water, ‘Ontari’io.’¹⁴⁹ Settlers applied the anglicised title Ontario to the lake in 1641. The name Lake Ontario is one trace of the colonial violence between Indigenous peoples and European settlers.

The Great Lakes themselves are often romanticized as a settler-Canadian national symbol of pure nature. Lake Ontario is featured in various Ontario travel advertisements that depict a lone human figure on an expanse of water.¹⁵⁰ Thinking of Lake Ontario simply as a natural wonder separates it from us, presenting “a romantic vision of nature itself as pristine, uncontaminated, [and] possessed of a sublimely unknowable character,” says Stefan Helmreich.¹⁵¹ In actuality, he contends, “nature is ... thoroughly implicated with cultural activity.”¹⁵² This is precisely the reality one can imagine when combining

¹⁴⁷ Donna Haraway, *Modest_Witness@second_Millennium. FemaleMan©_Meets_OncoMouseTM: Feminism and Technoscience* (New York & London: Routledge, 1997).

¹⁴⁸ Donna Haraway, *When Species Meet*, vol. 3, Posthumanities (Minneapolis: University Of Minnesota Press, 2008):15.

¹⁴⁹ John Steckley, “Ontari’io,” in *A Huron-English / English- Huron Dictionary* (Toronto: Edwin Mellen Press, 2007).

¹⁵⁰ “Ontario Travel Canada,” YouTube, 2018, <https://www.youtube.com/user/TravelOntarioCanada>.

¹⁵¹ Stefan Helmreich, *Alien Ocean: Anthropological Voyages in Microbial Seas* (Los Angeles: University of California Press, 2009): 225.

¹⁵² Ibid.

the enmeshed existence that Donna Haraway expresses with her term natureculture together with the lived reality of Lake Ontario.



Figure 7: *Swans Will Be Treated like Birds: Public Art Proposals*, Diane Borsato, 2009

The water from all five Great Lakes flows through Lake Ontario before it returns to the sea, along with all of the pollutants gathered as the water passes farmland and industrial corridors. The lake is so polluted that Toronto based artist Diane Borsato included “THE LAKE WILL BE CLEANED ENTIRELY” as one of her “absurd or impossible” public art proposals for the town of Port Credit on Lake Ontario (2009).¹⁵³

¹⁵³ The Blackwood Gallery, “The Projects: Port Credit,” Blackwood Gallery, accessed September 6, 2018, <http://blackwoodgallery.ca/exhibitions/2009/portcredit2009.html>.

Michelle Murphy, a historian of the recent past and technoscience studies scholar, has written about the industrial chemicals omnipresent in the Great Lakes. In her texts, Murphy emphasizes the importance of creating “modes of attention” that enable us to see and take responsibility for “histories and presences of chemical itineraries and their production in the infrastructures of settler colonialism, racism, and capitalism.”¹⁵⁴ We are enmeshed with the lake through these histories and their chemical traces:

Analyzing urine, blood, and breastmilk, twenty-first-century global bio-monitoring studies have concluded that all people alive today contain PCBs within them (Stockholm Convention on Persistent Organic Pollutants 2009); industrially produced chemicals like PCBs have become a part of human living-being. The pollution of the water has joined the molecular fabric of our bodies.¹⁵⁵

The presence of polychlorinated biphenyls (PCBs) in our bodies reveals another way we are tied to our environment. To pollute one is to pollute the other. The extent to which we are already contaminated could indicate that we have gone too far to try to reconcile.

Donna Haraway describes this tendency to become apathetic in the face of dire realities as “a position that the game is over, it’s too late”.¹⁵⁶ Although this feeling is understandable during a time when the world faces huge challenges such as the climate crisis, she argues, “There is a fine line between acknowledging the extent and seriousness of the troubles and succumbing to abstract futurism and its affects of sublime despair and its politics of sublime indifference.”¹⁵⁷ Instead, “staying with the trouble is both more

¹⁵⁴ Michelle Murphy, “Alterlife in the Ongoing Aftermath: Exposure, Entanglement, Survivance,” <http://www.toxicsymposium.org/conversations-1/2016/3/1/alterlife-in-the-ongoing-aftermath-exposure-entanglement-survivance>.

¹⁵⁵ Ibid.

¹⁵⁶ Donna Haraway, *Staying with the Trouble: Making Kin in the Chthulucene* (Experimental Futures) (New York: Duke University Press, 2016): 4.

¹⁵⁷ Ibid.

serious and more lively” says Haraway.¹⁵⁸ Murphy also echoes this call, proposing that we work together to conceive of another way to be in the world. She offers us the concept of “alterlife” as one way to “generate alter-concepts of care” and “alter-modes of collaboration.”¹⁵⁹

Alterlife acknowledges that one cannot simply get out, that this hurtful and deadly entanglement forms part of contemporary existence in this moment, in the ongoing aftermath. And yet the openness to alteration may also describe the potential to become something else, to defend and persist, to recompose relations to water and land, to become alter-wise in the aftermath.¹⁶⁰

Alterlife provides a way to live with our enmeshed state and move forward constructively, rather than longing for a time before alteration. The microbial life in Lake Ontario is itself a form of alterlife.

The microorganisms that are thriving in Lake Ontario today are very different than the microbes that lived in the lake 200 years ago.¹⁶¹ The microbial communities have shifted as the environment of the lake has been altered “... due to non-indigenous species, pollution, sedimentation, turbidity, and climate change.”¹⁶² These changes have been traced through the lake’s phytoplankton populations. Phytoplankton are photosynthetic

¹⁵⁸ Donna Haraway, *Staying with the Trouble: Making Kin in the Chthulucene* (Experimental Futures) (New York: Duke University Press, 2016): 4.

¹⁵⁹ Michelle Murphy, “Alterlife and Decolonial Chemical Relations,” *Cultural Anthropology* 32, no. 4 (2017): 496.

¹⁶⁰ *Ibid.*

¹⁶¹ I am interested in exploring the concept of ‘invasive species’ further – what does it mean to be invasive when the lake has always been in a state of change? – in future texts.

¹⁶² Lisa R. Estep and Euan D. Reavie, “The Ecological History of Lake Ontario According to Phytoplankton,” *Journal of Great Lakes Research* 41, no. 3 (September 2015): 669–87.

microbes that include cyanobacteria and algae.¹⁶³ Looking at the health of these microbes has been key in understanding the condition of many aquatic ecosystems.¹⁶⁴

When Lake Ontario first formed, its phytoplankton population was composed of species that could live in a low nutrient or oligotrophic environment and were adaptable to a wide range of conditions, making them eurytopic. When European settlers colonized Canada and began to pollute the lake with nitrogen and phosphorus run off these populations were displaced by phytoplankton that thrive in mineral rich, eutrophic, environments.¹⁶⁵ The lake continued to change due to capital driven industrial colonial activities, but the next big shift in population occurred from 1975 to 2000 when many species of phytoplankton began to die off dramatically as phosphorus levels went down.¹⁶⁶ These species have long been adapting to their environment, with some better able to change than others. Despite ongoing stressors such as “urban sprawl, chemical pollutants, agricultural intensification, land use changes, climate change effects ... habitat loss and invasive species” the phytoplankton population in Lake Ontario is currently stable and diverse.¹⁶⁷ The capacity for microbial life to adapt to altered environments provides hope for ongoing living together.

Anna Lowenhaupt Tsing in her book *The Mushroom at the End of the World* (2015), considers how we can “live within capitalist ruin” alongside her thinking partner

¹⁶³ J.A Raven and S.C. Maberly, “Phytoplankton Nutrition and Related Mixotrophy,” in *Encyclopedia of Inland Waters*, 2009.

¹⁶⁴ Dr. Antony Joseph, “Magic With Colors: Sea Surface Changes,” in *Investigating Seafloors and Oceans: From Mud Volcanoes to Giant Squid* (Elsevier Academic Press, 2017).

¹⁶⁵ Lisa R. Estep and Euan D. Reavie, “The Ecological History of Lake Ontario According to Phytoplankton,” *Journal of Great Lakes Research* 41, no. 3 (September 2015): 669.

¹⁶⁶ Ibid.

¹⁶⁷ Ibid.

the matsutake.¹⁶⁸ The matsutake is a wild mushroom that grows in forests disturbed by human activity. The red pine that the mushrooms most commonly grow under require the direct sun and mineral soils left behind by deforestation to thrive.¹⁶⁹ These mushrooms flourish because of human alteration of the environment. However, the capacity of some non-human life to succeed in our contaminated present is not a justification to ignore harm. “This is not an excuse for further damage,” Tsing says, but it does demonstrate “... one kind of collaborative survival.”¹⁷⁰

Working with the microbial life in Lake Ontario has demonstrated a way to survive together through adaptation. Jody Roberts, director of the Institute for Research at the Science History Institute in California, argues that since we do not have “the luxury of disengagement” the only way forward is to work within our entangled state.¹⁷¹ In light of this reality, Roberts asks, “How do we narrate stories that help us to understand how our remaking of this world, and ourselves, is not over, but a process; a process open to our efforts of remaking?”¹⁷²

Vancouver-based Anishinaabekwe artist Rebecca Belmore’s installation *Temple* (1996) took up this question in relation to Lake Ontario and our responsibilities towards water. Displayed in the Power Plant Gallery in Toronto, steps away from the lake, *Temple* depicted water in three forms: 1. water from Lake Ontario, the Don River, and tap water

¹⁶⁸ Anna Lowenhaupt Tsing, *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins* (Princeton: Princeton University Press, 2015).

¹⁶⁹ Ibid.

¹⁷⁰ Anna Lowenhaupt Tsing, *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins* (Princeton: Princeton University Press, 2015): 4.

¹⁷¹ Jody Roberts, “Narrating a Past for New Futures,” (2016).
<http://www.toxicsymposium.org/conversations-1/>.

¹⁷² Ibid.

packaged in plastic milk bags stacked in the gallery; 2. flowing through a public water fountain; 3. the presence of Lake Ontario, visible through a telescope.



Figure 8: *Temple*, Rebecca Belmore, 1996, <http://www.rebeccabelmore.com>

It is likely that Belmore was interested in working with Lake Ontario specifically because of her close ties to the lake from her time living in Toronto while studying at the Ontario College of Art and Design in the late 1980's.¹⁷³ Also significantly, when Belmore made this work there was an ongoing outbreak of E. coli in the water supply of the Kashechewan First Nations community of Northern Ontario. *Temple* is born out of the fight for access to clean water and the ongoing colonial inequality that has made this fight necessary. The artwork presents the disparities in water justice and, as Neimanis writes about Belmore's installation, it also presents the viewer with many questions:

¹⁷³ OCAD, "Alumni Profiles," University, Ontario College of Art and Design, accessed September 6, 2018, <https://www.ocadu.ca/alumni/our-alumni/alumni-profiles/1980s.htm>.

What is it, she asks, that we have come to worship at this ‘temple’? Water’s holism as contiguous with Creation? Massive hydrological infrastructure as the ‘temples of modernism’? The ‘fit and healthy body’ of the late capitalist consumer, needing regular ‘hydration’? Something else? Maybe each of us – indigenous or not – is interpellated by all of these questions, but in different ways and to different effect.¹⁷⁴

Water is much more than any one of the depictions that Belmore presents viewers. To every body water is essential, and our relationship to it is shaped by our experiences. The installation enables reflection on our relationship to the lake, our responsibilities towards it, and to water more broadly. As Belmore asks, “In Canada, we have such a wealth of water. But what will that be in the future?”¹⁷⁵

Artworks are one way to answer Belmore’s question, a way to imagine possible futures and paths forward. Neimanis argues that art can create “sites of collaborative inquiry” capable of introducing “understandings of water without any pretence of full knowledge or subsumption.”¹⁷⁶ I believe that art is well equipped to tell stories that may help us find a way to live otherwise and remind us that “our remaking of this world, and ourselves, is not over, but a process ... open to our efforts of remaking.”¹⁷⁷ I have taken up this question through the creation of artworks that invite discussion of how we might think, and live together.

¹⁷⁴ Astrida Neimanis, *Bodies of Water: Posthuman Feminist Phenomenology* (New York: Bloomsbury Academic, 2017): 172.

¹⁷⁵ Peter Goddard, “The Fountain of Truth; Ojibwa Artist Rebecca Belmore Uses Water for a Drenching, Blood-Soaked Theme in Her Venice Biennale Exhibit That Explores Its Universal Connection,” *Toronto Star*, June 2005.

¹⁷⁶ Astrida Neimanis, *Bodies of Water: Posthuman Feminist Phenomenology* (New York: Bloomsbury Academic, 2017): 171.

¹⁷⁷ Jody Roberts, “Narrating a Past for New Futures,” (2016).
<http://www.toxicsymposium.org/conversations-1/>.

Enmeshed Selves

“What other worlds can you perceive?”

– Natasha Myers, “Protocols for an
Ungrid-able Ecology”

"Without at least half a conversation to understand, and then attenuate and nuance our desires and needs, we cannot conceive of another mode of production, another set of social relations, another ethic of husbandry between ourselves and the earth. That is why we send pictures from deserts and write words on water, that is why we make earthworks that stand on the landscape of the mind. That is why we listen to the whispers of an eccentric planet. So that it can listen to us in turn, and keep wanting us, and our children, and their children, around."

– Raqs Media Collective, “Three and a Half
Conversations with an Eccentric Planet”

My work with mud, microbes, and Lake Ontario has developed through a series of projects. Each of these iterations helped me form a deeper understanding of the enmeshed nature of life, the role of microbes, material knowledge, and how to collaborate with non-human life responsibly. I first became interested in working with microorganisms after discovering how essential microbes are in my own body. I began looking at images of gram stained bacteria. Gram staining involves exposing bacteria to a dye in order to identify if they are gram-positive, meaning the bacteria have a thick cell wall indicated by a violet colour, or gram-negative, meaning they have a thin cell wall indicated by a pink or red colour.¹⁷⁸ The aesthetically pleasing images that result from this process contrast the horrific impacts that the infectious bacteria can have on the human body. I began exploring this schism by working with the imagery through drawings on graph paper. At

¹⁷⁸ Diffen LLC, “Gram-Positive vs. Gram-Negative Bacteria,” Diffen, July 2018, https://www.diffen.com/difference/Gram-negative_Bacteria_vs_Gram-positive_Bacteria.

the time I was thinking of microorganisms as fascinating invaders, a beautiful threat, but not as integral parts of the world.

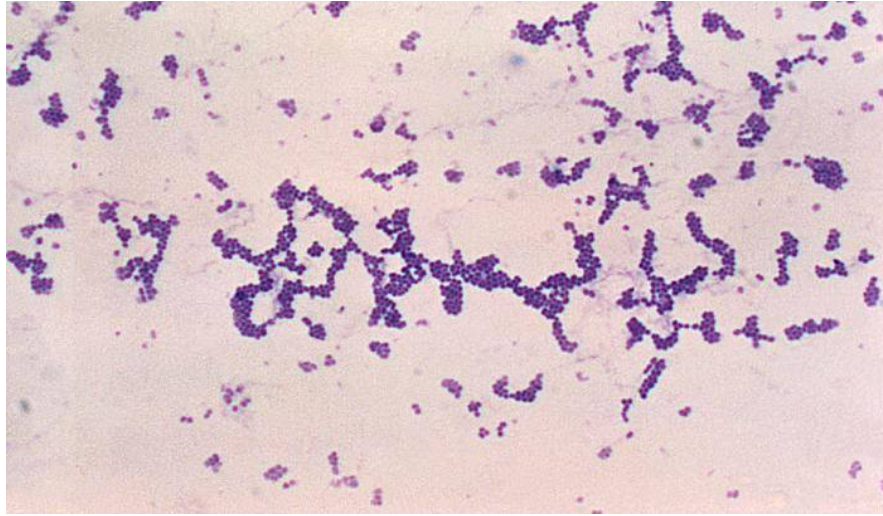


Figure 9: *MRSA Gram Stain*, Microbiology Study Guide, www.studyblue.org

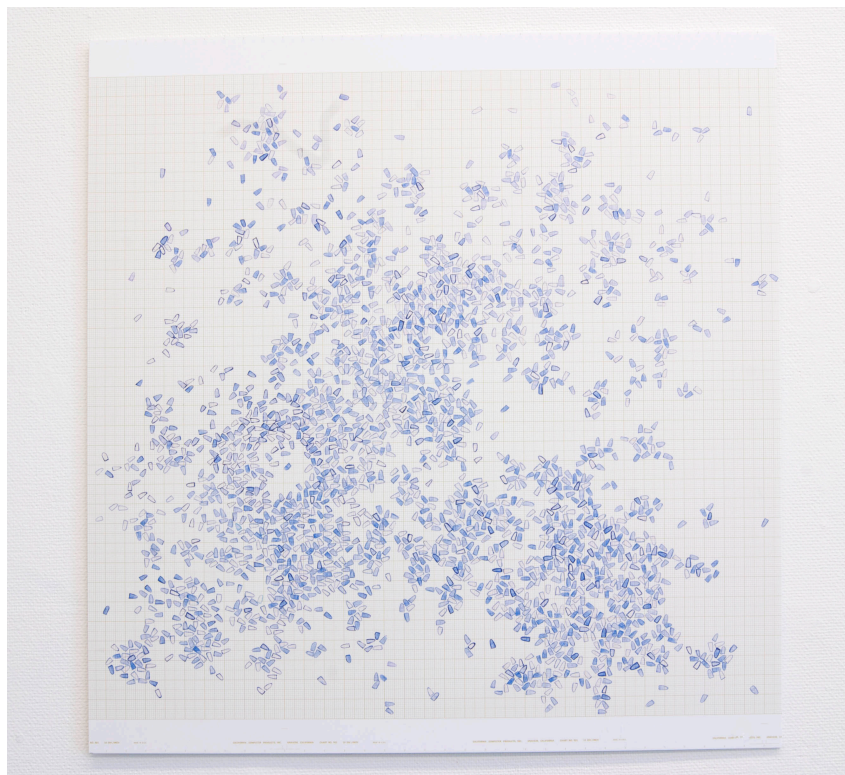


Figure 10: *Microbial Drawing – 1*, Ink on found graph paper, 2014. Photo and artwork by the author.

As I learned more about the human microbiome and the complex role of microbes within the environment, my relationship with them became more nuanced. I came to this understanding through a number of sources, including an online virology course offered by Columbia University,¹⁷⁹ microbiology textbooks,¹⁸⁰ and the work of bio artists. Looking through the *Invisible You* catalogue I began considering the need to foster a more generative relationship with microbes.

Invisible You was an exhibition mounted at the Eden Project in Cornwall, UK (2015) featuring work by established and emerging bio artists engaging the human microbiome. The exhibition included: Anna Dumitriu's project *Don't Try This At Home*, a work that explores the effectiveness of fecal transplants in treating previously untreatable disease; Rogan Brown's *Cut Microbe*, a hand cut paper sculpture based on a single cell bacterium, *Escherichia coli*; as well as *Microbial Me*, a work by emerging artist Mellissa Fisher in which she cast her face in agar, allowing the microbes transferred from her face to proliferate her self-portrait.¹⁸¹ All of the work highlighted various aspects of the human microbiome.

¹⁷⁹ Prof Vincent Racaniello, *Virology*, 52 vols. (Columbia University: iTunes University, 2015), <https://itunes.apple.com/us/course/virology-2012/id508805930>.

¹⁸⁰ Paulsen, Ian T., and Andrew J. Holmes, eds. *Environmental Microbiology: Methods and Protocols*. Second. New York: Springer, 2014.

¹⁸¹ The Eden Project. "Invisible You: The Human Microbiome." Cornwall: The Welcome Trust, 2015.

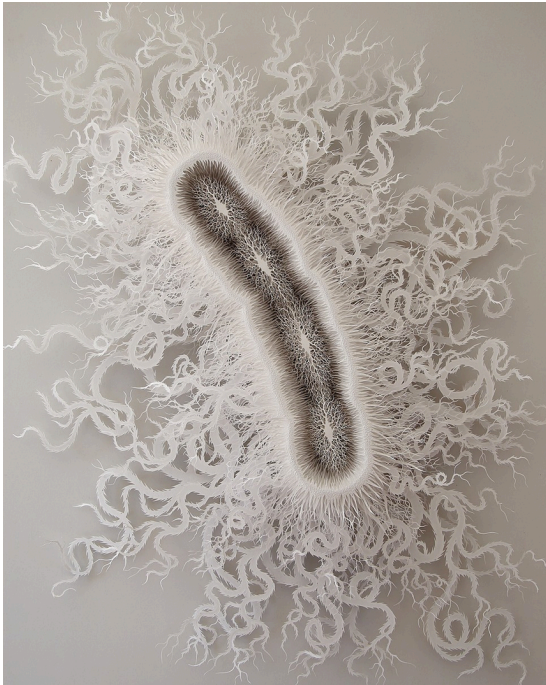


Figure 11: *Cut Microbe*, Rogan Brown, 2015

Figure 12: *Don't Try This At Home*, Anna Dumitriu, 2015



Figure 13: *Microbial Me*, Melissa Fisher, 2015

I was particularly influenced by the artwork of Anna Dumitriu, a UK based artist whose practice fuses craft, technology, and bioscience to explore our relationship with the microbial world, biomedicine, and technology.¹⁸² Her piece, *MRSA Quilt* (2012), is composed of cotton squares dyed with *Staphylococcus aureus* bacteria collected from Dumitriu's nose. MRSA is the antibiotic resistant strain of *Staphylococcus aureus* that is considered a serious threat to human health. Dumitriu is interested in exploring how the artwork can incite conversations about negative connotations surrounding bacteria. She states the artwork "...offers a way in to the story for many people who would otherwise have no access to it."¹⁸³ *MRSA Quilt* (2012) invited me to reconsider my own biases.



Figure 14: *MRSA Quilt*, Anna Dumitriu, Cotton and *Staphylococcus aureus* bacteria, 2012

¹⁸² Anna Dumitriu, "Bioart and Bacteria - The Artwork of Anna Dumitriu," 2014, <http://www.normalflora.co.uk/>.

¹⁸³ Regine Rapp and Christian de Lutz, *[Macro]Biologies & [Micro]Biologies: Art and the Biological Sublime in the 21st Century* (Berlin: Art Laboratory Berlin, 2015), <http://www.blurb.com/b/6244394-macro-biologies-micro-biologies-art-and-the-biolog>.

After these experiences, the focus of my thinking shifted toward the capacity for microbial life to transcend perceived barriers. I was no longer satisfied with only representing microbial life. However, I was also intimidated by the prospect of using biological matter in my practice without any laboratory training. I looked to contemporary bio artists who were able to overcome this barrier.

Anna Dumitriu entered the field of bio art with no formal scientific education.¹⁸⁴ Despite this, she was able to gain training and has been granted one of the highest lab clearances of any non-biologist in the UK.¹⁸⁵ Her piece, *Engineered Antibody* (2016), is exemplary of her capacity to work in lab spaces. This artwork was created in The University of California Irvine Liu Laboratory for Synthetic Evolution. Dumitriu was inspired by scientist Xiang Li's research¹⁸⁶ on antibodies purified from the blood of a HIV positive patient for gene therapy.¹⁸⁷ Made up of 452 hand-made beads, *Engineered Antibody* both represents and physically contains the twenty-one amino acids of the antibody.¹⁸⁸ Dumitriu created each bead from a mixture of amino acid and polymer clay.¹⁸⁹ The string of beads in the necklace also mimics the three-dimensional form of the

¹⁸⁴ McNay, Anna. "Anna Dumitriu: 'Bacteria Are Living Organisms That You Can Work with – Almost in a Painterly Kind of Way.'" Studio International. 2015.

¹⁸⁵ Anna Dumitriu, "Confronting the Bacterial Sublime: Building a Biosafety Level 2 Lab in a Gallery" (Artist Talk, The Science Gallery at The Naughton Institute, Dublin, 2012), <http://artscienceethics.tumblr.com/BacterialSublime>. (Transcript of an Artist Talk, The Science Gallery at The Naughton Institute, Dublin, 2012), <http://artscienceethics.tumblr.com/BacterialSublime>.

¹⁸⁶ An antibody is a protein that is produced by the immune system in order to combat foreign bodies and viruses, which it can bind to. Xiang Li is working to improve this antibody by engineering it to better block HIV infections through the introduction of an additional amino acid called sulfotyrosine.

¹⁸⁷ Chang C. Liu and Xiang Li, "Independent Replication Systems for Fast Evolution, Synthetic Biology, and Cell Biology," Chang C. Liu Laboratory for Synthetic Evolution, accessed June 1, 2016, <https://liulab.com/projects/>.

¹⁸⁸ Anna Dumitriu, "Bioart and Bacteria - The Artwork of Anna Dumitriu," 2014, <http://www.normalflora.co.uk/>

¹⁸⁹ Alex Chan, "Art and Biology Mix at New UC Irvine Exhibit," *Los Angeles Times*, February 4, 2016, sec. Arts & Culture, <http://www.latimes.com>.

antibody and is attached to textiles dyed with Coomassie Brilliant Blue – a stain used in laboratories to visualize and separate proteins. Through the form of the necklace, Dumitriu is interested in exploring the fact that all organic life is made of amino acids, which join together like strings of beads.¹⁹⁰ Dumitriu and many other bio artists' ability to overcome what I perceived to be steep barriers to access encouraged me to work in the field of bio art.

In my own practice, I have chosen to employ techniques that are safe outside of a lab environment, such as thin layer chromatography and the Winogradsky column. *Lake Ontario Portrait* (2017-present) and *Variants* (2017) were my first fully realized artworks that engaged the concepts present in my dissertation exhibition. *Lake Ontario Portrait* is comprised of fifteen six-foot tall plastic prisms filled with mud from fifteen locations around the Canadian and American shores of Lake Ontario, each with its own unique microbial community. *Variants* is a series of three sculptures, each made up of seven four-foot tall, thin, acrylic prisms filled with mud from Humber Bay Park West in Etobicoke. Each sculpture has been altered to create an extreme environment for the microbial life inside of it. One had a spectrum of pH introduced into it, another salinity, and the last nutrients. The unique qualities of each site are visually present from the moment the mud is placed in the prisms. They became even more apparent as the microorganisms began to flourish, forming complex, colourful communities. The mud in each prism is linked to a very particular environment, and to the time it was collected. Its specificity is acknowledged in the photographs of each collection site displayed in an artist book alongside the artwork.

¹⁹⁰ Anna Dumitriu, "Bioart and Bacteria - The Artwork of Anna Dumitriu," 2014, <http://www.normalflora.co.uk/>



Figure 15: *Variants (Salt)*, 2017. Photo and artwork by the author.
Figure 16: *Variants (Nutrient)*, 2017. Photo and artwork by the author.

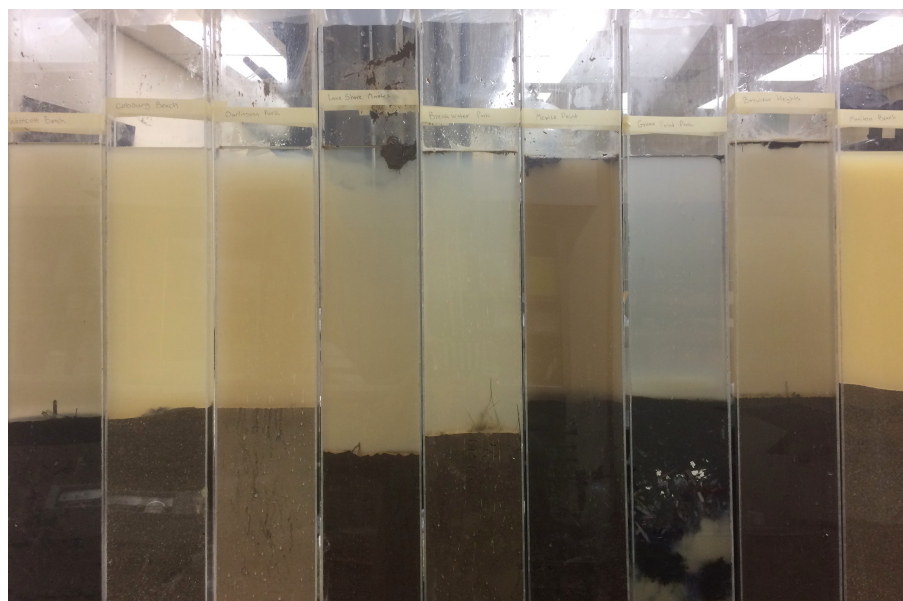


Figure 17: Mud first placed in *Lake Ontario Portrait*, 2017 – present. Photo and artwork by the author.



Figure 18: *Lake Ontario Portrait*, 2017-present. Photo and artwork by the author.

The landscape is also evoked by the formal qualities of the final work. The tops of the prisms come together to form a horizon line and a smaller landscape is created in each piece where the mud and water meet. Despite removing the material from its original context, the mud references the environment that it came from. This is manifested in unique visual features present in each prism created by various qualities of the mud and microorganisms living there.¹⁹¹ The sculptures are a site for encountering microbes that reveal the tightly enmeshed community between various actors including the mud,

¹⁹¹ The artwork's connection to site is explored further in "Chapter 2: Site Specificity."

microbial life, Lake Ontario, light, heat, viewers, and myself. The sculptures encourage visitors to become attuned to microbes and the webs of connections they form.

These concepts will be engaged with in my dissertation exhibition, *Enmeshed Selves*, to be held in Gales Gallery at York University, 2020. The dissertation exhibition will include *Lake Ontario Portrait* (2017 - present) as well as *Lake Ontario Portrait* (2020 - present). The second piece will mirror the first, with mud collected from the same sites three years later. The artwork will be filled with mud shortly before the exhibition so that throughout its time in the gallery, the microbial life will be beginning to grow. Showing viewers both the established artwork alongside the beginnings of growth will enable an appreciation of the liveliness of the material. It will also acknowledge the slowness, as well as the care required for the artwork to live.

The back wall of the gallery will feature a series of twelve inch tall columns along a shelf. These sculptures will contain mud from other collection sites around Lake Ontario, including some locations where I was unable to gather enough mud on the shore to fill the larger column, or locations of particular interest to myself – such as a site that was noticeably filled with litter, or near a pristine park. These sculptures will come together to form another, broader portrait of the lake to demonstrate the diversity of liveliness in this body of water.

The exhibition will be accompanied by an artist book which will enable viewers to gain a deeper understanding of the processes that went into the creation of the artwork. The book will feature images of the microbial growth along with a map of the collection sites along the lake. It will also describe the physical process of putting the artwork

together, as well as some of the microbial dynamics that are occurring inside the columns.

The format of the artist book allows viewers to form their own interpretation of the artwork before seeking more information about it. The book provides more context, but does not force viewers to engage it – unlike, for example, a didactic panel placed directly beside the artwork. I am interested in allowing a multitude of experiences for the public engaging the artwork.

With this in mind, I will also be hosting a workshop during the dissertation exhibition. In the workshop I will invite participants to create their own small scale version of my sculptures. They will then be invited to take the artwork home with them, provide it care, and watch it grow. I discuss this process, and other workshops I have given, in more depth in “Chapter 3, Collaborating with the Public.” My hope is that the exhibition provides an opportunity for an encounter with microbial life that leads to a deeper understanding of the liveliness of Lake Ontario and the connections formed by microbial life. Through enabling an encounter with microbes, an embodied experience of the artwork is capable of attuning viewers to the presence of non-humans – fostering the “modes of attention” that enable us to take responsibility in the way that Murphy calls for.¹⁹² A moment to consider how we could live otherwise.¹⁹³

¹⁹² Michelle Murphy, “Alterlife and Decolonial Chemical Relations,” *Cultural Anthropology* 32, no. 4 (2017).

¹⁹³ Ibid.

Chapter Two: Borders Unbound

It is crucial, in times of environmental/socioecological upheaval, to underscore and impress the interconnectedness of lands, waters, space, people, and time on my fellow Canadians and scholars.

– Zoe Todd, *Protecting Life Below Water*

border

noun **1.** A side, edge, brink, or margin; a limit, or boundary; the part of anything lying along its boundary or outline. **2.** The district lying along the edge of a country or territory, a frontier; *plural* the marches, the border districts.

verb **1.** To form a border or boundary to; to bound.

– Oxford English Dictionary

unbounded

adjective **1.** Not bounded or limited in extent. **2.** Not restrained or kept within limits; unchecked, uncontrolled.

– Oxford English Dictionary

Borders can be defined as barriers or lines of distinction between two things – they set them apart in our minds or in physical space. The concept of borders and the implications of crossing them have an important presence in my practice. I engage geographic borders, such as those between land and water, or between Canada and the United States of America; biologic borders that we use to distinguish one organism from another; and the borders that are drawn around disciplines or types of knowledge. By discussing borders in this text, I do not intend to legitimize them. Borders are shaping our world and to ignore their presence would simply allow them to remain unchanged. It is necessary to imagine how to move beyond, through, and across borders in order to discuss the place they may have in our collective future.

I was compelled to start this research because of microbes' ability to permeate our bodily borders and I continue to be interested in revealing the unbounded nature of what

we tend to draw lines around. As theorists Hastings Donnan and Thomas M. Wilson observe, borders can be “cultural, social, territorial, political, sexual, racial or psychological.”¹⁹⁴ These boundaries divide, while at the same time they mark a site of contact where things press up against each other. Some borders may appear impermeable, but as I will discuss in this chapter, they are often porous.

In his poem “Mending Wall” from 1914, Robert Frost illustrates the springtime ritual of two neighbors reconstructing the wall between their properties. The narrator is uncertain that the wall is necessary, but the neighbor states “Good fences make good neighbours.” The narrator continues to question this notion:

*Why do they make good neighbours? Isn't it
Where there are cows? But here there are no cows.
Before I built a wall I'd ask to know
What I was walling in or walling out,
And to whom I was like to give offence.
Something there is that doesn't love a wall,
That wants it down." I could say "Elves" to him,
But it's not elves exactly, and I'd rather
He said it for himself. I see him there
Bringing a stone grasped firmly by the top
In each hand, like an old-stone savage armed.
He moves in darkness as it seems to me,
Not of woods only and the shade of trees.
He will not go behind his father's saying,
And he likes having thought of it so well
He says again, "Good fences make good neighbours."*¹⁹⁵

One farmer is steadfast in his belief that distinct barriers are necessary for civility. The second observes that the need to repair the wall suggests that there is “Something . . . that

¹⁹⁴ Hastings Donnan and Thomas M. Wilson, *Borders: Frontiers of Identity, Nation and State* (New York: Berg, 2001): 20.

¹⁹⁵ Robert Frost, “Mending Wall,” 1914.

doesn't love a wall, / That wants it down."¹⁹⁶ These borders are not absolute; they need to be maintained, both physically and psychologically, to retain their power. Despite the intention to separate, this barrier and the ritual of reconstructing it brings the two neighbors together. Frost's poem illustrates the complexity of border making and the tension between our desire for boundaries and the violence of division. The presupposition that we need barriers to keep belongings safe, ordered, or protected is part of a colonial mindset that promotes protectionism and division.¹⁹⁷ However, having boundaries and respecting each other's personal boundaries is also important to consider. "We try to separate yours from mine to keep out that which is unwanted" argues geographer Joseph E. Taylor III, "but the only constant is transgression."¹⁹⁸ We are enmeshed across borders, even at times when we prefer to remain distinct, as in rural Montana where farmers build fences around their plot of land, but "rolling tumbleweeds forced them to establish socialistic 'weed districts' and coerce collective responses to keep their fields clean."¹⁹⁹ Boundary making is not a simple exercise.

Feminist philosopher Rosi Braidotti describes herself and others embarking on projects of decentralization as border crossing figures who "mark the shifting boundaries of very affective and dynamic kinship relations" between all matter.²⁰⁰ Braidotti argues that we need to form new border-crossings between planes of knowledge to avoid disjunction and segregation. These sites of connection foster our capacity to "carry out

¹⁹⁶ Robert Frost, "Mending Wall," 1914.

¹⁹⁷ Having borders or divisions is also present in indigenous cultures where hunting grounds were delineated. However, modern conceptions of borders are highly colonial.

¹⁹⁸ Joseph E. Taylor III, "Lines That Don't Divide: Telling Tales about Animals, Chemicals, and People in the Salish Sea," in *BORDER FLOWS: A Century of the Canadian- American Water Relationship*, ed. Lynn Heasley and Daniel Macfarlane (Calgary: University of Calgary Press, 2016): 216.

¹⁹⁹ Ibid.

²⁰⁰ Rosi Braidotti, "Posthuman, All Too Human: Towards a New Process Ontology," *Theory Culture and Society* 23, no. 7–8 (2006): 197–208.

alternative modes of becoming and transversal relations that break up segregational patterns.”²⁰¹ Exploring the borders that we place between physical space, living things, and types of knowledge enables us to see to see “meta-patterns” that would otherwise go unnoticed.²⁰² Revealing and forging these kinds of connections can help us envision possible futures that are not dictated by current divisions.

In this chapter I will discuss how working across geographic, political, disciplinary, and biological divides is essential to forging a more sustainable future. I will think-with microbial life in order to examine the ways we can cross these borders, as well as the many ways in which their porous nature is revealed.

Geographic Borders

Recognizing individual and human aspects of borders and borderlands, expressed for example in borderland literature and art but not necessarily in everyday life, can be used as a means for cultural criticism, and criticism of the colonializing and homogenizing ‘gazes’ which are directed towards borderlands.

–Tuulikki Kurki, “Borders from the Cultural Point of View”

Geographic borders encompass political lines drawn around nations as well as physical borders that exist in places of transition, where mountains become plains, where fields become forests, or where land becomes water. In my work with Lake Ontario, mud, and microbes, I have crossed both political and physical borders. These liminal spaces have become another thinking companion in my reflections on permeability.

²⁰¹ Rosi Braidotti, “A Theoretical Framework for the Critical Posthumanities,” *Theory, Culture and Society*, May 4, 2018, <https://doi.org/10.1177/0263276418771486>.

²⁰² Ibid.

Political Borders



Figure 19: Minna Rainio & Mark Roberts, *Borderlands* (2004), Three-screen video installation

Political borders come into contact with each other, creating borderlands between them. Despite the restrictions they delineate, borderlands are “the meeting places of various cultures, and ethnic and linguistic groups ... hybrid spaces, spaces of flows.”²⁰³ Finnish filmmakers Minna Rainio and Mark Roberts engage the Finnish-Russian border in their work *Borderlands* (2004). The three-screen video projection depicts the landscape on either side of the border. The forest views are accompanied by the voices of Finns and Russians as they talk about their experiences of the border between them, physically, politically, and culturally. “The border zone is a human construct that in some

²⁰³ Tuulikki Kurki, “Borders from the Cultural Point of View: An Introduction to Writing at Borders,” *Culture Unbound: Journal of Current Cultural Research* 6 (2014): 1063.

ways doesn't really exist," says Rainio. "You can stand three feet on either side of it and nothing really changes. But it is a powerful, arbitrary line in the landscape and people live very different lives on either side of it."²⁰⁴ The simultaneously permeable and impermeable nature of national borders that Rainio describes is something I felt while working on *Lake Ontario Portrait* (2017- Present) in the Coalesce BioArt Lab at the University at Buffalo. I wrote about this experience during the residency:

Driving along the shore of Lake Ontario between Toronto and Buffalo connected me to the scale as well as the binational nature of the lake. A distinction between the Canadian and American shores of Lake Ontario was only made when I needed to cross the border. Despite the fact that I was going back and forth multiple times a week I never became comfortable with moving between the two nations. Every passage was unique, but my most memorable experience was during my first trip around Lake Ontario, while collecting mud in October 2017.

When I arrived at the border, driving my car with a trunk full of mud, I knew that I was in a vulnerable position. There are no written rules against the movement of mud or soil, but I could certainly see that it would look suspicious. I needed to ask the American border agent permission to allow my mud and myself across.

When the agent saw the mud in the trunk, in large white buckets that formerly held Chapman's Ice Cream, he was observably uneasy.

I was told that I needed to go for further inspection.

I parked and was approached by two members of the American border agricultural team. They searched my car, asked about the mud, and if I had any seeds in the vehicle. I explained that the mud was for an art project in connection with the University at Buffalo; purposefully avoiding any mention of microbial life, which I knew would only raise more concern. An agent then put on long gloves to search the mud, presumably to see if I had hidden any other suspicious materials inside the already suspicious mud. While he conducted the search, the other agent told me that I would likely need to dump the mud and return to Canada. Feigning nonchalance, I told her that I would have no problem doing that if necessary.

²⁰⁴ Mary Abbe, "Borders Unbound," *Star Tribune*, January 21, 2010, <http://www.startribune.com/borders-unbound/82156817/>.

My mud and I were eventually cleared and entered New York State.

I was struck by the fact that mud would be treated as contraband, despite the fact that so many materials flow across the border. Microbes and pollutants in the sediments of the Great Lakes constantly cross this invisible barrier and, of course, “birds, deer, wolves, fish, wind, and fire don’t read boundary markers and are not, for the most part, subject to legal restraint.”²⁰⁵ My experience bringing mud across the border revealed the highly constructed nature of the division and the political power enacted along such an arbitrary line.

The border also made me aware of my role as a particular body moving through political space, with my privilege as a white Canadian likely enabling me to cross with the mud rather than being turned back. In our current political climate, it is impossible to ignore mounting tensions in relation to borders. These lines that divide nation states are increasingly becoming a site of denial rather than acceptance, charged with divisiveness.

Mobility and constraint at the border do not impact all bodies equally. In her book *Mohawk Interruptus* (2014), anthropologist Audra Simpson examines the struggle to maintain political sovereignty on the part of the Mohawks of Kahnawà:ke, a reserve community in what is commonly called southwestern Quebec. The Kahnawà:ke Mohawks often do not claim either Canadian or American citizenship:

They refuse the “gifts” of American and Canadian citizenship; they insist upon the integrity of Haudenosaunee governance.²⁰⁶ Moreover, some in

²⁰⁵ Lynne Heasley and Daniel Macfarlane, eds., *Border Flows: A Century of the Canadian- American Water Relationship* (Calgary: University of Calgary Press, 2016): 302.

²⁰⁶ The Haudenosaunee Grand Council of Chiefs, also known as the Iroquois League Council or Six Nations Confederacy Council, is the central government of the Iroquois Confederacy. The Grand Council of Chiefs is composed of fifty Chiefs representing the Five (and later Six) Nations of the Iroquois

this study answer only to that governmental authority. So the bestowal of settler citizenship has been received with a certain “awkwardness” if not outright refusal—a refusal to vote, to pay taxes, to stop *politically* being Iroquois.^{207 208}

Part of this refusal to be absorbed into a settler nation is the use of a Confederacy passport that officially declares the individual holding it as a citizen of the Six Nation Haudenosaunee. Simpson goes on to describe many instances where individuals using their Confederacy passport were harassed, detained, or refused entry:

On July 17, 2010, the Iroquois Nationals Lacrosse Team (INLT) “bowed out” of the World Lacrosse League Championship tournament in Manchester, England. They did so because the United Kingdom refused to recognize the Haudenosaunee passport as secure and therefore legitimate. Their passports were signed and issued by the chiefs of the Iroquois Confederacy, a governance structure that predates the United States and the United Kingdom by at least three hundred years. The INLT had used this type of passport to travel to international competitions for the past thirty years. Numerous newspapers also reported that the Iroquois were the “creators of the very sport” they were to compete in.²⁰⁹

The clear mistreatment of the 2010 Iroquois Nationals Lacrosse Team, based solely on their refusal to use a settler passport, highlights the intense disparity between my capacity to move across national borders and the lack of freedom of others. It is because of my

Confederacy (Official website of the Haudenosaunee Confederacy Council, www.haudenosauneeconfederacy.com)

²⁰⁷ The Kanien’kehá:ka (Mohawk) of Kahnawake speak a language that belongs to the Iroquois family. The Iroquoian-speaking peoples of North America include the Cherokee from the Southern Appalachian area; the Tuscarora and the Susquehanna of the mid-Atlantic region; and the Huron, Wenro, Erie, Tobacco, Mohawk, Oneida, Onondaga, Cayuga, and Seneca of the Great Lakes –St. Lawrence River Valley regions of North America. These last five nations; the Mohawk, Oneida, Onondaga, Cayuga, and Seneca are the most renowned of the Iroquoian linguistic group, particularly for the alliance or Confederation called the League of the Haudenosaunee, the People of the Longhouse. They were also known as the Five Nations Confederacy, now Six Nations. (Official website of the Haudenosaunee Kahnawake Branch of the Mohawk Nation, <http://www.kahnawakelonghouse.com>)

²⁰⁸ Audra Simpson, *Mohawk Interruptus: Political Life Across the Borders of Settler States* (North Carolina: Duke University Press, 2014) 25.

²⁰⁹ Ibid.

privilege that I was able to cross the border, collect mud, and create this body of work.

Acknowledging this, and using the artwork to create space for many voices and kinds of knowing, is integral to my project.

Physical Borders

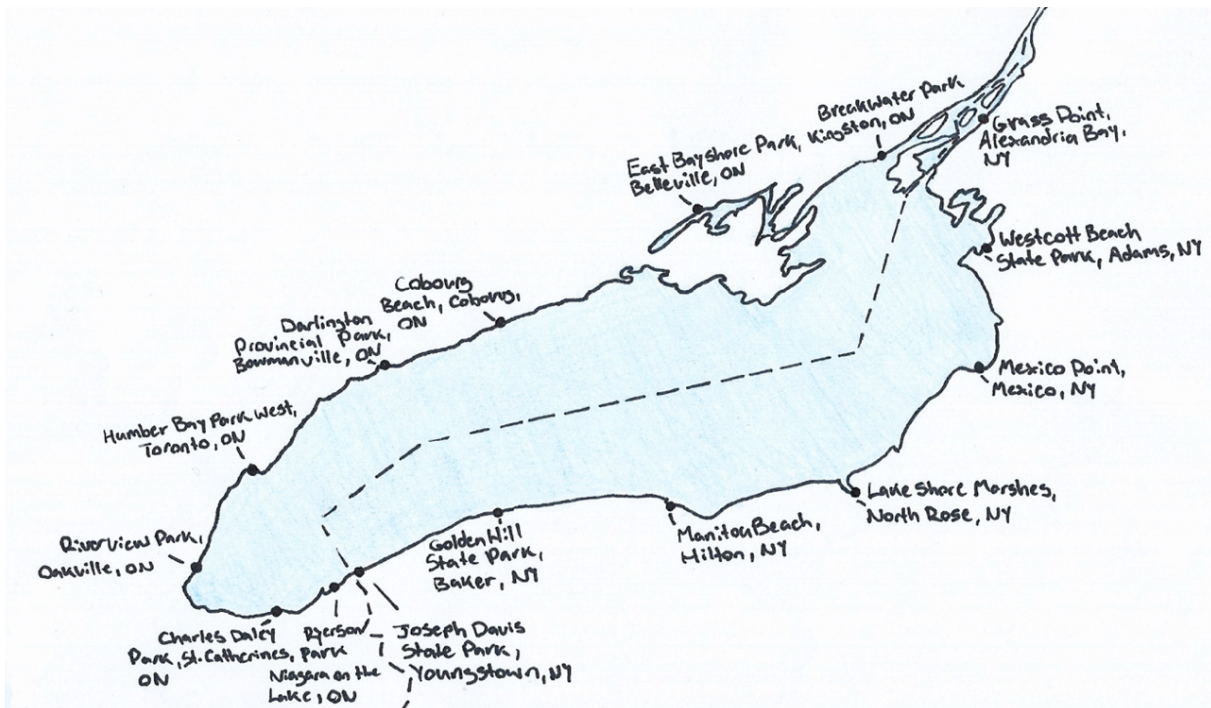


Figure 20: The fifteen mud collection sites along the shore of Lake Ontario. Image by the author.

I also felt the presence of borders as I drove around the lake, as cities melded into farmers' fields, the suburbs into parks. On both of my mud-collecting trips (2017 and 2019) I went from Toronto, around the lake towards Kingston, across the border to Watertown, then to Buffalo, and back to Toronto again. The entire journey, with stops to dig up mud along the way, took two days on both occasions. While negotiating the

landscape around Lake Ontario I came to know a variety of terrains that surround the lake. My point of encounter was always the shoreline, a fluid place where water and land meet. The flow of water over land blurs any distinction that could be made between the two. In this way, the shore mimics the borders of our skin that I had set out to explore. This transitional space in bodies of water is defined geographically as the ‘nearshore zone’ or ‘littoral zone’.²¹⁰ The physical border between these zones has been delineated in the maps below to help study the diverse ecosystems in the Great Lakes. However, the researchers who produced this data acknowledge that these divisions are not as definite as the illustration indicates: “Ecosystem classification and mapping is an approximation and generalization of ecosystem structure and function based on our best understanding and measurement of natural phenomena.”²¹¹ These places of transition are not easily pinned down or restricted to a border; they are constantly in motion.

²¹⁰ Catherine M. Riseng et al., “Ecosystem Classification and Mapping of the Laurentian Great Lakes,” *Canadian Journal of Fisheries and Aquatic Sciences* 75, no. 10 (2018).

²¹¹ *Ibid*: 1707.

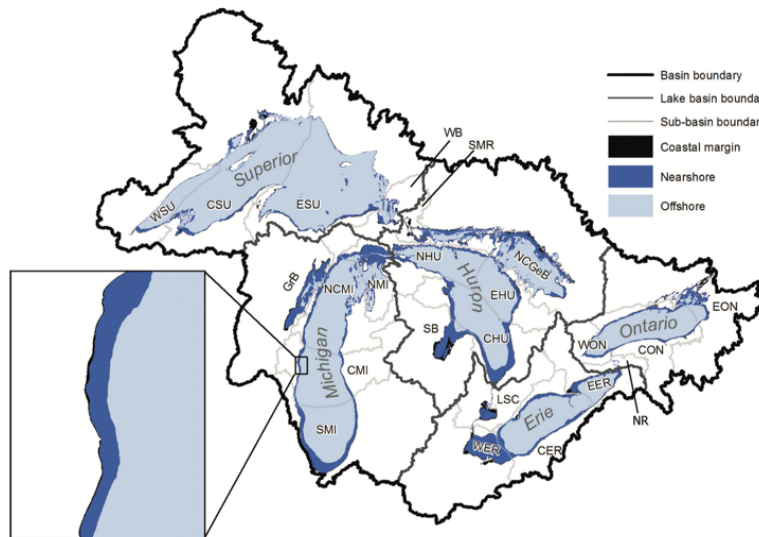


Figure 21: Lakes, lake sub-basins and aquatic zones from “Ecosystem Classification and Mapping of the Laurentian Great Lakes”

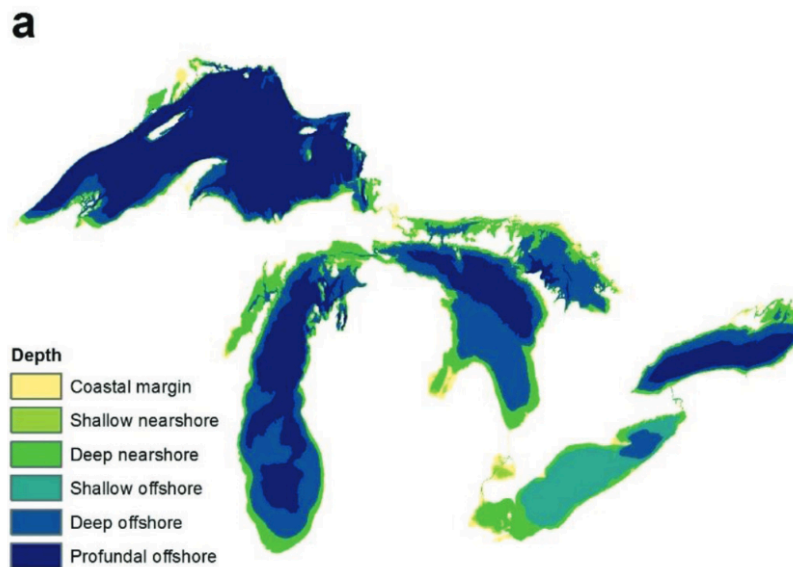


Figure 22: Variables associated with the four classification factors and their threshold criteria used to define the aquatic ecological units: (a) depth from “Ecosystem Classification and Mapping of the Laurentian Great Lakes”

The movement of Lake Ontario also moved my body as I stepped towards and away from the shore with the rhythm of the lake. As I set out to gather the mud, I had a general idea of where each of the fifteen locations would be. However, once I arrived, I had to find sites where I could actually access the water; this became a particular challenge in cities such as Toronto, Kingston, and Buffalo, where barriers often restrict access to the lake. Where I chose to collect mud was influenced by the physical realities of negotiating the landscape. Once I was at the shore, I shoveled mud into a bucket, being careful to collect both soil and water. I then took a photograph of each location from the shore towards the lake. The images were prompted by the connection to the physical landscape that I felt. It became important to me that the landscape be present in my exhibition not only through the unique microbes of each place, but also in the form of a photographic document. The images help to break down the notion that the mud and microbes are from an abstracted or idealized Lake Ontario. Instead, they depict a variety of particular locations on the lakeshore, including a farmer's field likely contaminated with fertilizer run-off, a state park lined with a boardwalk, and the edge of Toronto with views of the city and garbage on the shore. These actual places ground the work in the opportunities and contaminated realities of what it means to be enmeshed. The mud and microbes that I take from the lake are also shaped by their environment. Once placed inside the sculpture, they are formed into a unique community that has been able to adapt. The resiliency of the microbes became apparent when I tested what microbes were present in the columns using mass spectrometry. The data revealed that the microbial life

in the column were as diverse after a year of growth as they would have been when placed into the sculptures.²¹²



Figure 23: Mud collection, 2019. Photo by the author.

The act of collecting mud, taking it from Lake Ontario, and placing it inside my sculptures is full of ethical implications that I am still contending with. I take a very minimal amount of material from the land; however, as author Anna Tsing argues, what counts as disturbance is dictated by point of view. “From a human’s vantage, the disturbance that destroys an anthill is vastly different from that obliterating a human city,” however, Tsing goes on to say, “from an ant’s perspective, the stakes are different.”²¹³ Taking a small amount of mud from the shores of Lake Ontario seems

²¹² This process is described in detail in “Chapter 3, Collaborating with Scientists.”

²¹³ Anna Lowenhaupt Tsing, *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins* (Princeton: Princeton University Press, 2015): 206.

trivial, but on the microbial level I have made a significant impact. How do I decide if taking mud is worth the disturbance it causes? Once again following Tsing, I would argue that “Disturbance is never a matter of ‘yes’ or ‘no’; disturbance refers to an open-ended range of unsettling phenomena. Where is the line that marks off too much?”²¹⁴

I would argue that the level of disturbance, as well as intent, are important aspects of this conversation. By taking from the lake I hope to encourage closeness between the body of water, microbes, and viewers that may otherwise go unnoticed. I provide a way for the microbial life to be seen and felt. I also do not harm the microbes or endanger them any more than they would normally experience in their original habitat. The opportunity to engage the complex notion of our enmeshed state encourages me to continue this project.

In a panel discussion that I took part in called “Living Things” at the Universities Art Association of Canada in Waterloo, Ontario (2018), there was a discussion about the harms and benefits of projects that engage non-human life.²¹⁵ Artist and researcher Amanda White spoke about her work with plants. She argued that we should not stop making artwork in collaboration with non-humans just because of the complexity involved, but at all times recognize what is at stake and attempt to minimize harm. The threshold for White was if the plants she works with could have a life as part of her artwork as well as after it. Similarly, in my work, it is important to me that microbes have the capacity to live and die in the environment I have built and the potential for them to continue on beyond our collaboration.

²¹⁴ Anna Lowenhaupt Tsing, *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins* (Princeton: Princeton University Press, 2015): 206.

²¹⁵ Amanda White, Nicole Clouston, and Ophélie Queffurus, “Living Things Panel” (Universities Art Association Conference Presentation, October 27, 2018).



Figure 24: Amanda White, *A Breathing Room* (2015-2017)
<https://amandawhite.com/A-Breathing-Room>

The living and dying that takes place in my research helps me to contend with the living and dying in the world at large. Bio artist Jennifer Willet also seriously considers the role of life, death, and suffering in her practice. She argues that living as well as dying are a part of the ecology of the lab, the artwork, and the environment.²¹⁶ Willet states that, “It is as if we perceive the discomfort of viewing another’s suffering as a form of suffering itself – and so instead of engaging in the co-production of food or biotechnology on a personal level, we have chosen to look away from the consequences of our actions through industrialization.”²¹⁷ This lack of responsibility, of turning away

²¹⁶ Jennifer Willet, “Re-Imagining Biotech Futures through Bioart Practices,” in *Propeller Symposium* (University of Windsor, 2019).

²¹⁷ Jennifer Willet, “INCUBATOR Art Lab: Re-Imagining Our Biotech Future Through Art / Science Research,” *Art & Research Artnodes*, no. 20 (2017):79.

from the living and dying inherent to our interconnected existence, does not lessen the suffering of non-humans. We need to live in the reality that working with other living beings involves both life and death.

In creating this body of work without simplifying or romanticizing what it means to be enmeshed, what it means to take from the lake, and to collaborate with non-humans I am attempting to, in the words of Donna Haraway, “stay with the trouble”.²¹⁸ By working through disturbance, I aim to create a space to consider other, larger, acts of disturbance that have been shaping our world. Disturbance can also be generative, as Tsing states, “ways of life develop through coordination in disturbance. As ways of life come together, patch-based assemblages are formed. Assemblages ... are scenes for considering livability—the possibility of common life on a human-disturbed earth. Precarious living is always an adventure.”²¹⁹ Through disturbance we may be able to foster resilience as we develop ways to prevent further harm while building a way to live together.

I would argue that my artwork is one way to experience the microbial presence and begin to gain a deeper, embodied understanding of the enmeshed nature of bodies, as well as our actions upon the environment. Microbial life offers us a way to think through and shift dualistic constructs – instead, thinking in terms of flux where things are never one or the other, but always in constant negotiation. Once we start to attune our senses to see the liveliness of material, we are taking a small step in expanding our sense of community responsibility and developing our understanding of ethics. As Barad states:

²¹⁸ Donna Haraway, *Staying with the Trouble: Making Kin in the Chthulucene (Experimental Futures)* (New York: Duke University Press, 2016).

²¹⁹ Anna Lowenhaupt Tsing, *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins* (Princeton: Princeton University Press, 2015): 209.

Ethics is therefore not about right responses to a radically exteriorized other, but about responsibility and accountability for the lively relationalities of becoming, of which we are a part. Ethics is about mattering, about taking account of the entangled materializations of which we are part, including new configurations, new subjectivities, new possibilities. Even the smallest cuts matter. Responsibility, then, is a matter of the ability to respond. Listening for the response of the other and an obligation to be responsive to the other, who is not entirely separate from what we call the self. This way of thinking ontology, epistemology, and ethics together makes for a world that is always already an ethical matter.²²⁰

Listening is a step toward taking responsibility. Through sensing microbes, coming into contact with them visually without an intermediary, there is an opportunity to listen to the non-human other who is also very much a part of our selves. My sense of accountability while creating this body of work is to consider how the cuts that I have made in the landscape matter and to listen for the response of my non-human collaborators.²²¹

Seeing microbial life in mud begins to awaken our senses to them in spaces outside the gallery. Becoming attuned to the microbial presence has enabled me to notice the liveliness of the world around me in ways I previously had not. Going on a walk by bodies of water I often spot the small lines of pigment along the shore that mark the traces of microbial colonies. At the same time that I am becoming familiar with microbial life, I am also listening to Lake Ontario and the particular sites along the shore that have been brought together in my installation

²²⁰ Rick Dolphijn and Iris van der Tuin, *New Materialism: Interviews & Cartographies* (Ann Arbor: Open Humanities Press, 2012): 68.

²²¹ I will expand on my responsibilities and working ethically in collaboration with microbial life in “Chapter 3.”

Site Specificity

The integral role that Lake Ontario plays in my research, as site and thinking partner, has led me to consider how my body of work relates to the field of site-specific artwork. The borders between places where the materials are sourced, where the artwork is made, where the meaning is located, where the artwork is viewed, and how the artwork is experienced is explored in the field of site specific art. Site specific artwork became prominent in the late 1960's with artists such as Robert Smithson, Dorothea Rockburne, Daniel Buren, and James Turrell creating installations formally determined or directed by a specific site. The artworks transformed space to create an experiential encounter. The work's inability to be easily purchased or moved resisted its commodification in an increasingly commercial art world.²²²

Artist Richard Serra, while debating the controversial removal of his public artwork *Tilted Arc* (1981) by U.S. General Services Administration that commissioned it after public outcry, expressed a key characteristic of some site-specificity. He stated explicitly that "to move the work is to destroy the work."²²³ He argued that the artwork is so inextricably tied with the location and its specific conditions, it cannot exist anywhere else. To move the artwork is to alter it, to "re-place it, to make it something else."²²⁴

²²² Miwon Kwon, *One Place After Another: Site Specific Art and Locational Identity* (Cambridge: The MIT Press, 2002).

²²³ Richard Serra, *Writings/ Interviews* (Chicago: University of Chicago Press, 1994): 194.

²²⁴ Nick Kaye, *Site-Specific Art* (New York: Routledge, 2000): 2.



Figure 25: Richard Serra, *Tilted Arc*, Federal Plaza, New York, 1981 - 1989

As our understanding of site and place has shifted, the nature of an artwork's site specificity has become more elastic, evolving to encompass many relations to site. This evolution has had positive impacts, in particular enabling a more nuanced relation to sites. However, the popularity of this term has simultaneously led to its dilution, used to refer to a multitude of art practices, including playlists, and pop-up stores.²²⁵ Miwon Kwon in her book *One Place After Another* (2002), addresses site specificity in order to refocus and reframe its meaning in a contemporary art context. Kwon argues that the term has adapted to a more nomadic and expanded understanding of site:

Dispersed across much broader cultural, social, and discursive fields, and organized intertextually through the nomadic movement of the artist—

²²⁵ Zoë Lescaze, "What Happens When Site-Specific Art Outlasts Its Surroundings?," *The New York Times*, May 13, 2019, sec. Arts and Letters.

operating more like an itinerary than a map—the site can now be as various as a billboard, an artistic genre, a disenfranchised community, an institutional framework, a magazine page, a social cause, or a political debate. It can be literal, like a street corner, or virtual, like a theoretical concept.²²⁶

‘Site specific’ can describe many kinds of art making that exists in, or in relation to, a particular location. These artworks are distinguished by Kwon from other installations by their “site-bound knowledge and experience.”²²⁷ Similarly, author and performance studies researcher Nick Kaye describes site specific artists as those with “practices which, in one way or another, articulate exchanges between the work of art and the places in which its meanings are defined.”²²⁸ The various strategies of site specificity are connected by the aim to share, or reveal, an understanding of site with the viewer. In my research, the artwork is informed by my experiences of Lake Ontario. I aim to foster a deeper understanding of the lake as well as provide an opportunity for viewers to reflect on their own relationship with Lake Ontario, and their ecological responsibilities to the lake.

Land art closely relates to my practice through its connection to the environment as well as its concern with the ethical implications of human impact on the land. Boetzkes defines land art by the ethical stakes that it engages rather than the materials that it is composed of, “Monumental land-based sculptures of the late 1960 and the diverse media used in more contemporary art ... I would argue these two generations are connected by their elucidation of the earth as a domain of ethical concern.”²²⁹ Boetzkes clarifies that

²²⁶ Miwon Kwon, *One Place After Another: Site Specific Art and Locational Identity* (Cambridge: The MIT Press, 2002): 3.

²²⁷ Ibid: 12.

²²⁸ Nick Kaye, *Site-Specific Art* (New York: Routledge, 2000): 1.

²²⁹ Amanda Boetzkes, *The Ethics of Earth Art* (University of Minnesota Press, 2010): 3.

there are important distinctions between the early earthworks and contemporary land art. However, she argues that they are similar in their ability to prompt us to rethink our relationship to the earth.²³⁰

Robert Smithson's *Spiral Jetty* (1970) exemplifies early land art. In this piece, Smithson sculpted black basalt rocks and earth from the site into a 1,500-foot-long and 15-foot-wide spiral extending into the Great Salt Lake, Utah. Smithson was attracted to the lake due to the "reddish coloration of the water, caused by the high presence of microbes ..."²³¹



Figure 26: Robert Smithson, *Spiral Jetty*, 1970. Photo by George Steinmetz

²³⁰ Amanda Boetzkes, *The Ethics of Earth Art* (University of Minnesota Press, 2010): 3.

²³¹ "Robert Smithson, *Spiral Jetty*," Dia Art Foundation, Dia, accessed July 9, 2019, <https://www.diaart.org/visit/visit/robert-smithson-spiral-jetty>.

The shape of *Spiral Jetty* emerged from Smithson's fascination with whirlpool arrangements, salt crystallography, and fossil formations.²³² Describing the artwork after an intense storm, Smithson stated, "Its mass was intact because it's almost 80% solid rock, so that it held its shape. Yet at the same time it was affected by the contingencies of nature."²³³ Despite being impacted by environmental factors *Spiral Jetty* was built with the intent to resist dissolving back into the landscape. Although it is known to become submerged in water, sometimes for years at a time, it re-emerges. The artwork reflects on the location's past, as well as the forces that created it.²³⁴

Another aspect of the work is its reference to the unchanging permanence of the landscape, a concept that is no longer viable from a 21st century perspective in light of the climate crisis. Boetzkes argues that in the beginnings of earth art, "the limit/essness, and not the limitedness, of the earth was the basis of its radicality."²³⁵ Earth art emerged when environmental awareness was deepening; however, at the time "'environment' seemed a vastly expansive term, informed by a comparable frontier spirit, capable of embracing a multiplicity of interventions, both gallery-based and in wide open spaces."²³⁶ Although Land art brought attention to space in a different way, the land was often still considered a resilient site that could absorb human intervention, in contrast to our current understanding of ecology. The context of making land art has shifted dramatically over time, as we gain a deeper understanding of how vulnerable sites like the Great Salt Lake

²³² Robert Smithson, "The Spiral Jetty," in *The Collected Writings*, ed. Jack Flam (New York: New York University Press, 1979): 261.

²³³ Robert Smithson, "The Earth, Subject to Cataclysms, Is a Cruel Master, Interview with Gregoire Muller," in *The Collected Writings*, ed. Jack Flam (New York, 1979).

²³⁴ Ibid.

²³⁵ Amanda Boetzkes, *The Ethics of Earth Art* (University of Minnesota Press, 2010): 5.

²³⁶ Nicholas Alfrey, Stephen Daniels, and Joy Sleeman, "To the Ends of the Earth: Art and Environment," *Tate Papers* 17, no. Spring (2012).

actually are. In my own work with Lake Ontario I am acutely aware of the delicacy of the ecosystem and actively trying to encourage responsibility for the ecosystem of the lake through encounters with microbial life in my sculptures.



Figure 27: Andy Goldsworthy, *Sycamore leaves edging the roots of a sycamore tree*, 2013

Artist Andy Goldsworthy's work in the landscape characterises traditional methods of land art, literally being made of the site and displayed in it; however, its scale and aims differ from earlier land art. Goldsworthy's field works are often made of found materials from rural Scotland. They distinguish themselves from the environment through Goldsworthy's interventions which include balancing rocks, carefully composing leaves, and weaving sticks. Goldsworthy describes his practice as a way to become "aware of

things I was blind to.”²³⁷ He goes on to say, “Essentially, that's the purpose of my art; to understand, to know, to touch, to feel, to find out, these are things that are very important and through that you get to understand the place, and you get to understand the flow of life that passes through that place.”²³⁸ The artist’s physical and intimate experience of the landscape are essential to the artwork. Each installation is a trace of time spent engaging that place, appreciating it, as well as the liveliness of the site.

The pieces are also made distinct by their impermanence. All of the installations created by Goldsworthy are ephemeral, meant to fade back into the landscape they came from. “It makes me think of ripening seeds,” Goldsworthy articulates, “The ones that explode if you touch them. That's their way of distributing the seed, it's like a chain reaction.”²³⁹ The artwork embraces rather than resists being impacted by the site. Thorough its impermanence the artwork acknowledges that this site will change, that it is not an idealized place of ‘Nature’, but natureculture. As Goldsworthy describes it, “The land doesn't exclude human nature from its processes, we're part of that.”²⁴⁰

The experience of the landscape and understanding it in a new way are also integral to my installations. My current body of work, including *Lake Ontario Portrait*, is inextricably tied to Lake Ontario, my time spent in the site, and the actions of microbial life from the lake. Each column in the piece is from a distinct location brought together in the installation. The work does not acknowledge what material came from which site, blurring divisions between these places as well as between nations; diminishing if not

²³⁷ Andy Goldsworthy and Marian Lovett, “The Circa Interview - Andy Goldsworthy: Touchstones,” *Circa Art Magazine* 74, no. Winter (1995): 43.

²³⁸ Ibid: 44.

²³⁹ Ibid.

²⁴⁰ Ibid: 45.

eradicating the role of the border. Instead, what is focused on is the lake and the microbes themselves.

Kwon argues that artworks that communicate an artist's deep experience of site "can turn local encounters into long-term commitments and transform passing intimacies into indelible, unretractable social marks..."²⁴¹ It is my aim to turn my own experiences of the lake into an authentic encounter that can communicate a sense of Lake Ontario to the viewer. My artwork is displayed in a gallery context, removed from its original site; however, it is always bound up in Lake Ontario.



Figure 28: Walter De Maria, *The New York Earth Room*, 1977. © The Estate of Walter De Maria. Photo: John Cliett

²⁴¹ Miwon Kwon, *One Place After Another: Site Specific Art and Locational Identity* (Cambridge: The MIT Press, 2002): 166.

In a variation on land art, Walter de Maria's *The New York Earth Room* (1977) removes material from its typical site and places it in a new context. In this case, a thirty-six-hundred-square-foot loft in New York City's Soho district is filled with soil. The dirt itself was not sterilized before being installed, however, the life that the earth is capable of supporting is diligently removed, as it is weeded every night.²⁴² The artwork denies the soil's visible liveliness to create an impression of purity, a very different way of looking at the material than my own work.

What struck me most while visiting the installation in 2018 was the immersive sensation of being in the presence of soil: the earth's strong scent, the humidity in the air, and the density of the rich black earth. The artist has used this space to make apparent the earth's presence through the viewer's embodied experience. Where the soil originally came from is not known. The artwork's caretaker since De Maria's death, painter Bill Dilworth, argues that the artwork is better off that way, "It makes it more genuine and available to everyone."²⁴³ I would argue that the lack of origin also adds to the understanding of the material as "pure soil." The dirt is not meant to evoke an understanding of a specific place beyond the site it is installed in. *The New York Earth Room* offers a moment to encounter soil, to consider it, and its formal value. However, this value is experiential without attuning us to the lived reality of the material itself.

²⁴² Elena Martinique, "New York's Earth Room - Walter De Maria's Masterpiece," *Wide Walls*, April 15, 2018, <https://www.widewalls.ch/walter-de-maria-new-york-earth-room/>.

²⁴³ Alina Cohen, "The Artist Whose Masterpiece Involved Filling an Apartment with 140 Tons of Dirt," *Artsy*, January 16, 2019, <https://www.artsy.net/article/artsy-editorial-artist-masterpiece-involved-filling-apartment-140-tons-dirt>.

Lake Ontario Portrait, despite being removed from the original site that it reflects on, is not an abstracted grouping of soil. It is also not a representation of the site. It is a living fragment of the lake itself – recreating the liveliness of the lake as well as my intervention. It becomes its own site, a place of encounter and reflection.

Leaking

My artwork relies on the capacity for me to contain, at least to a certain extent, the mud and microbes I am working with. The top of each prism is open, covered by a thin layer of parafilm that keeps moisture in while allowing gas to escape. The rest of the artwork needs to be watertight. Despite my attempts to create solid borders, on many occasions the mud and microbes refuse to be contained – leaking, sometimes in vast quantities, out of the boundaries I have attempted to draw.

I had set up my show *Mud (Lake Ontario)* at York University in April 2017. The work was all placed and ready for my comprehensive exam the next morning. I turned the gallery lights off and then I heard a crack. I turned the lights back on and discovered that one of the six-foot prisms from *Lake Ontario Portrait* (2017 – present) had split down the middle: a foot-long crack up from the bottom of the sculpture. The mud began to ooze out of the rupture. I decided I would remove that prism from the show, but then I heard crack, crack, crack. Three more prisms broke open. Eventually all of the acrylic homes I had built were leaking.²⁴⁴

²⁴⁴ The mud compacted overtime and eventually that pressure, and the degradation of the acrylic from UV exposure, led to the ruptures. I have since solved this material issue by switching to polycarbonate, a much more stable and flexible plastic – although still not impervious to small leaks.

In one moment, the sculptures were contained, and in the next they had become unbound. Although at the time I was distraught, I have come to see this instance as another way to think about the permeability of barriers and the agency of mud, microbes, and water. The boundaries I form are not absolute.

‘To leak’ has many connotations that are united by the fact that leaking is always subversive – leaks sneak through. Contemporarily, “leakers” have been described as “a new kind of political actor.”²⁴⁵ Political leaks, such as those we have seen from WikiLeaks or Edward Snowden, can be understood as altruistic or malicious depending on one’s own experiences or position. Leaks can also be biological.

A leaking body is often assumed to be a body that is not functioning properly. To leak is in fact inherent to all bodies. As Neimanis argues, “to be human means also always to leak beyond the limits of that humanity, then our embodiment affords the possibility of more-than-human contact with the world.”²⁴⁶ Moreover, physiologically “Biological membranes are intrinsically permeable to small, uncharged molecules and some leakage is inevitable when such molecules are intermediaries in metabolic processes.”²⁴⁷ All bodies leak past the barriers that we often assume demarcate the edge of what makes up us. Microbial life itself is also leaky:

The presence of leaky functions in microbial communities encourages the evolution of interactions that, at first glance, appear social or even altruistic, but importantly they do not require reciprocity to be stable. Moreover, when dependencies evolved in this manner persist, they have the potential to develop into intricate networks of mutual dependency.²⁴⁸

²⁴⁵ Gabriel J. Michael, “Who’s Afraid of WikiLeaks? Missed Opportunities In Political Science Research,” *Review of Policy Research* 32, no. 2 (2015): 175.

²⁴⁶ Astrida Neimanis, *Bodies of Water: Posthuman Feminist Phenomenology* (New York: Bloomsbury Academic, 2017): 45.

²⁴⁷ Jeffery J. Morris, “Black Queen Evolution: The Role of Leakiness in Structuring Microbial Communities,” *Trends in Genetics* 31, no. 8 (August 2015): 475.

²⁴⁸ *Ibid.*: 482.

The leakiness of microbial function triggers microbes to work together. Leakiness as a tie between bodies can lead to greater cooperation or sense of connection.

Alysse V. Kushinski, in her dissertation “The Potential of Leaks” (2019) argues that, “Despite leaks’ threatening consequences, they always mark a change, a transformation, a revelation. The leak becomes a means through which we can challenge ourselves to reconsider the (non)functionality of boundaries—an opening through which new possibilities occur, and imposed divisions are contested.”²⁴⁹ The leaks in my sculptures ruptured the boundaries I had formed. These leaks forced me to reconsider my relationship to borders, provided me with a deeper understanding of the latent power of the mud, microbes and water within my sculptures, and led to new material understandings. Although disruptive, leaks can also be generative.

Biological Borders

“Why should our bodies end at the skin?”

—Donna Haraway, *A Cyborg Manifesto*

“For animals, as well as plants, there have never been individuals”

—Scott F. Gilbert, “A Symbiotic View of Life”

²⁴⁹ Alysse Verona Kushinski, “The Potential of Leaks: Mediation, Materiality, And Incontinent Domains” (Doctoral Dissertation, Graduate Program in Communication and Culture, Toronto, York University, 2019): ii.

Throughout most of daily life, humans often think and act as if each of us is a singular and discrete biological entity – as if our selves were wholly demarcated by the edges of our skin. Microbial life not only permeates our perceived biological boundaries, but it also plays integral roles within us, making it possible for our bodies to function as effortlessly as they often appear to. Humans and all other multi-cellular life, no matter where you draw the biological boundaries, have had deeply entwined relationships with microbes throughout evolutionary history.²⁵⁰ Research is revealing how impactful microorganisms have been in determining the trajectory of life, leading to questions about how we understand biological individuality.²⁵¹ What appears so easy to single out – one human body, one squid, one termite – becomes nearly impossible to define as an individual when many selves are working to support the life being observed.

In the fields of biology, history, and philosophy, biological individuality has often been discussed in relation to Darwinian evolution with the goal of identifying “a single unit of selection in the process of evolution.”²⁵² Biologist Isabella Sarto-Jackson argues that an individual should be “self-preserving, have boundaries as well as be cohesive and localized.”²⁵³ It needs to “be sentient in the sense of displaying selectivity towards its environment” and be “a sufficient predictor of its own future.”²⁵⁴ The biologic individual also needs to be able to replicate.²⁵⁵

²⁵⁰ Margaret McFall-Ngai et al., “Animals in a Bacterial World, a New Imperative for the Life Sciences,” *Proceedings of the National Academy of Sciences of the United States of America* 110, no. 9 (2013).

²⁵¹ Ibid.

²⁵² Scott Lidgard and Lynn K. Nyhart, eds., *Biological Individuality: Integrating Scientific, Philosophical and Historical Perspectives* (Chicago: The University of Chicago Press, 2017): 1.

²⁵³ Isabella Sarto-Jackson, “Using Cognitive Biology to Tackle Individuality,” in *Biological Individuality and Other Issues in Contemporary Philosophy of Biology* (SOPhiA 2018, University of Salzburg, Austria, 2018): 181.

²⁵⁴ Ibid.

²⁵⁵ Ibid.

Although it may be useful in some instances to set these boundaries, this terminology does not evoke the liveliness of the individuals it describes. The definition of a single individual is also highly debated with some researchers arguing that an individual should include all microbial symbionts,²⁵⁶ and others that only the eukaryote²⁵⁷ can be a biological individual,²⁵⁸ with a large range of perspectives in between.²⁵⁹ In this text, I am not attempting to define an individual. Instead, I want to point out how difficult it is to draw borders around organisms. A more nuanced understanding of what composes a self calls into question some of the assumed divisions made between living things.

Many microbial symbionts cannot be grown in a lab environment²⁶⁰ and so it has only been with the development of molecular sequencing technologies that researchers have been able “for the first time to recognize the true diversity, ubiquity, and functional capacity of microorganisms.”²⁶¹ It is essential to note that awareness of the interconnectedness of beings is not new. It has been present in Indigenous knowledge systems long before it became provable using the scientific method.²⁶² It is only recently however that the diverse ways that microbes have developed as symbionts to animals and plants is becoming knowable to the sciences. Organisms are now revealing themselves to be not “genetically homogeneous entities” as was previously believed.²⁶³

²⁵⁶ Javier Suárez, “The Importance of Symbiosis in Philosophy of Biology: An Analysis of the Current Debate on Biological Individuality and Its Historical Roots,” *Symbiosis* 76, no. 2 (2018): 77–96.

²⁵⁷ A eukaryote is any cell or organism with a defined, membrane-bound nucleus.

²⁵⁸ A.E. Douglas and J.H. Werren, “Holes in the Hologenome: Why Host-Microbe Symbioses Are Not Holobionts,” *MBio* 7, no. 2 (2016).

²⁵⁹ This is by no means a full explanation of the debates on biological individuality. For a more in-depth review of the state of the topic see Pradeu, 2016; Lidgard and Nyhart, 2017; and Wasmer, 2018.

²⁶⁰ Ilana Zilber-Rosenberg and Eugene Rosenberg, “Role of Microorganisms in the Evolution of Animals and Plants: The Hologenome Theory of Evolution,” *FEMS Microbiology Reviews* 32, no. 5 (2008).

²⁶¹ Margaret McFall-Ngai et al., “Animals in a Bacterial World, a New Imperative for the Life Sciences,” *Proceedings of the National Academy of Sciences of the United States of America* 110, no. 9 (2013): 3229.

²⁶² Joe Sheridan and Dan Roronhiakewen Longboat, “The Haudenosaunee Imagination and Ecology of the Sacred,” *Space and Culture* 9, no. 4 (2005): 365–81.

²⁶³ Austin Booth, “Symbiosis, Selection, and Individuality,” *Biology and Philosophy* 29, no. 5 (2014): 259.

It is now accepted that the majority of all living things are holobionts. ‘Holobiont’, a term coined by Margulis in 1990, describes an animal or plant with all of its associated, persistent microbial symbionts.²⁶⁴ The holobiont is “a critically important unit of anatomy, development, physiology, immunology, and evolution.”²⁶⁵ In many ways, it no longer makes sense to try and separate the integrated symbionts that compose a living being. When researchers do deprive animals of microbial symbionts in a sterile environment, many do not develop fully.²⁶⁶ In humans, the gut microbiome has such an important role in our bodily function that it has been deemed a “forgotten organ.”²⁶⁷ The composition of gut microbe colonies even changes depending on diet, “For example, the gut microbiome of most people in the United States is adapted to digest a high-fat, high-protein diet, whereas populations in rural Malawi and the Amazonas of Venezuela have distinct microbial consortia and functional gene repertoires optimized for breaking down complex carbohydrates”²⁶⁸ The gut in many animals is home to an incredibly diverse array of microbes, some specialized to only exist in one particular animal’s digestive tract.²⁶⁹ These microbial partners can be vertically transmitted directly from a parent or horizontally picked up from the environment. Humans acquire our microbiome from the environment starting the moment we exit the womb. The breast milk human babies

²⁶⁴ Surindar Paracer and Vernon Ahmadjuan, *Symbiosis: An Introduction to Biological Associations* (Oxford University Press USA, 2000).

²⁶⁵ Scott F. Gilbert, Jan Sapp, and Alfred I. Tauber, “A Symbiotic View of Life: We Have Never Been Individuals,” *The Quarterly Review of Biology* 87, no. 4 (2012): 325.

²⁶⁶ Ibid.

²⁶⁷ Ann M O’Hara and Fergus Shanahan, “The Gut Flora as a Forgotten Organ,” *EMBO Reports* 7, no. 7 (July 2006): 688.

²⁶⁸ Margaret McFall-Ngai et al., “Animals in a Bacterial World, a New Imperative for the Life Sciences,” *Proceedings of the National Academy of Sciences of the United States of America* 110, no. 9 (2013): 3229.

²⁶⁹ Ilana Zilber-Rosenberg and Eugene Rosenberg, “Role of Microorganisms in the Evolution of Animals and Plants: The hologenome Theory of Evolution,” *FEMS Microbiology Reviews* 32, no. 5 (2008).

consume even contains particular fatty-acids that cannot be digested by the child, but do fuel microbes in their gut to promote a healthy microbiome.²⁷⁰

There are numerous insects that also rely on nutritionally-important symbiotic microorganisms.²⁷¹ Pea aphids feed on plant sap, but are only able to survive on this limited diet because of the amino acids made by their symbiotic bacteria *Buchnera aphidicola*. The relationship between the aphids and *Buchnera aphidicola* is estimated to have begun approximately 250 million years ago.²⁷² *Buchnera* are endosymbiotic, residing inside the cytoplasm of aphid cells in specialized compartments called bacteriocytes.²⁷³ These bacterial symbionts are passed down to the offspring of aphids in the cytoplasm of maternal eggs. This inheritance of bacterial strains has been compared to the transfer of mitochondria in other multicellular organisms. “In human lineages, for example, mitochondria are inherited maternally, in the cytoplasm of the maternal egg that partially forms the zygote from which each human develops.”²⁷⁴ Without this vertical transmission the pea aphid cannot survive.

Termites similarly require bacterial symbionts to help them gain nutrients from the cellulose rich foods they eat. Until recently there had been no consensus on whether termites receive gut microbes vertically, like aphids, or horizontally.²⁷⁵ Using mass spectrometry sequencing ecologist and evolutionary biologist Thomas Bourguignon

²⁷⁰ Rikke G. Nejrup et al., “Lipid Hydrolysis Products Affect the Composition of Infant Gut Microbial Communities in Vitro,” *British Journal of Nutrition* 114, no. 1 (July 2015): 63–74.

²⁷¹ Austin Booth, “Symbiosis, Selection, and Individuality,” *Biology and Philosophy* 29, no. 5 (2014): 259.

²⁷² A.C.C. Wilson et al., “Genomic Insight into the Amino Acid Relations of the Pea Aphid, *Acyrtosiphon pisum*, with Its Symbiotic Bacterium *Buchnera aphidicola*,” *Insect Molecular Biology* 19, no. 2 (March 2010).

²⁷³ Ibid.

²⁷⁴ Austin Booth, “Symbiosis, Selection, and Individuality,” *Biology and Philosophy* 29, no. 5 (2014).

²⁷⁵ Thomas Bourguignon et al., “Rampant Host Switching Shaped the Termite Gut Microbiome,” *Current Biology* 28 (2018): 649–54.

showed that the complex gut microbiota of termites is formed through a mixture of both. “Our results indicate that ‘mixed-mode’ transmission, which combines colony-to-offspring vertical transmission with horizontal colony-to-colony transfer, has been the primary driving force shaping the gut microbiota of termites.”²⁷⁶ Would the pea aphid along with *Buchnera aphidicola* be considered one individual because they are born together? Would the microbes that a termite inherits from its parents be thought of as one individual, but those that it acquires from the environment be separate? Dividing holobionts is a messy business.

Another instance of symbiosis is the Hawaiian bobtail squid, which depends on the luminescent bacteria *Vibrio fischeri*. The luminescence provided by the bacteria mimics moonlight, allowing the squid to hunt without being seen by predators. After the hunt is over, the squid expels the majority of the bacteria back into the water. The few remaining microbes multiply and are at an optimal density for the next night.²⁷⁷ When born, the squids specifically attract *Vibrio fischeri* using chemoattractants, flooding their light organ with their symbiont while simultaneously guarding against other bacteria.²⁷⁸ The bacteria not only impact the squid’s capacity to pursue food, but when deprived of their microbial symbiont in a lab environment the light organ does not form fully.²⁷⁹ This influence makes it clear that, “the parts of a squid-*Vibrio* holobiont are thus involved in a complex interplay involving development, physiology, and behavior.”²⁸⁰

²⁷⁶ Thomas Bourguignon et al., “Rampant Host Switching Shaped the Termite Gut Microbiome,” *Current Biology* 28 (2018): 649.

²⁷⁷ Austin Booth, “Symbiosis, Selection, and Individuality,” *Biology and Philosophy* 29, no. 5 (2014).

²⁷⁸ K. Nikilakakis et al., “Characterization of the *Vibrio Fischeri* Fatty Acid Chemoreceptors, VfcB and VfcB2,” *Applied and Environmental Microbiology* 8, no. 2 (January 2016): 696–704.

²⁷⁹ Austin Booth, “Symbiosis, Selection, and Individuality,” *Biology and Philosophy* 29, no. 5 (2014).

²⁸⁰ Ibid.

Although it may seem simple enough to identify the squid as one body and *Vibrio fischeri* as another, the dependence of the squid on the bacteria for its development complicates their taxonomical separation. There are numerous examples of these kinds of partnerships that call into question our understanding of one self. When the living world is not so easily divided into separate entities it becomes increasingly clear how deeply enmeshed we all are.

This complexity has led to many overlapping understandings of what an individual is including animals as ecosystems,²⁸¹ individuality as a spectrum,²⁸² or symbiotic collectives.²⁸³ Naming an individual entity may not be entirely possible and is highly influenced by perspective. One prevailing view in the sciences contends that:

Defenders of the hologenome concept tend to emphasize the collaborative aspect of life, and that they show a tendency to focus their studies on the evolution of the symbiotic relationship, irrespective of the different organisms that engage in the symbiosis. On the contrary, detractors of the hologenome concept tend to emphasize the conflicting interests of the entities that compose the holobiont, and, on these grounds, tend to reject any attribution of individuality, conceiving the holobiont as a community of relatively independent individuals.²⁸⁴

I would argue that many diverse understandings are needed to begin grasping what an individual can be and how complex a self is. What is important to recognize is how complicated the relationships between all matter is. The nuanced nature of beings

²⁸¹ McFall-Ngai et al., “Animals in a Bacterial World, a New Imperative for the Life Sciences.” *Proceedings of the National Academy of Sciences of the United States of America* 110, no. 9 (2013).

²⁸² Thomas Pradeu, “The Many Faces of Biological Individuality,” *Biology and Philosophy* 31, no. 6 (2016): 761–73.

²⁸³ Austin Booth, “Symbiosis, Selection, and Individuality,” *Biology and Philosophy* 29, no. 5 (2014).

²⁸⁴ Javier Suárez, “The Importance of Symbiosis in Philosophy of Biology: An Analysis of the Current Debate on Biological Individuality and Its Historical Roots,” *Symbiosis* 76, no. 2 (2018): 77.

challenges many preconceived notions of how our world functions as well as the human imperative to divide it into comprehensible sections.

Borders of Thought

“Alone, in our separate kinds of expertise and experience, we know both too much and too little, and so we succumb to despair or to hope, and neither is a sensible attitude.”

– Donna Haraway, *Staying With The Trouble*

“But I tried to learn because I think it's important to change, to push the border as far as you can, and still be a philosopher while intruding in another field, and considering not that I am annexing the other field because the border is still there but rather re-creating the border.”

– Vinciane Despret, “On asking the right questions”

The division of knowledge into separate areas of expertise has a long legacy in Western culture. Greek philosopher Aristotle categorized knowledge as theoretical, practical, or productive in 300 BC.²⁸⁵ In academia, subjects continue to be divided into disciplines based on common “tools, methods, procedures, exempla, concepts, and theories that account coherently for a set of objects or subjects.”²⁸⁶ Learning a discipline is characterized by mastering that discipline’s particular body of knowledge, as well as adopting its terminology, and research strategies.²⁸⁷

²⁸⁵ Joe Moran, *Interdisciplinarity* (New York: Routledge, 2010).

²⁸⁶ J Thompson Klein, *Interdisciplinarity: History, Theory, and Practice* (Detroit: Wayne State University Press, 1990): 104.

²⁸⁷ Kathryne M. Drezek, Deborah Olsen, and Maura Borrego, “Crossing Disciplinary Borders: A New Approach to Preparing Students for Interdisciplinary Research” (38th Annual Frontiers in Education Conference, Saratoga Springs, New York, 2008).

Thinking-with microbial life using a diffractive framework has brought me to many kinds of research. Working in this way is often described as ‘interdisciplinarity.’ Interdisciplinary, cross-disciplinary, transdisciplinary, and multi-disciplinary research are defined by their integration of “knowledge and modes of thinking in two or more disciplines or established areas of expertise to produce a cognitive advancement... that would have been impossible or unlikely through single disciplinary means.”²⁸⁸ Interdisciplinary research can cross borders productively; however, as social and cultural historian Joe Moran argues, it also “assumes the existence and relative resilience of disciplines as modes of thought and institutional practices.”²⁸⁹

Barad considers it a mistake to argue that we need to integrate various fields of thought “as if they were always already separate rather than always already entangled.”²⁹⁰ Approaching disciplines as inherently separate, even while working to bring them together, will always maintain the border between them. She goes on to note:

All of this is to say that we come up with a different way of thinking about what insights the Sciences, the Humanities, the Arts, the Social Sciences, and let’s not forget insights derived outside of academia, can bring to one another by diffractively reading them through one another for their various entanglements, and by being attentive to what gets excluded as well as what comes to matter.²⁹¹

Researching across disciplinary borders enables individuals to follow their curiosity and gain a deeper understanding of their research questions, as well as the blind spots within their own fields. As Barad argues:

²⁸⁸ V. Boix Mansilla and E.D. Duraising, “Targeted Assessment of Students’ Interdisciplinary Work: An Empirically Grounded Framework Proposed,” *The Journal of Higher Education* 78 (2007): 222.

²⁸⁹ Joe Moran, *Interdisciplinarity* (New York: Routledge, 2010).

²⁹⁰ Rick Dolphijn and Iris van der Tuin, eds., *New Materialism: Interviews and Cartographies* (Ann Arbor: Open Humanities Press, 2012).

²⁹¹ *Ibid.*

It is difficult to see the diffraction patterns—the patterns of difference that make a difference—when the cordoning off of concerns into separate domains elides the resonances and dissonances that make up diffraction patterns that make the entanglements visible.²⁹²

This more ecological manner of conducting research is reminiscent of the Winogradsky column. Instead of separating or isolating aspects to study, it brings the ecosystem together to see how it interacts. This type of investigation often places researchers in spaces where they may not be considered an expert.

Bio artist Jennifer Willet implores researchers to “go somewhere you do not belong.”²⁹³ Placing oneself in the uncomfortable position of the amateur forces us to alter the way that we may be used to conducting research and can expose biases, such as the use of specialized language, which may have gone unnoticed. Working beyond one discipline also enables exchange between research, as well as researchers, that reveals the “diffraction patterns” Barad discusses. In the field of bio art researching across disciplines is inherent.

Bio Art

“Bio artists engage with, grow, activate, engineer, and display living matter, forms, bodies, and environments that are continuously malleable, unstable, and impermanent.”

—Jennifer Johung, “Bio Art”

²⁹² Rick Dolphijn and Iris van der Tuin, eds., *New Materialism: Interviews and Cartographies* (Ann Arbor: Open Humanities Press, 2012).

²⁹³ Jennifer Willet, “INCUBATOR Art Lab: Re-Imagining Our Biotech Future Through Art / Science Research,” *Art & Research* Artnodes, no. 20 (2017): 83.

“We trust art audiences to recognize that because Bio Art is alive, all Bio Art has political, social, cultural, and ethical implications....”

–Eduardo Kac, et.al., *What Bio Art Is: A Manifesto*

Artist Eduardo Kac, credited with coining the term ‘bio art,’ argues that it “employs one or more of the following approaches: (1) the coaching of bio-materials into specific inert shapes or behaviors; (2) the unusual or subversive use of biotech tools and processes; (3) the invention or transformation of living organisms with or without social or environmental integration.”²⁹⁴ Working across art, science, and often other disciplines, bio artists engage a diverse range of topics. These include, biotechnology (Jennifer Willet, Paul Vanouse, Tagny Duff); gender norms (Shannon Bell, Julia Reodica); subjectivity (King Dublin, Heather Dewey-Hagborg); human/non-human relationships (Kathy High, Elaine Whittaker); memory (Jude Abu Zaineh, Anika Yi); ecological change (Amanda White, Alana Bartol); and the posthuman (Stelarc, Orlan).²⁹⁵

Bio art curator and theorist Jens Hauser argues that the field cannot be defined by one specific conceptual, material, or procedural aim.²⁹⁶ Instead, the heterogeneous array of artistic practices that are deemed bio art are connected by the use of “wet” or biological matter.²⁹⁷ This material can be interacted with through methods ranging from advanced biotechnology techniques such as genome editing in a lab, to DIY biology like growing a kombucha scoby at home.

²⁹⁴ Eduardo Kac, *Signs of Life: Bio Art and Beyond* (New York: The MIT Press, 2009): 18.

²⁹⁵ This is by no means an exhaustive list. Instead it is a sample of the diversity of contemporary bio art practices.

²⁹⁶ Jens Hauser, “Biotechnology as Mediality: Strategies of Organic Media Art,” *A Journal of the Performing Arts* 11, no. 2 (2011): 129–36.

²⁹⁷ Ibid.

Another characteristic of bio art, according to Hauser, is its capacity to generate “presence.”²⁹⁸ The “presence” of bio art is brought about by the interaction between the living art object and the viewer: “the observer of bio art must shift between the symbolic artistic space and the “real life” of the presented processes suggested by the organic presence.”²⁹⁹ This embodied experience confronts the viewer with the liveliness of materials as well as themselves, bringing attention to their physical body and that of the artwork.³⁰⁰ Cultural geographer Andrew Lapworth describes this interaction as an “encounter” that can “materially produce, rather than merely represent, new subjects and worlds.”³⁰¹ Encountering bio art can generate new understandings and forge new connections in the mind of viewers, or as Lapworth describes it, “extracts from the determinations of subjects and objects the possibilities for new material sensibilities and compositions of being.”³⁰² The ability of bio art to confront the viewer and its potential to impact their understanding of the world is also described by art-science historian William Myers. In his book, *Bio Art: Altered Realities* (2015), Myers argues that bio art “... can do much more than visualize previously invisible forces ... it can offer us ways to ponder their meaning for our lives, help us arrive at new theoretical and practical positions, and forge new cognitive frameworks and terms to describe them.”³⁰³ The potential impacts of bio art are directly linked to the liveliness of the materials its practitioners work with.

²⁹⁸ Jens Hauser, “Biotechnology as Mediality: Strategies of Organic Media Art,” *A Journal of the Performing Arts* 11, no. 2 (2011): 129–36.

²⁹⁹ Ibid: 132.

³⁰⁰ Ibid.

³⁰¹ Andrew Lapworth, “Theorizing Bioart Encounters after Gilbert Simondon,” *Theory, Culture and Society* 33, no. 3 (2016): 150.

³⁰² Ibid.

³⁰³ William Myers, *Bio Art: Altered Realities* (New York: Thames & Hudson, 2015), 13.

Despite its diversity, bio art has been typically associated with projects that employ spectacle as well as a scientific aesthetic to address emerging biotechnologies and their implications. What looks like science to a viewer is shaped by signifiers that we link with a scientific aesthetic. Aesthetics is a term that describes a sensory experience, “used broadly to encompass the perception, production, and response to art, as well as interactions with objects and scenes that evoke an intense feeling, often of pleasure.”³⁰⁴ In bio art, artists often employ a range of scientific aesthetics in their work. The set of indicators that we associate with science have been informed by the imagery scientists have used to communicate their research³⁰⁵ as well as depictions of science in popular culture such as images of labs in film, advertising, or descriptions in literature. A scientific aesthetic is often associated with sleek clean surfaces, glass beakers or test tubes, mechanical apparatuses that are somewhat obscure, and white lab coats. These symbols of science are also associated with the objective authority that the field of research is coupled with. Artworks that employ a scientific aesthetics often take up the authority of science in order to question it or to shroud the artwork in the same perceived objectivity.

This aesthetic can be seen in the practice of the pioneering bio art collective TC&A. In their artwork, *Victimless Leather—A Prototype of Stitch-less Jacket grown in a Technoscientific “Body”* (2004), an immortal cell line was used to grow a living layer of tissue on a biodegradable polymer matrix shaped like a small coat.³⁰⁶ Presented inside a

³⁰⁴ Anjan Chatterjee, “Neuroaesthetics: A Coming of Age Story,” *Journal of Cognitive Neuroscience* 23, no. 1 (2010): 53.

³⁰⁵ Nicola Mößner, *Visual Representations in Science: Concept and Epistemology* (London and New York: Routledge, 2018).

³⁰⁶ Oron Catts and Ionat Zurr, “Victimless Leather- A Prototype of Stitch-Less Jacket Grown in a Technoscientific ‘Body,’” Artists’ Website, accessed May 30, 2016, <http://www.tca.uwa.edu.au/vl/vl.html>.

scientific apparatus of glassware, *Victimless Leather* is fed automatically through a series of polymer tubes. The fleshiness of the piece and the lab aesthetic of the apparatuses keeping it “semi living” confronts viewers with the promises and horrors of a biotechnological “victimless utopia.”³⁰⁷ The spectacle of the technoscientific apparatus is employed purposefully by TC&A. As discussed in the introduction, the collective aimed to make apparent to viewers the need to care for the artwork through the use of technology, or to demonstrate an “aesthetics of care.”³⁰⁸



Figure 29: *Victimless Leather*, Tissue Culture & Art Project, 2004



Figure 30: *Ear-On-Arm*, Stelarc, 2008

³⁰⁷ Oron Catts and Ionat Zurr, “Victimless Leather- A Prototype of Stitch-Less Jacket Grown in a Technoscientific ‘Body,’” Artists’ Website, accessed May 30, 2016, <http://www.tca.uwa.edu.au/vl/vl.html>.

³⁰⁸ Oron Catts, “Not Moving - Living,” *Leonardo* 48, no. 2 (2015): 170.

Spectacle has been employed by Australian artist Stelarc who often manipulates his own body to explore notions of the posthuman. In his project *Ear-On-Arm* (2008), Stelarc constructed a sculptural human ear out of biocompatible material and with a team of doctors surgically attached it under the skin of his forearm.³⁰⁹ He was interested in exploring whether altering his body might enable him to “adjust its awareness.”³¹⁰

Artworks like these often evoke a strong reaction from viewers, jarring them into attention. Although the use of spectacle clearly has a place within bio art, it also risks ostracizing viewers. Bio art curator Treva Michelle Legassie notes, “Those who encounter live matter for the first time in a gallery or museum setting often recall an initial shock, which is followed by an uneasy, queasy, and uncanny feeling.”³¹¹ The association of bio art with spectacle and discomfort has had widespread implications for the interpretation and connotations of the field.

Bio art that does employ spectacle also seems to be what is given the most media attention. For example, many articles were written about the “human cheese” exhibited at the Grow Your Own show at the Science Gallery Dublin, curated by (2013) Daisy Ginsburg. The artwork is a part of the *Selfmade* series by microbiologist Christina Agapakis and artist Sissel Tolaas. In the work, bacteria cultured from a variety of human sources – including the armpit of Tolaas – is added to milk, then aged to create farmhouse cheddar and whey cream cheese.³¹² Multiple articles describe the artwork as “bizarre,” focusing on the piece’s novelty, as well as the repulsion or curiosity it evokes.³¹³

³⁰⁹ Stelarc, “Ear on Arm: Engineering Internet Organ,” Stelarc, accessed May 29, 2016, <http://stelarc.org/?catID=20242>.

³¹⁰ Ibid.

³¹¹ Legassie, “Keepers of the Bio Art Laboratory: Mangling Methods and Curating Critically.”

³¹² Jennifer Willet, “INCUBATOR Art Lab: Re-Imagining Our Biotech Future Through Art / Science Research,” *Art & Research* Artnodes, no. 20 (2017).

³¹³ Gambino, 2014; Meier, 2013; Wainwright, 2013; Williams, 2013;

Although the artwork incited many responses, the articles did not move beyond a surface level discussion of bio art as spectacle.

In my own experience, those unfamiliar with bio art practices are often wary of them. During studio visits at the University of Victoria and at York University many curators have suggested that I refuse the title “bio artist.” Some curators deemed it too “science-y” and others suggested that calling the work bio art restricted its interpretation. Artist Diane Borsato often works with living materials, such as flowers in her series *Bouquet* (2016-ongoing), but resists calling this work bio art in part due to these associations.³¹⁴ I am interested in expanding the conversation about bio art to include the diverse practices and voices the field contains.

Contact between researchers in different fields is another generative aspect of bio art practice. Bio art encourages “hybrid work environments” that bring together individuals brought up through different disciplines.³¹⁵ Spaces such as the INCUBATOR Lab (Windsor, Ontario), The Pelling Lab (Ottawa, Ontario), SymbioticA (the first lab of its kind, Perth, Western Australia), NATURE Lab (Troy, New York), and the Coalesce: Center for Biological Arts (where I was an artist in residence, 2016-17, Buffalo, New York), have all been established as hybrid spaces between science and art. In these labs the barriers to access are lowered and artists without formal scientific training are invited in.

Beyond these spaces, accessing hard scientific laboratories can be quite challenging. There are financial and institutional barriers put in place that separate non-

³¹⁴ Diane Borsato, “Studio Visit with Diane Borsato at York University”, November 10, 2015.

³¹⁵ Lindsay Kelley, *Bioart Kitchen: Art, Feminism and Technoscience* (New York: I.B. Yauris & Co. Ltd, 2016): 77-78.

experts from experts. Understandably, there are also safety concerns when allowing a novice into a lab environment. However, there are instances where a more traditional lab would host an artist. Often to gain access artists need to learn the conventions of the lab such as expected behavior, typical protocols, and specialized language.³¹⁶ This was the case when Anna Dumitriu worked in UC Irving's Liu Laboratory for Synthetic Evolution, and when Marta de Menezes created her piece *Nature?* (1999) in the laboratory of Professor Paul Brakefield at the University of Leiden, Holland. All of these moments of connection offer opportunities for researchers to come together to investigate the topic at hand. Legassie argues that the act of transgressing the traditional roles of artist or scientist "mangle the lab and museum."³¹⁷ In traversing the borders of disciplines bio artists begin to reveal the possibilities of deeper collaboration beyond the aims of disciplinary research.

Bio artists expand their own scientific literacy, as well as the literacy of those who view their work. These researchers are not typically trying to represent scientific ideas so they can be more easily understood. Instead, by presenting artwork that engages stereotypically scientific material, bio artists can expand curiosity about, and discussion of, concepts often restricted to the sciences. Barad calls for a deeper understanding of science. She argues that "we need all kinds of people around the lab bench, so that scientific literacy should no longer be seen as being solely the responsibility of the sciences. I think that is one of the ways in which we get ourselves in a lot of trouble in

³¹⁶ Jennifer Willet, "Re-Imagining Biotech Futures through Bioart Practices," in *Propeller Symposium* (University of Windsor, 2019).

³¹⁷ Treva Michelle Legassie, "Keepers of the Bio Art Laboratory: Mangling Methods and Curating Critically," *Canadian Art Review* 43, no. 2 (2018): 88.

terms of education.”³¹⁸ Through a variety of strategies, including bio art, artists are taking a stake in the responsibility of engaging knowledge across borders of thought.

Another crucial consideration when discussing bio art are the implications of working with living materials. The living artwork raises concerns, as well as opportunities. Artists are required to relinquish a certain amount of control to the natural rhythms of their non-human collaborators. While discussing the benefits and challenges of working with microorganisms Dumitriu stated “Bacteria are a challenge to work with creatively. They are living things and do not always behave as expected.”³¹⁹ Their unpredictability can lead to unanticipated results, such as the unique staining patterns created by dyed bacteria in *MRSA Quilt* (2012).

Working with living beings also raises ethical concerns. Bio artists need to contend with bio ethics in order to “develop and implement ethical guidelines for ethically responsible handling of living material.”³²⁰ Bio ethics is addressed in *What Bio Art Is: A Manifesto* (2017) written by Eduardo Kac in collaboration with a number of prominent bio artists including Marta De Mendes and Paul Vanouse. It states, “All art materials have ethical implications, but they are most pressing when the media are alive. We advocate for an ethical Bio Art: ethical with respect to humans and nonhumans.”³²¹ Philosopher Nora S. Vaage argues that the living and dying inevitable in most bio art practices is mitigated by the fact that “the affective, visceral qualities of living artworks

³¹⁸ Rick Dolphijn and Iris van der Tuin, eds., *New Materialism: Interviews and Cartographies* (Ann Arbor: Open Humanities Press, 2012).

³¹⁹ Anna Dumitriu, “The Challenges and Rewards of Working with Bacteria as an Artistic Medium,” *Artlink* 34, no. 3 (2014): 50. *ArtLink* 34, no. 3 (2014), 50.

³²⁰ Nora S. Vaage, “What Ethics for Bioart?,” *Nanoethics* 10 (2016): 87.

³²¹ Eduardo Kac et al., “What Bio Art Is: A Manifesto,” 2017, http://www.ekac.org/manifesto_whatbioartis.html.

may spur the audience to adjust, revise or develop their personal ethical framework.”³²²

Contending with the ethics of bio art has clear ties to my own struggle with taking from the land and working with microbial life.³²³

Bio Artists

In order to gain a better understanding of the breadth of bio art practices, as well as the place of my own research alongside them, I look to the artwork of contemporary bio artists employing various strategies: Marta de Menezes, Jude Abu Zaineh, Heather Barnett, Paul Vanousse, and Amy M. Youngs.

Marta De Menezes

In *Nature?* (1999), Portuguese bio artist Marta de Menezes worked with and exhibited live, altered butterflies. Using a small needle, Menezes physically manipulated the wings of the butterflies in the pupa stage in the laboratory of Professor Paul Brakefield at the University of Leiden. This interfered in the normal development of the wing, inducing asymmetrical wing patterns in the living butterflies. The butterflies were not genetically altered so their mutation could not be passed down to offspring; meaning that each iteration of the artwork only lived as long as the butterfly did. As Menezes describes, “The new patterns are something that never existed before in nature, and that rapidly disappear from nature not to be seen again.”³²⁴ *Nature?* was displayed as a greenhouse inside the gallery, filled with the live altered butterflies and open to

³²² Nora S. Vaage, “What Ethics for Bioart?,” *Nanoethics* 10 (2016): 104.

³²³ This will be addressed in more depth in “Chapter 3.”

³²⁴ Marta De Menezes, “Nature?,” Artist’s Website, Marta De Menezes, 2000 1999, <http://martademenezes.com/portfolio/projects/>.

viewers.³²⁵ The artwork brings into question where we draw the border around what is natural, a topic Menezes has continued to explore.

During an artist talk given at the Festival of Art and Science hosted by the SciArt Salon in Toronto (2019), Menezes presented the audience with two images of mice and asked “which one is natural?”³²⁶



Figure 31: BALB/c mouse, Image courtesy of The Jackson Laboratory, www.jax.org

The mouse pictured on the right is a BALB/c, a strain of mouse bred for laboratory use in the 1920's.³²⁷ The second, a nude mouse, is a spontaneous mutation of the first mouse. Its mutation makes the mouse T-cell deficient, which simultaneously impacts its hair growth and makes it immunodeficient.³²⁸ The nude mouse was not manipulated in order to make it T-cell deficient, but it is widely used in lab environments as a test subject

³²⁵ Marta De Menezes, “Nature?,” Artist’s Website, Marta De Menezes, 2000 1999, <http://martademenezes.com/portfolio/projects/>.

³²⁶ Marta De Menezes, “Evolve, Mutate, Transform” (Artist Talk, Festival of Art and Science, Art Science Salon at the University of Toronto, March 29, 2019).

³²⁷ Mouse Genome Database Project and The Jackson Laboratory, “BALB/c,” Scientific Research Initiative, Mouse Genome Informatics, 2019, http://www.informatics.jax.org/inbred_strains/mouse/docs/BALB.shtml.

³²⁸ Ibid.

because of this.³²⁹ Menezes in her project *Truly Natural* (2018), proposes to use CRISPR-cas9³³⁰ to edit the genome of the nude mouse to remove its immune disorder. The artist poses the question, “is this ethical?”³³¹ This question is not posed in the hopes of a decisive answer, but to begin a deeper conversation about the implications of CRISPR-cas9, including its humanitarian possibilities. Calling attention to our presumptions about the “natural” world leads us to question current divisions as well as the future possibilities of increasing numbers of genetically modified organisms and their place in our world.

Jude Abu Zaineh

Emerging Canadian-based bio artist Jude Abu Zaineh works with food and microbial culturing to explore connections to home and her immigrant experience. In *Home is Where the Maqlouba is: A Bioart Workshop* (2018) Abu Zaineh prepared and served a traditional Palestinian dish while participants were taught how to make Maqlouba. The dish is described by the artist as “an upside down rice casserole” that involves “layering some sliced potatoes in a pot. On top of that, you have sliced tomatoes, cauliflower, some form of meat — either chicken or beef — and then it's packed with a lot of spiced rice.”³³² This meal has particular meaning for Abu Zaineh who has memories of eating it with her family while growing up in Kuwait. As part of the

³²⁹ Marta De Menezes, “Evolve, Mutate, Transform” (Artist Talk, Festival of Art and Science, Art Science Salon at the University of Toronto, March 29, 2019).

³³⁰ CRISPR-cas9 is an accessible gene editing technique adapted from a naturally occurring genome editing system in bacteria.

³³¹ Ibid.

³³² Sanjay Maru, “Art Exhibit ‘bringing People Together’ Using Traditional Palestinian Dish,” *CBC News*, April 23, 2019, <https://www.cbc.ca/news/canada/windsor/university-art-exhibit-bringing-people-together-using-maqlouba-1.5106849>.

workshop, the participants ate together while discussing bio art and the role of food in home making. After the meal, the group used fragments of the food to line petri dishes that were then grown in the INCUBATOR lab.



Figure 32: Jude Abu Zaineh, *Home is Where the Maqlouba is*, 2018

Abu Zaineh states that her work explores “what it means for Palestinians to exist in a migratory space of “in-betweenness”; attempting to conform and adapt to the cultures and traditions of their new homesteads while maintaining a connection to their Palestinian heritage and identity.”³³³ The “in-betweenness” that the artist described is echoed in her methods. This artwork combines techniques that transgress the borders of the lab, being made outside of the lab and then brought within. The universality of food enables Abu Zaineh to make the audience feel a sense of home while simultaneously

³³³ Jude Abu Zaineh, “Home Is Where the Maqlouba Is: An Overview of a Bioart Workshop” (Taboo, Transgression, Transcendence in Art & Science, UNAM and CCD, Mexico City, 2018).

challenging them to consider what home can mean through growing the leftovers on petri dishes. Viewing the petri dishes as they transform, becoming covered in microbial life, reveals the ongoing liveliness of the meal and the ongoing becoming of home making.

Heather Barnett

In her research, British artist Heather Barnett collaborates with *Physarum polycephalum*, commonly known as slime mold. During a workshop I took part in titled “Superorganism City” (March 2019), Barnett discussed the capacity for slime mold to solve problems for humanity. Barnett is part of the Plasmodium Consortium, a collective that researches alongside slime mold and helped found the world’s only scholar-in-residence position for a non-human. Slime mold has been a faculty member at Hampshire College in Western Massachusetts since 2017.³³⁴ During its time there, slime mold has been asked to give its opinion on a number of pressing global issues by navigating various petri dish environments.

One of the questions addressed the growing national tensions at borders, and in particular the border between the United States of America and Mexico. Researchers created one petri dish divided in the middle by plastic. A colony of slime mold was placed on one side of the border where there were plenty of nutrients, and another group was placed on the other where food was limited. Another petri dish with the same nutrients, and slime mold placement was made without a border. The slime mold thrived

³³⁴ “Hampshire College Welcomes First Non-Human Scholars-In-Residence,” College Website, Hampshire College, May 2017, <https://www.hampshire.edu/news/2017/05/05/hampshire-college-welcomes-first-non-human-scholars-in-residence>.

in the borderless environment, causing the researchers to assert that the USA and Mexico should open their constructed borders and allow for free passage.

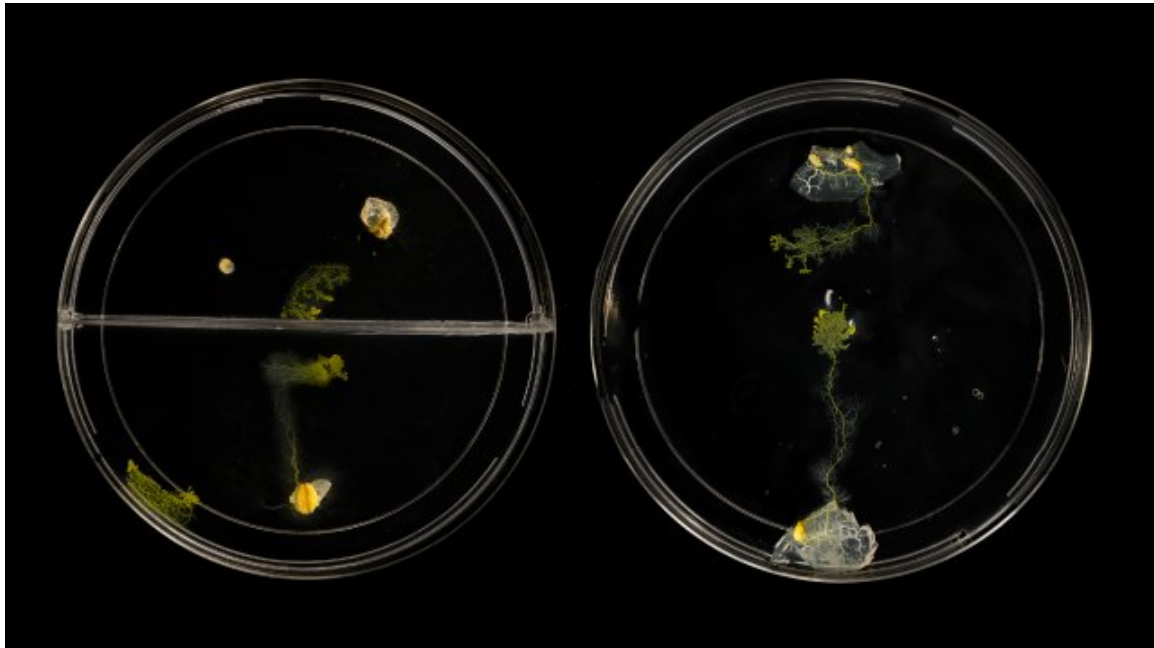


Figure 33: Petri dish on left with border, petri dish on right without. <https://www.the-scientist.com/daily-news/slime-mold-in-residence-30000>
Photograph by Raina Mendel

On behalf of the slime mold, members of the collective prepared letters and sent them to the most relevant officials notifying them of its research. Secretary of Homeland Security Kirsten Nielsen was briefed on the slime mold's position, as was the United Nations.³³⁵ Artist Jonathon Keats, another member of the collective, argues that slime mold's "advice is objective, and transcends our polarized political environment, because they don't

³³⁵ Brian Resnick, "Trump Doesn't Have a Science Adviser. This Slime Mold Is Available," *Vox*, April 5, 2018, <https://www.vox.com/science-and-health/2018/3/6/17072380/slime-mold-intelligence-hampshire-college>.

belong to our species.”³³⁶ He goes on to state that the project is a way to “look at what nature is telling you what’s good for our species.”³³⁷

Paul Vanouse

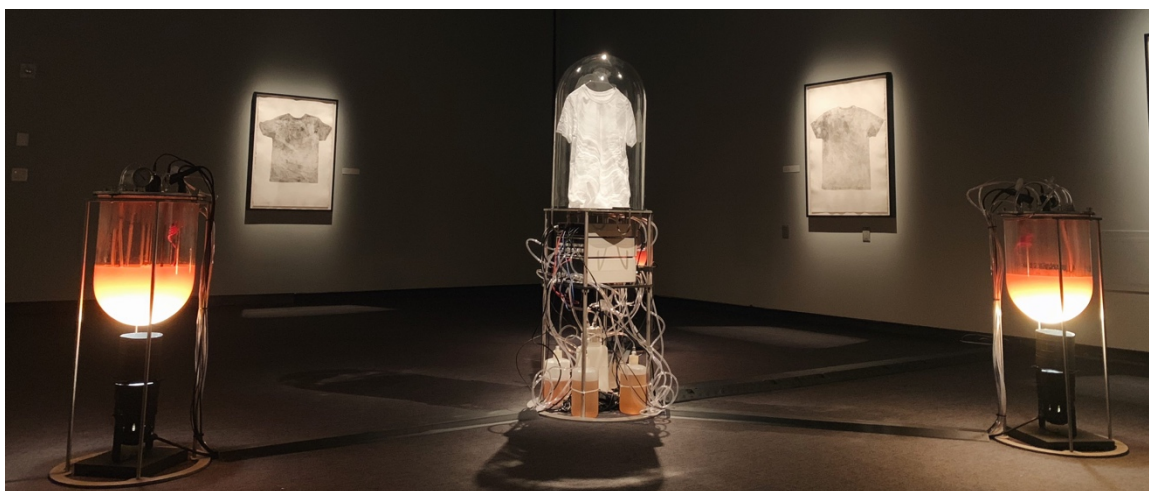


Figure 34: Paul Vanouse, *Labour*, 2019, Burchfield Penny Art Center, photo: Tullis Johnson

Paul Vanouse, bio artist and founder of the Coalesce bio art lab, describes his practice as guided by “radical interdisciplinarity and impassioned amateurism.”³³⁸ In his most recent project *Labour* (2019) Vanouse created an installation that exudes the smell of sweat, without the actual human labour. Instead, a community of microorganisms formed by *Staphylococcus epidermidis*, *Corynebacterium xerosis* and *Propionibacterium*

³³⁶ Bruce Sterling, “A Recent Jonathan Keats Emanation,” *Wired*, March 15, 2018, <https://www.wired.com/beyond-the-beyond/2018/03/recent-jonathan-keats-emanation/>.

³³⁷ Brian Resnick, “Trump Doesn’t Have a Science Adviser. This Slime Mold Is Available,” *Vox*, April 5, 2018, <https://www.vox.com/science-and-health/2018/3/6/17072380/slime-mold-intelligence-hampshire-college>.

³³⁸ Paul Vanouse, “Intro,” Artist’s Website, Paul Vanouse, accessed August 22, 2019, <http://www.paulvanouse.com/>.

avidum creates the familiar odour.³³⁹ These microbes are the same species found on human skin that produce the unique bouquet of human sweat, particularly due to stress. The installation is humorous while simultaneously drawing our attention to the integral role of microbes in our bodily functions. It also speaks to the biotech industry which is increasingly attempting to outsource the labour associated with being human. Vanouse also discusses the role of microbial labour, as in the production of foods, medicines, and building materials.³⁴⁰

Amy M. Youngs

Bio artist Amy M. Youngs creates “ecosystem artworks” that embrace and reveal interdependencies between species.³⁴¹ In her *Machine for Living Interdependently* (2012–2015) Youngs created a vertical ecosystem where worms, plants, humans, and bacteria work together to break down food scraps, grow food, and produce oxygen. Youngs has created numerous installations that enable humans to cohabitate with worms and plants in a domestic environment. Another example is her piece *River Construct* (2010), where a rabbit and mosquito fish were introduced to produce manure and eat algae out of the water source, respectively. This work highlights the role of other animals beyond humans in these ecologies as well as creating a link between the care given to pets such as rabbits and the indoor ecosystem of the artwork more broadly.

³³⁹ Paul Vanouse, “Labour,” Artist’s Website, Paul Vanouse, 2019, <https://www.paulvanouse.com/labor.html>.

³⁴⁰ Paul Vanouse, “What does exploitation smell like?,” interview by Katia Kreuzhuber, Magazine Article, 07 2019, https://ars.electronica.art/aeblog/en/2019/07/16/labor_paul_vanouse/.

³⁴¹ Amy M. Youngs, “Living with Worms in the Flooding Machine,” *Antennae: Journal of Nature in Visual Culture* Summer (2014).



Figure 35: Amy M. Youngs, *Machine for Living Interdependently*, 2012–2015

Figure 36: Amy M. Youngs, *River Construct* as exhibited at Redline Gallery in Denver, CO, 2010 © Amy Youngs

The artworks demonstrate several possible ways for humans and non-humans to live together. The non-human collaborators are not simply a tool used to create compost, but a roommate, and a companion. The creation of “interdependent domestic bliss” through Youngs’ sculptural work is at once humorous and serious.³⁴² The need for immediate collaboration in the face of catastrophic climate change is very much present. Through her research she calls for us to collaborate with non-humans to reduce greenhouse gasses and to create a more comfortable living environment.³⁴³ As Youngs compels us, “Breathe easy, and invite them into your home.”³⁴⁴

³⁴² Amy M. Youngs and students in the Vermiculture Furniture course at The Ohio State University, *Worms in Our Furniture (or Future)* (Ohio: Self-published, 2013).

³⁴³ Ibid.

³⁴⁴ Amy M. Youngs, “Living with Worms in the Flooding Machine,” *Antennae: Journal of Nature in Visual Culture* Summer (2014).

Nicole Clouston

The practices that I have outlined here utilize various strategies in engaging the non-human. Similar to Youngs and Abu Zaineh, I do not employ a scientific aesthetic or advanced bio technological techniques. Instead, I utilize accessible DIY biology techniques that can be conducted safely outside a lab – specifically soil microbe culturing informed by the Winogradsky column. This method enables me to work in diverse environments, and hold workshops where the public can engage the artwork directly.³⁴⁵

As Vanouse considers in relation to *Labour* (2019), microbes are often only discussed in terms of their capacity to benefit humanity. I am interested in working with environmental microbes, rather than those specifically found in the human microbiome, to broaden our discussion of microorganisms beyond their use value for humans. Through working with microbes that have an existence beyond just the human body, I aim to direct focus away from humans, towards many bodies including theirs and the body of water they come from. This strategy can open up a site where viewers experience the microbial presence in a different way. Seeing the microbes in my sculptures enables an encounter that is not mitigated by a microscope or made known through symptoms caused by a pathogen. Viewers are able to come into contact with microbial life and consider how these life forms embody the ties that enmesh us all.

³⁴⁵ The workshops will be discussed further in "Chapter 3: Collaborating with the Public."

Chapter 3: Collaboration

While we may all ultimately be connected to one another, the specificity and proximity of connections matters—who we are bound up with and in what ways. Life and death happen inside these relationships.

– Thom Van Dooren, *Flight Ways*

collaboration

noun **1.** the action of working with someone to produce something. **2.** Traitorous cooperation with an enemy.

– Oxford English Dictionary

In my practice, I have collaborated with humans and non-humans in the making of artworks and texts that I could not have created on my own. The nature of these collaborations and the act of collaborating itself has become an important part of my practice. Collaboration can be broadly defined as working with someone to produce something or the “co-construction of new knowledge.”³⁴⁶ I would argue that collaboration is a way to think together and work together to explore beyond one’s own experience. Working together across the lines we draw around disciplines enables a far more robust search for understanding. As discussed in “Chapter Two,” researchers can gain more insight when they are able to follow their curiosity without adhering to disciplinary boundaries and by working with thinkers from diverse backgrounds.

The overuse and oversimplification of ‘collaboration’ has diluted the meaning of the term. Collaboration is often romanticized as an act of bringing minds together to create something greater, without much consideration of its complexities. Collaboration

³⁴⁶ Vera John-Steiner, *Creative Collaboration* (ProQuest eBook Central: Oxford University Press USA, 2006), <https://ebookcentral-proquest-com.ezproxy.library.uvic.ca/lib/uvic/detail.action?docID=430979>: 3

has also been instrumentalized by capitalism as a corporate buzzword leading to the term's association with productivity or consumerism.³⁴⁷ What we are collaborating on as well as how we collaborate matters. In my use of the term collaboration is a relationship of thinking-with.³⁴⁸ This is not an idealized coming together, but instead a way to work in tandem with another while being impacted by other ways of thinking. I would argue that meaningful collaboration is not simple, not in the act of collaborating or in the results of collaboration. It is important to acknowledge the generative aspects of collaboration, while at the same time remaining aware of its complexities, such as inequality.

Collaboration occurs ideally when all parties are open to being altered by each other. As author Vera John-Steiner argues, “transformative changes require joint efforts ... these partnerships require a prolonged period of committed activity.”³⁴⁹ Choosing to work together, choosing to listen, is a way of making things ‘matter’ in the sense that Barad uses the term.³⁵⁰ Barad argues that mattering is an act of paying attention in a way that recognizes how all matter impacts each other or as she states “taking account of the entangled materializations of which we are part.”³⁵¹ In this way, “collaboration is an intensely political activity.”³⁵² In my work with others – with scientists during my residency at the Coalesce Bio Art Lab, with non-humans, and with the public – I aim to create the conditions for meaningful collaboration.

³⁴⁷ DeFillippi, B. et. al., 2006; Doorley, S & Witthoft, S., 2012; Shiach, M & Virani, T, 2017

³⁴⁸ Donna Haraway, *When Species Meet*, vol. 3, Posthumanities (Minneapolis: University Of Minnesota Press, 2008).

³⁴⁹ Vera John-Steiner, *Creative Collaboration* (ProQuest eBook Central: Oxford University Press USA, 2006), <https://ebookcentral-proquest-com.ezproxy.library.uvic.ca/lib/uvic/detail.action?docID=430979>.

³⁵⁰ Karen Barad, *Meeting the Universe Halfway* (London: Duke University Press, 2007).

³⁵¹ Rick Dolphijn and Iris van der Tuin, eds., *New Materialism: Interviews and Cartographies* (Ann Arbor: Open Humanities Press, 2012).

³⁵² Karen Savage and Dominic Symonds, “Introduction,” in *Economies of Collaboration in Performance* (Cham: Palgrave Macmillan, 2018):10.

Donna Haraway argues that collaborations are the site of important work, stating that working together has the potential to be:

...modest, daring, contemporary, risk-filled projects for recuperation, in which people and animals tangle together in innovative ways that might, just barely possibly, render each other capable of a finite flourishing—now and yet to come. The collaborations among differently situated people—and peoples—are as crucial as, and enabled by, those between the humans and animals ...My hope is that these knots propose promising patterns for multispecies response-ability inside ongoing trouble.³⁵³

These transformative knots can be most impactful when collaborators enter into the relationship while “staying with the trouble.” This means acknowledging that collaborating can encompass a wide variety of relationships with varying levels of equality. The power imbalances that often accompany working together need to be acknowledged and attempts to dismantle these imbalances should be made. In this chapter I will explore my experiences of different forms of collaboration that have become critical in the way I conduct research: collaborating with scientists, with microbes, and with the public.

Collaborating with Scientists

Collaborative projects between artists and scientists, or art-science research, bring together ways of knowing that are often portrayed in opposition to each other.

Increasingly this stereotypical view of the fields has begun to dissolve, making way for meaningful partnerships. The collaborations happening at the intersection of art and

³⁵³ Donna Haraway, *Staying with the Trouble: Making Kin in the Chthulucene (Experimental Futures)* (New York: Duke University Press, 2016).

science include artists in labs, scientists in studios, or both in hybrid spaces. Art-science work can be conducted by one individual; however, this research is often done in cooperation. In this section I will be focusing on collaborations between artists and scientists, in line with my own experiences working as an artist in the Coalesce Bio Art Lab at the University at Buffalo (2017-2018).

Art-science collaborations are becoming more prevalent through many international residencies supporting the field – such as CERN Collide and Accelerate Residencies at the European Organization for Nuclear Research in Switzerland; The Bridge: Experiments in Science & Art, an online residency run out of New York City; SymbioticA Residency at the University of Western Australia; Cultivamos Cultura Residency in Portugal. Residencies such as these do the important work of bringing together international researchers who are interested in collaborating, a feat that is much more difficult on an individual level. The kind of contemporary art-science research being done through these residencies and beyond is very diverse. Researchers are working on projects that include sculptural engagements with bioengineering, interpretations of large data sets from space, and engagements with artificial intelligence. Artists and scientists can work together in a variety of ways to conduct this research from long term collaborations, to week-long residencies, or a brief dialogue conducted remotely.

As with all forms of working together, art-science collaborations can be fraught relationships. It is challenging to work across the divides that have been established between ways of knowing.³⁵⁴ As psychologist Mihaly Csikszentmihalyi aptly describes,

³⁵⁴ Some of the difficulties of collaborating across disciplines, and the need to do so, was described in “Chapter 2.”

“Each domain is made up of its own symbolic elements, its own rules, and generally has its own system of notation. In many ways, each domain describes an isolated little world in which a person can think and act with clarity and concertation.”³⁵⁵ It is difficult to learn the notation of another discipline, but it is important to adopt some of its cultural norms and language so that both collaborators understand each other.

The fields of art and science have often been held up as opposites, as in the famous 1959 lecture “The Two Cultures and The Scientific Revolution” in which British novelist and scientist C.P. Snow outlined how divided the fields are.³⁵⁶ He argued that “the intellectual life of the whole of Western society is increasingly being split into two polar groups,” one composed of researchers in the sciences and the other in the humanities.³⁵⁷ Although an astute observation of the state of the field at the time, continuing to treat art and science as divided will only perpetuate a segregation of knowledge. The false perception that these fields are too inherently different to work together can lead to misconceptions – artists having preconceived notions about who a scientist is or how they conduct research and vice versa. Stereotypical assumptions are another barrier that art-science researchers must overcome and that their projects together can help combat.

Art-science researcher Roberta Buiani, in her talk given at the Society for Social Studies of Science Annual Meeting (2019), discussed how art-science collaborations or STEAM (Science, Technology, Engineering, Art, and Mathematics) work can be more or

³⁵⁵ Mihaly Csikszentmihalyi, *Creativity: Flow and the Psychology of Discovery and Invention* (New York: Harper Perennial, 1997): 37.

³⁵⁶ C.P. Snow, “The Two Cultures and The Scientific Revolution” (The Rede Lecture, Cambridge University Press, 1959).

³⁵⁷ Ibid: 3.

less meaningful depending on the collaborators and conditions for their work together.³⁵⁸ She argues that often art-science collaborations serve the scientist more than the artist. Moreover, artists and scientists are at a power imbalance with the scientific researcher often taking the role as gatekeeper to resources such as a lab space and funding. In many instances, the work may not be a collaboration, but an artist illustrating the research of a scientist.³⁵⁹ Art then functions as public-relations, or an engaging dissemination method for scientific research rather than research-creation in its own right. These conditions can often form when artists are asked to respond to the research of a scientist rather than developing a more generative partnership. Buiani argues that meaningful collaboration is possible, specifically referencing the work that bio artist Elaine Whittaker has been conducting alongside scientists at the Peling Lab (University of Ottawa). In this environment, artists and scientists work together sharing lab space while developing their projects. The researchers' work does not need to intersect directly, but can become sources of insight for each other. One of the artworks that resulted from Whittaker's time in the lab was *Lungs of the Earth* (2018), a piece that features a translucent maple leaf that contains human lung cells introduced by Whittaker. The lab environment alongside the scientists' knowledge of cell culturing enabled the project, but the artist is the one directing her own research-creation.

³⁵⁸ Roberta Buiani, "Complacent or Deluded? Assessing the Role of Sciart," in *Interpretations of Liminalities in Art and Science* (Society for Social Studies of Science Annual Meeting, New Orleans, 2019).

³⁵⁹ Ibid.

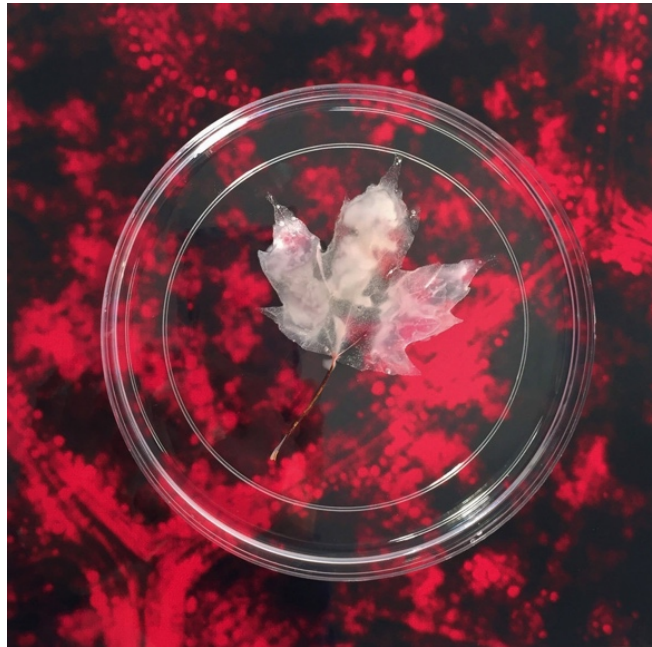


Figure 37: *Lungs of the Earth* (detail) Digital microscopy image, decellularized maple leaf with human lung epithelial cells in petri dish, 2018, Elaine Whittaker

Anthropologist Natasha Myers asserts that many art-science collaborations “leave the scientist intact” rather than challenging the notions of what science is and how it could be.³⁶⁰ As an alternative Myers suggests, “art/science convergences might be more generative if they began with the assertions that 1) *science is not what we thought it was*, and 2) *it could be otherwise*.”³⁶¹ Collaborations between artists and scientists work best when both are willing to be impacted by the other. I also want to acknowledge that it is not just the scientist that needs to be open to the artist. As the call for an artist-in-residence from the Civic Laboratory for Environmental Action Research (CLEAR) illustrates:

³⁶⁰ Natasha Myers, “Protocols for an Ungrid-Able Ecology Kinesthetic Attunements for a More-than-Natural History of a Black Oak Savannah,” in *Naturally Postnatural - Catalyst*: Jennifer Willet, Catalyst Book Series (Noxious Sector Press, 2017): 1.

³⁶¹ Ibid: 1.

We're looking to work with artists who will become a full lab member for the duration of their residency. We work collaboratively towards shared goals + shared research products and are looking for artists who work the same way. If you believe in the autonomous genius of artists and that things you create are entirely from your own ideas & experiences, this would be a horrible fit. If you want to try something new, weird + in community, call us.³⁶²

The generosity of all participants, in terms of time and consideration to the collaboration, is important.

Although the benefit artists gain through accessing a technology as well as the expertise of a scientist they would not typically have in their studio seems to be clear, it may be less obvious what artists can bring to the partnership. Medical doctor Caroline Wellbery argues that art-science collaborations work by “providing not only inspiration but also insight” to scientists.³⁶³ She goes on to state that, “By working with artists who see the world through a different lens, scientists invest in the opportunity to develop ideas that defy conventional rubrics and are untethered to outcomes.”³⁶⁴ Scientists, as Myers argues, often feel prohibited from working in non-normative ways.³⁶⁵ Artists can provide scientific researchers the space to look at their own field from a different perspective. The work done in art-science research also shares many of the benefits of working across disciplinary borders discussed in “Chapter 2,” including a diffractive reading of information. Art-science studies scholar, curator, and poet Hannah Star Rogers argues:

³⁶² Max Liboiron, “Call for Artist-in-Residence at CLEAR Laboratory,” Civic Laboratory for Environmental Action Research (CLEAR), 2020, https://civiclaboratory.nl/2020/01/09/call-for-artist-in-residence-at-clear-laboratory/?fbclid=IwAR1Bav3MvIePef4t8YiNM7R0GkXBrScIJBJfu_NiVUYBC6RdKb0rc3R_dJo.

³⁶³ Caroline Wellbery, “Art–Science Collaborations — Avenues toward Medical Innovation,” *The New England Journal of Medicine* 373, no. 26 (2015): 2495.

³⁶⁴ Ibid.

³⁶⁵ Natasha Myers, *Rendering Life Molecular: Models, Modelers, and Excitable Matter* (Durham: Duke University Press, 2015).

Our society needs to grapple with these social, political, economic, and cultural effects. Asked these questions by artists, we may all have an informed opinion shaped by our individual daily experiences, and fueled by our interpretations of artworks that address these subjects. Our scientists are specialized enough to handle the details: we need artists to help us imagine futures.³⁶⁶

Not all collaborative relationships between artists and scientists work to benefit everyone involved or produce research that is meaningful, however there are many instances where this is possible. Speaking from my own experience during the Coalesce Bio Art Residency at the University of Buffalo, working together with researchers in the sciences can be extremely rewarding.

Coalesce Bio Art Residency

Coalesce is a laboratory/studio space established by bio artist Paul Vanouse.³⁶⁷ Activities in the lab include the development of Vanouse's bio art projects, teaching bio art classes to University at Buffalo students, hosting talks and workshops, as well as inviting artist residents to use the space. As stated on their website, "*Coalesce: Center for Biological Arts* is a hybrid studio laboratory facility dedicated to enabling hands-on creative engagement with the tools and technologies of the life sciences."³⁶⁸ Through the residency, artists are capable of accessing resources often unavailable or

³⁶⁶ Hannah Star Rogers, ed., *Art's Work in the Age of Biotechnology: Shaping Our Genetic Futures* (NC State University Libraries, 2019): 4.

³⁶⁷ See "Chapter 2" for a description of Paul Vanouse's bio art practice.

³⁶⁸ "Coalesce: Center for Biological Arts," Academic, Genome, Environment and Microbiome Community of Excellence, University at Buffalo, accessed January 11, 2020, <http://www.buffalo.edu/genomeenvironmentmicrobiome/coalesce.html>.

very difficult to attain. As discussed in “Chapter 2,” there are often barriers put in place that limit the capacity for artists to work meaningfully with scientists or inside a lab.

During the yearlong residency from 2017 - 2018 I worked closely with two scientists: Dr. Solon Morse, an evolutionary biologist interested in studying microbes ecologically who is the Coalesce lab manager, and Dr. Lauren Sassoubre, an environmental engineer with a focus on microbial populations and communities in water who is an assistant professor in the Department of Civil, Structural and Environmental Engineering at the university. Both Dr. Morse and Dr. Sassoubre were enthusiastic collaborators interested in supporting my research and generating concepts together. Although I had spent time considering the dominance of the field of science, as well as deconstructing my understanding of a scientist as an objective individual, I was still intimidated. My experience working with Dr. Morse and Dr. Sassoubre helped to reinforce what I had already known: science is not done in a perfect vacuum devoid of individual interests, but in an interesting and vibrant space of research.

I entered the residency knowing that I would be working with the microbial life in soil. I had also decided that I would build sculptures based on the Winogradsky column. However, I was still uncertain where this mud would come from or what the focus of the project would be. In discussions with Dr. Morse and Dr. Sassoubre we considered looking at extreme environments, or bodies of water in and around Buffalo that have a unique ecology. As I drove between Toronto and Buffalo while commuting to the residency, the presence of Lake Ontario became more significant to me. Lake Ontario has

been the body of water closest to me for the majority of my life, and my relationship with the lake, as well as the history of this body of water compelled me to work with it.³⁶⁹

As the concept developed, it became clear that the greenhouse on campus would be an ideal location for the sculptures to grow. With the assistance of Dr. Solon Morse, I reached out to the University at Buffalo faculty who were in charge of the Dorsheimer Laboratory/ Greenhouse on campus. The facilities are described on the university web page, “This large greenhouse is actually four separate greenhouse units with environments ranging from tropical to cold. It is used for instruction and research in biology and the botanical sciences.”³⁷⁰ Dr. James O. Berry, a Professor in the Department of Biological Sciences was kind enough to let me work in the greenhouse he manages. Allowing my sculptures into the greenhouse despite not previously interacting with the bio art lab or having any experience working with artists was very gracious. Dr. Berry even provided updates on my artwork without being asked.

Email December 6, 2016

Hi Nicole. I notice that one of your columns, the one on the far right as you face the display, has overflowed a bit. It looks like the mud has been pushed up to the top (maybe by gas?), leaving an empty space at the bottom, and some of the water has overflowed out the top. Another column has a large living waterbug. Very cool. Otherwise, it is looking good. Cheers, Jim.³⁷¹

Email January 14, 2017

³⁶⁹ For a deeper explanation of my relationship with Lake Ontario as thinking partner during this project see “Chapter 1.”

³⁷⁰ The University at Buffalo, “Dorsheimer Laboratory/Greenhouse,” University at Buffalo, Building Profile, accessed January 11, 2020, <http://www.buffalo.edu/administrative-services/managing-facilities/planning-designing-and-construction/building-profiles/profile-host-page.host.html/content/shared/university/page-content/facilities/dorshe.detail.html>.

³⁷¹ Dr. Barry James, “Bioart in Greenhouse,” December 6, 2016.

Hi Nicole. I checked on your art project today. I noticed that some of the rubber bands and parafilm have degraded on a couple of them, and these have lost some of the liquid. They are getting very colorful.³⁷²

The interest in my project that Dr. Barry showed was encouraging. It also demonstrated the type of positive interaction that can form at the intersection of art and science.

Although we were not working together directly, Dr. Barry shared his research project with me and I shared mine with him, leading to enthusiasm about each other's practice.

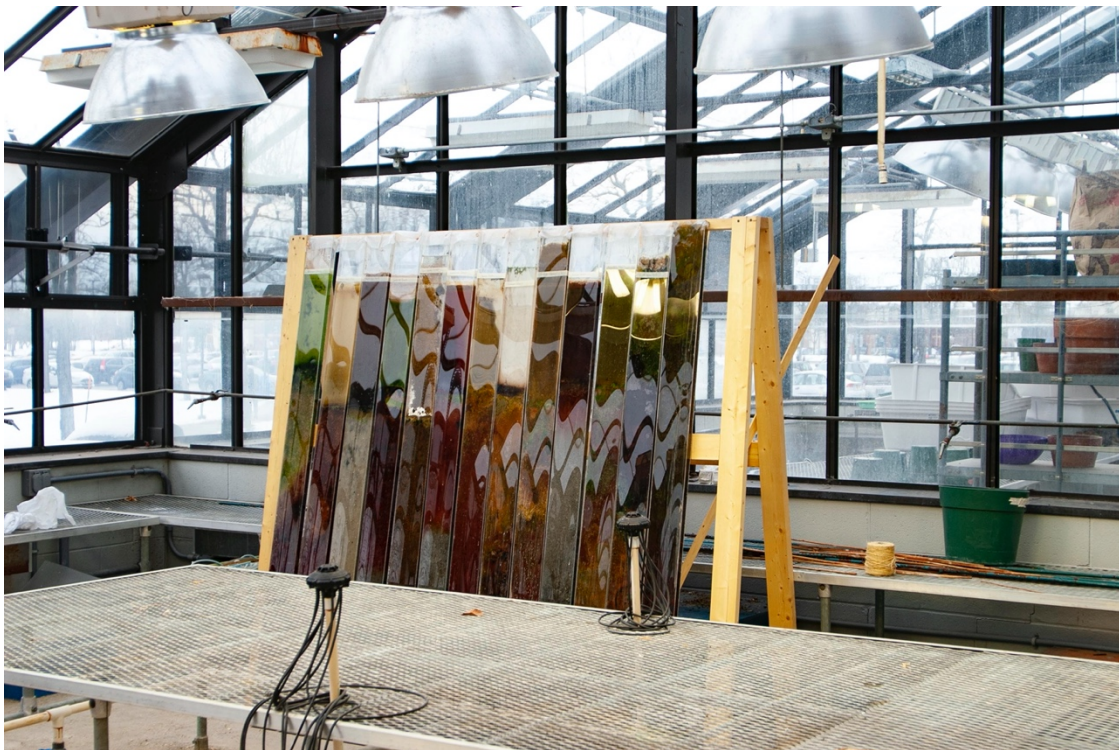


Figure 39: Lake Ontario Portrait, 2017 - present, growing in the Dorsheimer Laboratory/ Greenhouse at the University at Buffalo, Photo and artwork by author.

³⁷² Dr. Barry James, "Bioart in Greenhouse," January 14, 2017.

Another valuable experience during the residency was conducting my own lab work. As part of the project I was interested to discover what was actually growing inside the columns. From visual analysis based on Winogradsky's method I could tell very generally what was present: for example, Cyanobacteria will appear green and grow near the top of the sculpture where it has more access to oxygen. However, I wanted to gain a deeper understanding of the microbial life inside the artwork and my collaborators suggested we use DNA analysis. Once the sculptures had begun showing significant signs of growth I took samples from near the top and bottom of each column. The plan was to prepare these samples by isolating the DNA and then to send them for processing at Dalhousie University where they have the equipment to do mass spectrometry. I was invited by Dr. Sassoubre into her lab to do the DNA extraction because her space has more specialized equipment meant to work with the microbial life in water. The lab is not typically used by the bio art residents, instead it is a hard science space used for Dr. Sassoubre's research, as well as that of her graduate students. We used the "PowerSoil® DNA Isolation Kit" by MoBio to do the isolation. This kit provided all the instructions and materials necessary except for the microcentrifuge used to help break open the DNA in the samples, pipettors to precisely add solutions, and a vortex mixer to homogenize the solutions.³⁷³ The DNA samples were then frozen and sent to be processed. My samples were sent to Dalhousie University's Mass Spectrometry Laboratory.³⁷⁴ There, the purified DNA would have been placed in the mass spectrometer where DNA fragments are

³⁷³ MoBio Laboratories Inc., "PowerSoil® DNA Isolation Kit Instruction Manual" (MoBio Laboratories Inc., 2014).

³⁷⁴ Prof. Alison Thompson and Xiao Feng, "Mass Spectrometry Laboratory," Dalhousie University, Dalhousie University Department of Chemistry, n.d., <https://www.dal.ca/faculty/science/chemistry/research/dalchem-mass-spectrometry-laboratory.html>.

suspended in a vacuum chamber. The DNA is then exposed to an ultraviolet laser that accelerates the fragments towards a sensor. The molecules of the DNA are separated according to size – lighter molecules hit the sensor before heavier ones – and read by a computer. The data reveals the DNA sequence of each organism. The sequences are then cross-referenced with DNA sequence databases in order to identify species.

I felt surprisingly comfortable in the lab. Although the rules are quite different from an art space, the lab protocols set in place to keep everything sterile and safe were reminiscent of the protocols of various studios that I have worked in. Each has particular rules to follow to produce your intended results such as adding a particular amount of a solution before putting your sample into the centrifuge or making sure to spray a release agent onto a plaster mold so that your material will not stick. In both the lab and studio awareness of your physical presence in the space and the ways certain equipment should and should not be interacted with are quite similar. The repetitive actions required for the DNA extraction also aligned with the maneuvers needed to create my sculptural work. The experience reminded me of the affective and embodied nature of scientific practice that Myers references.³⁷⁵ The bodily action needed in the lab is not often discussed, as Myers highlights in her book *Rendering Life Molecular*, the physical presence of being in the act of doing science is important to recognize because it gives a more embodied – rather than objectified – understanding of what the act of science is.

³⁷⁵ Natasha Myers, *Rendering Life Molecular: Models, Modelers, and Excitable Matter* (Durham: Duke University Press, 2015).

PowerSoil® DNA Isolation Kit

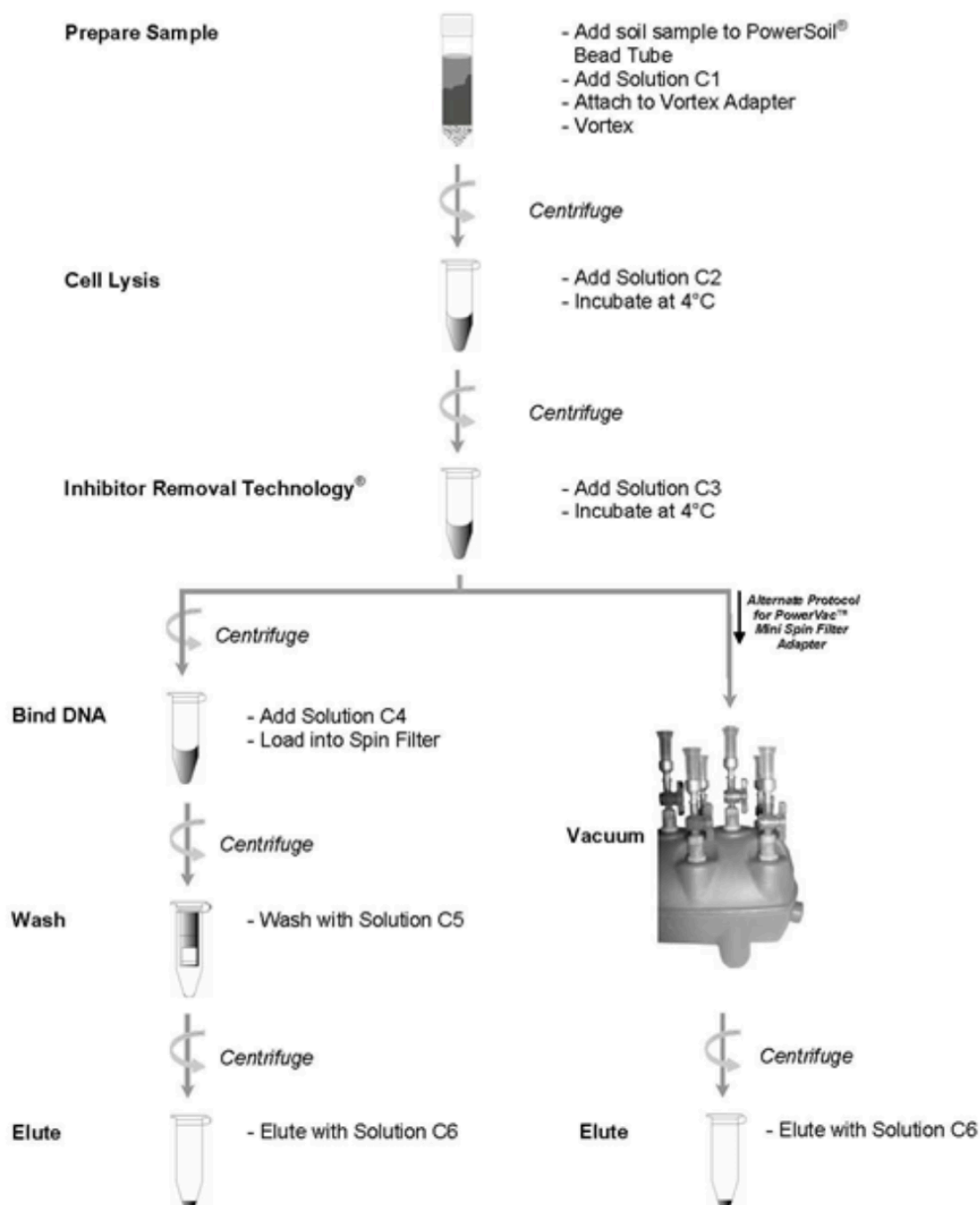


Figure 40: Procedures for the “PowerSoil® DNA Isolation Kit” by MoBio Technologies Inc.

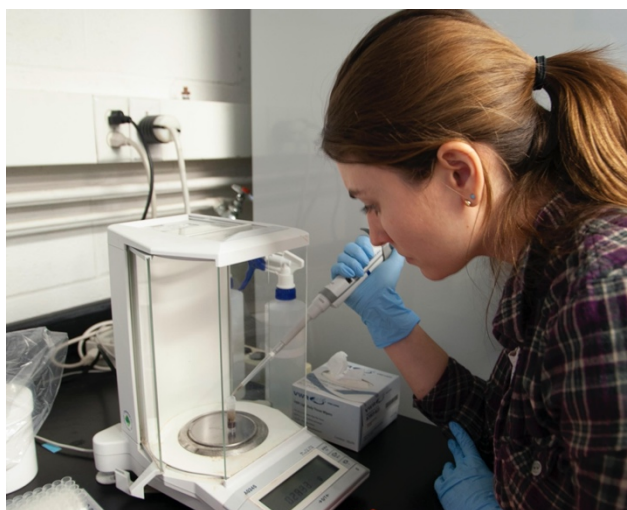


Figure 41: Dr. Sassoubre's Lab Space, 2018. Photo by the author.
Figure 42: Clouston preparing soil samples, 2018. Photo by Dr. Sassoubre.



Figure 43: Final DNA read on extraction, 2018. Photo by the author.

When the results were sent back to Coalesce after being tested at Dalhousie University there was an overwhelming amount of data that needed to be analyzed. Dr. Morse sent me the file, but there was no program on my computer that could open it. The data was processed by Dr. Morse to eliminate erroneous information, such as “cutting the ends off” of the DNA sequence where there are often errors, eliminating chimeras (two separate DNA sequences that have been mistakenly spliced together) as well as eliminating samples with too few base-pairs.³⁷⁶ The DNA sequences were then compared to an online database where existing known sequences are logged and matches were found. This process identified the Phyla, a grouping of species based on genetic similarities more specific than Kingdom, but more general than Class. The results revealed where the microbial communities in the columns maintained or increased their diversity over time. The populations in the columns have been rendered in the graph below:

³⁷⁶ Nicole Clouston, “Interview with Dr. Morse and Dr. Sassoubre”, Audio recording, August 16, 2018.

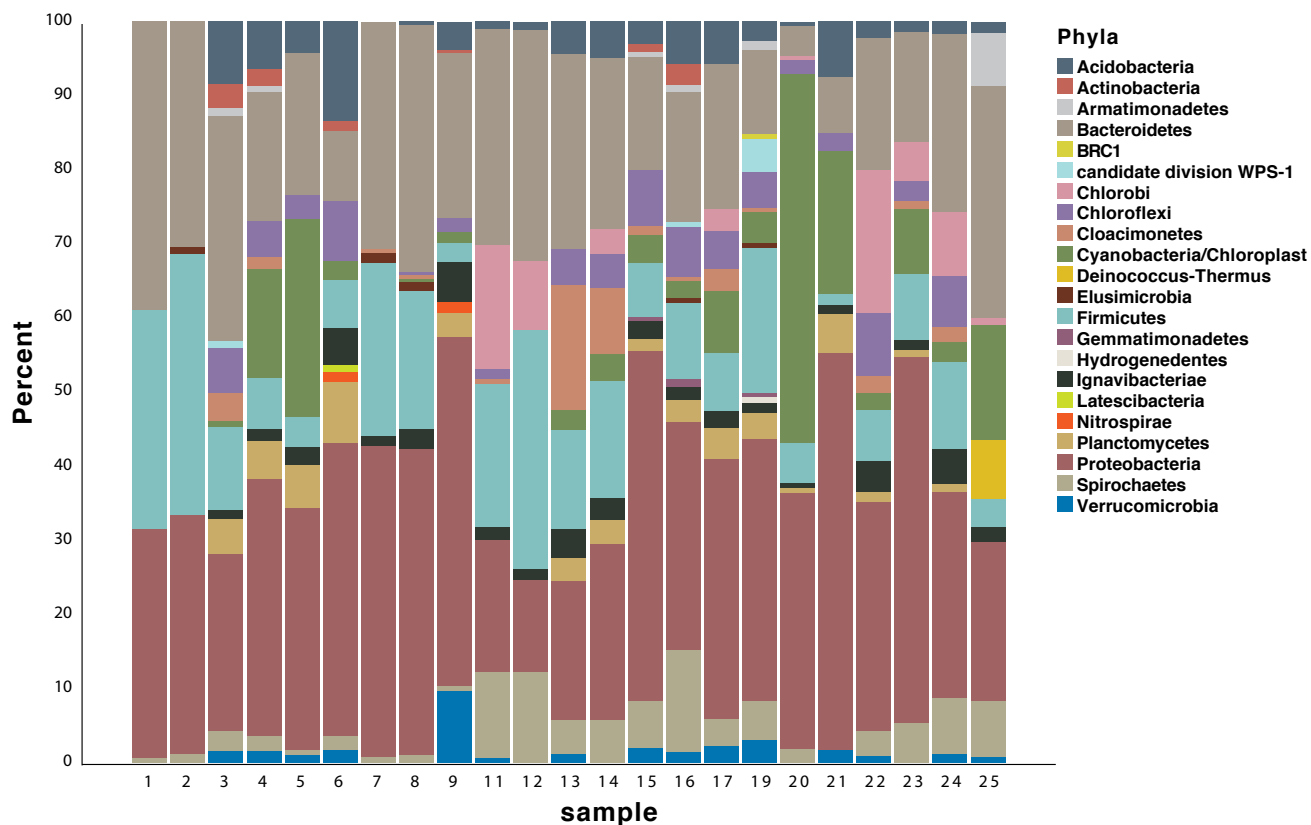


Figure 44: Diagram depicting the phyla per sample from *Lake Ontario Portrait*, 2017-present, plotted using SPSS Software and edited in Adobe Illustrator by Solon Morse, 2018

Speaking with Dr. Morse and Dr. Sassoubre about the results during an interview after the residency had ended, I received the following responses:

Dr. Morse: Yeah, the diversity inside your columns is a lot higher than what we got out of water samples too. I don't know to what extent that stuff accumulates after the fact these columns may be pulling things in – or if this is all stuff we could see from the collected mud.

Dr. Sassoubre: Soil is way more diverse than water, so it doesn't surprise me. And I think they need each other. They are making things the other one is eating so I think the whole thing would crash if too many of them weren't in there.

Dr. Morse: Yeah, there are metabolic dependencies. One will use metabolic by-products of another as the source of food.

Clouston: I was trying to describe that – exactly which bacteria are producing what waste and how that waste is picked up and used by other bacteria.

Dr. Morse: A network might be interesting. I am not sure to what extent – showing different groups connected through a network of interaction – there is probably a lot of missing knowledge too about how these things interact.^{377 378}

As I have referenced previously, the ongoing capacity for the microbial life in the sculptures to thrive has been a source of great hope on my part. Knowing that the work we are doing together supports the microbes' growth is important. Moreover, the data demonstrates that cooperation is an inherent part of living together even at the microbial level.

Another subject that we discussed during our interview was how Dr. Morse and Dr. Sassoubre thought about their experience of working with me, as well as with artists more generally:

Dr. Sassoubre: I think that one of the things that is unexpected about working with artists is actually how closely, how similar the skillset and mentality, or even personality maybe of artists and microbiologists is. I mean it's an attention to detail, it's a repetitive task thing, all of these things that I would have never thought were similar but in watching you in the lab and other people in the lab – I thought oh actually a lot of things are similar. Which I think is really cool I think that art may work better than some other meshes. I think that's pretty cool.

Dr. Morse: Yeah I think [that in] a lot of the science that I have done the interesting stuff happens by accident, because you mess up in the lab or whatever and something interesting happens and you pursue that. Even

³⁷⁷ Nicole Clouston, "Interview with Dr. Morse and Dr. Sassoubre," Audio recording, August 16, 2018.

³⁷⁸ Days before my dissertation defence, I was informed that ethics approval had not been processed in advance of this interview due to a clerical error beyond my control. The research was deemed minimal risk, I receive consent from Dr. Morse and Dr. Sassoubre, and was given permission to use the interview by the ethics board under the condition that I state it was not approved ahead of the interview.

doing ecology stuff, most of the ways in which we ended up collecting our samples were ...they weren't planned. We have figured it out by accident.³⁷⁹

Later in the discussion Dr. Sassoubre also stated:

Dr. Sassoubre: Yeah it is a lot more similar. It's nice to not be thinking about – it seems more like what academia should be right – people exchanging ideas, thinking about things in new ways, looking at things from other perspectives. Less focused on whether something is publishable or whether something is going to get you tenure.³⁸⁰

Working with myself and other artists through the residency enabled Dr. Sassoubre to shift focus from publishable research. Instead, during our work together we were all able to follow our curiosity and as Dr. Sassoubre says “look at things from other perspectives.”³⁸¹

Another insight that I gained from my time collaborating with Dr. Sassoubre and Dr. Morse is how passionately they each talk about their research. While describing how happenstance comes into scientific research, Dr. Morse discussed his time studying bat flies, he stated:

Dr. Morse: For instance, we were trying to catch bats in a cave and we were bringing bats down and getting them out of the nest and they were just covered in the flies we were interested in and we thought at first we were catching these bats that were just heavily infested. Eventually we realized that the flies were up there, flying around and we were catching the flies and the bats so eventually we stopped going for the bats and started catching flies, but it was only because we were trying to catch the bats to get the flies off of them that we realized we don't have to catch the bats, just the flies.³⁸²

Elaborating on his experience, Dr. Morse stated:

³⁷⁹ Nicole Clouston, “Interview with Dr. Morse and Dr. Sassoubre, Audio recording,” August 16, 2018.

³⁸⁰ Ibid.

³⁸¹ Ibid.

³⁸² Ibid.

Dr. Morse: Oh you have to go in a bat cave it is the most amazing experience ever. And these were caves in the tropics and they are hot caves so in the back of the cave it is sometimes close to 40 degrees Celsius and it's so humid. The climate inside the caves is driven by the bats, and these caves are often occupied from a quarter of a million to more than a million bats and it's really hot. The organisms that are in these caves there are centipedes that are 12 or 13 inches and scorpions with a leg span of ten inches that are just hanging everywhere. You are constantly brushing into them and they eat all of the cockroaches that are everywhere. You have to close your backpack if you set it down or it will fill up with cockroaches. ... You get to the back of the cave and there is this small opening that separates this big chamber from a roost at the back of the cave. In the evening the bats will start to come out and if you turn off your light there is no light you can't see anything, but there will be a quarter of a million bats flying by you, through this little opening you are standing in and it's like a river – you are walking upriver through this river of bats and they are just brushing your face and you can't see anything – it's a rustle of wing and squeaking it's unbelievable.³⁸³

The formal format of the scientific journal strips a lot of excitement away in order to clearly convey specific facts. The norms of a discipline such as the particular language of a field creates a divide while it also restricts researchers to specific methods. One can imagine a sensory interpretation of Morse's experience alongside with other modes of communication such as a journal being incredibly compelling.

Another wonderful aspect of the residency is the ongoing collaborative relationship that I was able to form with Dr. Morse, Dr. Sassoubre, as well as Paul Vanouse. I have been invited back to the lab on multiple occasions, including to host a workshop and give a talk on my research. The generative collaboration that I was able to be a part of across disciplines occurred despite differences in how we communicate and conduct research. Stretching across divides to work collaboratively is even more tenuous when working with non-human life such as microbes.

³⁸³ Nicole Clouston, "Interview with Dr. Morse and Dr. Sassoubre," Audio recording, August 16, 2018.

Collaborating with Non-Humans

Care of earth, care of people, return of the surplus.

—Permaculture Design Group,
Permaculture Ethics

Agency is about response-ability, about the possibilities of mutual response, which is not to deny, but to attend to power imbalances.

— Karen Brad, *New Materialism:
Interviews & Cartographies*

Working with microbes has made my current research possible – they have become my thinking partners, guided my research-creation, and continue to live within the sculptural work I created. As art-science researcher and editor Meredith Tromble describes in her introduction to the journal “Public 59: Interspecies Communication” working across species is not a simple task. She asks, “how an exchange of thoughts, feelings, or information between a human and nonhuman can be verified, when humans rarely understand each other?”³⁸⁴ This question resonates with my own attempt to work with microbes in a manner that I feel comfortable calling collaboration. Collaborations with non-humans are complicated by differences in how we communicate and the inherent power disparities between us. Another person can give consent or end the collaboration if they want to, but microbes cannot. Although imperfect, I would argue that the attempt to understand how meaningful relationships, connections, as well as collaborations between humans and non-humans can be formed is an important task. “Contemporary artists,” Tromble states, “do their work of pushing us from the known

³⁸⁴ Meredith Tromble, “Interspecies Communication: An Introduction and Provocation,” *Public 59*, no. 59 Summer (2019):1.

towards the unknown...to stutter and stumble towards meaning.”³⁸⁵ I am moving into the unknown as I discuss the implications of calling my research-creation collaboration, alongside the many researchers that have informed my understanding, including microbial life itself. Throughout our collaboration I have asked, “What does it mean to form a meaningful relationship with non-human life?” I attempt to reconcile the power disparity between us and form a meaningful connection by caring for and about the microbial life I work with.

In her book *Matters of Care*, Maria Puig de la Bellacasa describes care as:

... much more than a moral stance; it involves affective, ethical, and hands-on agencies of practical and material consequence. Another critical dimension of this generic conception is the accent on care as vital in interweaving a web of life, expressing a key theme in feminist ethics, an emphasis on interconnection and interdependency in spite of the aversion to “dependency” in modern industrialized societies that still give prime value to individual agency.³⁸⁶

Care, as it is understood here, is capable of extending ties and enmeshing, or interweaving, actors.³⁸⁷ Caring can be a catalyst for change, but Puig de la Bellacasa also stresses that ‘care’ is not an innocent term:

...care in nature-cultures cannot be purged from its predicaments: for example, the tendency to pastoral paternalism, the power it gives to care takers, and the unequal depletion of resources it implies in existing divisions of labor and exploitation of nonhumans and humans.³⁸⁸

³⁸⁵ Meredith Tromble, “Interspecies Communication: An Introduction and Provocation,” *Public* 59, no. 59 Summer (2019): 4.

³⁸⁶ Maria Puig de la Bellacasa, *Matters of Care: Speculative Ethics in More Than Human Worlds*. (Minneapolis: University of Minnesota Press, 2017):164.

³⁸⁷ Ibid.

³⁸⁸ Ibid.

She argues that care does not need to be reclaimed from these “impurities,” but from its oversimplification “whether by idealizing or denigrating it.”³⁸⁹ Care between myself and the microbial life in my sculptures is not an act of idealized love or of obligation. Instead, care between us is a set of constantly negotiated and thoughtful interactions. The task of care requires me to “stay with the trouble” by “learning to be truly present,” to employ two notions proposed by Donna Haraway. Caring in my work is an active engagement that does not turn away from the contradictions, discrepancies, and difficulties present in care.³⁹⁰

Care can take many forms – caring about, caring for, being given care – each with its own characteristics and potential for “practical and material consequence.”³⁹¹ Feminist scholars Joan Tronto and Bernice Fischer³⁹² in their influential work on care, distinguish between ‘caring about’ and ‘taking care of’:

Whereas caring about someone or something does not necessarily involve any overt action, *taking care of* implies the responsibility for initiating and maintaining caring activities. (People may care about the suffering of those they see of television and in the streets but do nothing about it.) Taking care of requires more continuous time spent and more explicit knowledge of the situation than does caring about.³⁹³

I *care about* microbes through contemplating them and empathizing with them, but importantly I also *take care of* microbes through interacting with them daily and

³⁸⁹ I Maria Puig de la Bellacasa, *Matters of Care: Speculative Ethics in More Than Human Worlds*. (Minneapolis: University of Minnesota Press, 2017):11.

³⁹⁰ Donna Haraway, *Staying with the Trouble: Making Kin in the Chthulucene (Experimental Futures)* (New York: Duke University Press, 2016): 1.

³⁹¹ Maria Puig de la Bellacasa. *Matters of Care: Speculative Ethics in More Than Human Worlds* (Minneapolis: University Of Minnesota Press, 2017): 4.

³⁹² I was led to the writings of Joan Tronto and Bernice Fischer through Puig de la Bellacasa’s work on care

³⁹³ Berenice Fisher and Joan Tronto, “Toward a Feminist Theory of Caring,” in *Circles of Care: Work and Identity in Women’s Lives*, ed. Emily K Abel and Margaret K. Nelson (New York: State University of New York Press, 1990): 42.

remaining attuned to their needs. I take care of the microbes by providing light, keeping the microbes warm, changing the parafilm that keeps them moist, and adding more water when needed in response to any shifts I notice. Changes in their appearance or behavior are how the microbes and I communicate. Their vibrancy or lack thereof, amount of gas being produced, height of the water, scent, expansion and contraction of colonies – all provide information that I respond to by taking care of.³⁹⁴ Over the course of our relationship I have become a better caregiver. I have developed my ability to listen to what the microbial life has to say and know what to do in response. Tronto and Fisher believe that to take care of “some one or some thing or some situation we need to know enough to predict or try to guess at the outcome of our intervention.”³⁹⁵ In order to “know enough” I need to constantly reassess my relationship with the microbial life.³⁹⁶ I spend time being with them, maintaining them, and communicating with them. Knowing enough to take care of non-humans also requires taking the time to care about them. This involves empathizing with, contemplating, and attempting to understand their perspective.

Understanding the point of view of microbial life is challenging because microbes experience our environment very differently than I do. Biologist Jakob von Uexküll describes these differences in experience as the “*umwelt*” – a living thing’s subjective world.³⁹⁷ In his ground-breaking 1934 text *A Foray Into the Worlds of Animals and*

³⁹⁴ Information is defined by the Oxford English Dictionary as “what is conveyed by a particular arrangement or sequence of things.”

³⁹⁵ Berenice Fisher and Joan Tronto, “Toward a Feminist Theory of Caring,” in *Circles of Care: Work and Identity in Women’s Lives*, ed. Emily K Abel and Margaret K. Nelson (New York: State University of New York Press, 1990): 42.

³⁹⁶ Ibid.

³⁹⁷ Berenice Fisher and Joan Tronto, “Toward a Feminist Theory of Caring,” in *Circles of Care: Work and Identity in Women’s Lives*, ed. Emily K Abel and Margaret K. Nelson (New York: State University of New York Press, 1990): 42.

Humans Uexküll argues that an animal's environment is vital to understanding the animal itself. He believes that biological differences between animals mean that each living being experiences their environment uniquely:

... the space peculiar to each animal, wherever that animal may be, can be compared to a soap bubble which completely surrounds the creature at a greater or less distance. The extended soap bubble constitutes the limit of what is finite for the animal, and there with the limit of its world; what lies behind that is hidden in infinity.³⁹⁸

The physical apparatuses the living being has to perceive the world, as well as its motives, shape its umwelt. What drives the microbial life within my sculptures and how do they experience these environments I instigated? I can speculate about what it would mean to experience the world through the microbial umwelt, but these speculations will always be tainted by my inability to shed my human way of being. Queer theorist José Esteban Muñoz argues that attempts to understand the non-human may not be fully possible, but are still important.

The fact that this thing we call the inhuman is never fully knowable, because of our own stuckness within humanity, makes it a kind of knowing that is incommensurable with the protocols of human knowledge production. Despite the incommensurability, this seeming impossibility, one must persist in thinking in these inhuman directions.³⁹⁹

Meredith Tromble also argues that the attempt is important because of the positive change that trying to communicate can create:

³⁹⁸ Berenice Fisher and Joan Tronto, "Toward a Feminist Theory of Caring," in *Circles of Care: Work and Identity in Women's Lives*, ed. Emily K. Abel and Margaret K. Nelson (New York: State University of New York Press, 1990): 42.

³⁹⁹ José Esteban Muñoz, "Dossier: Theorizing Queer Inhuman-Isms," *GLQ: A Journal of Lesbian and Gay Studies* 21, no. 2 (2015): 209.

The importance of that effort, and what is not at all ridiculous about radically extending our attention to other forms of being, are the tiny changes this effort makes in us. Imagining ourselves into communication with other species exercises our ability to notice, to evaluate, to interpret unfamiliar events. It requires a modest estimation of our own importance, an openness to the desires and interests of other beings. Practicing these human capacities ... is an assured benefit ... Perhaps the intraspecies languages that some humans made such a point of pride for our kind are just a starting point; stimulated by the dream of interspecies communication we can access more channels of exchange and richer communicative capacities⁴⁰⁰

Although it may not be possible to fully understand what it is to be a microbe or to straightforwardly communicate with non-humans, the attempt can push us toward a different way of knowing. This kind of deep contemplation also attunes us to the non-human experience.⁴⁰¹ Ethnologist Vinciane Despret believes that through collaboration, the human and non-human participants are “rendering each other capable” of doing more than either could alone.⁴⁰² While I am impacting the microbial life in the sculptures, they are simultaneously impacting me by literally coming into contact with my body as well as shifting how I understand the world around me. I am “rendered capable” by our relationship.⁴⁰³ Without the influence of microbial life I would be unable to conduct the research that I have been engaged in throughout this dissertation. On a more intimate level, I would be unable to survive without the impact of my microbial thinking-partners.

⁴⁰⁰ Meredith Tromble, “Interspecies Communication: An Introduction and Provocation,” *Public* 59, no. Summer (2019):13.

⁴⁰¹ José Esteban Muñoz, “Dossier: Theorizing Queer Inhuman-Isms,” *GLQ: A Journal of Lesbian and Gay Studies* 21, no. 2 (2015): 209.

⁴⁰² Vinciane Despret, “The Becoming of Subjectivity in Animal Worlds,” *Subjectivity*, Palgrave Macmillan Ltd, 23 (2008): 127

⁴⁰³ Ibid.

Artists Collaborating with Non-Human Life

To gain a deeper understanding of the complicated relationships formed when working with non-humans I will look at four contemporary artists' practices, Aganetha Dyck, Hubert Duprat, Maria Peñil Cobo, and Kathy High. Each artist has produced a body of work alongside non-humans with varying degrees of care or consideration given to their collaboration. The work of these researchers also contextualizes my own struggle to form a collaborative way of working with microbial life.

Aganetha Dyck

Winnipeg-based artist Aganetha Dyck is known for her collaborative work with honeybees. Dyck places found objects such as porcelain figurines, paper covered hangers, and shoes inside honeybee apiaries. Over months, and sometimes years, the bees lay down honeycomb on the object's surface. The results are collaborative sculptures that transform the original objects. Dyck hopes the artworks will incite conversations about the entwined fate of bees and humans.⁴⁰⁴

Dyck demonstrates deep care for, and about, the bees she works with. In an interview, Dyck expressed her affection for the bees saying that "... they are warm, they smell wonderful, they look gorgeous, and they are just the best pollinators in the world"⁴⁰⁵ going on to conclude, "I have great respect for the honeybees."⁴⁰⁶ It is clear Dyck treats the bees as vital partners in the artistic process.

⁴⁰⁴ "Interview with Aganetha Dyck: Canadian Visual Artist," *Mason Studio* 14, no. 10 (2011), <http://www.mason-studio.com/journal/2011/10/interview-with-aganetha-dyck-canadian-visual-artist/>.

⁴⁰⁵ Sook-Yin Lee, "Artist Aganetha Dyck Collaborates with Bees," *Definitely Not the Opera* (CBC Radio Canada, May 22, 2015), <http://www.cbc.ca/player/play/2667722407>.

⁴⁰⁶ Ibid.

Dyck also recognizes that deep knowledge about honeybees is essential to her ability to take care of them, and therefore her ability to collaborate with them. She states, “communication and collaboration with the honeybees begins with the acknowledgment and understanding of their ways of existing and their methods of working.”⁴⁰⁷



Figure 44: Masked Ball Series, *Promenade Princess*, Masked Ball Series, 2008, Aganetha Dyck. Photo by Peter Dyck

Dyck has gained knowledge from texts, her peers in the bee keeping community, as well by spending time with the bees. Every day during their collaboration Dyck would create drawings of the honeybees as a form of “devotional practice.”⁴⁰⁸ The daily ritual of being

⁴⁰⁷“Interview with Aganetha Dyck: Canadian Visual Artist,” *Mason Studio* 14, no. 10 (2011), <http://www.mason-studio.com/journal/2011/10/interview-with-aganetha-dyck-canadian-visual-artist/>.

⁴⁰⁸ Serena Keshavjee, “Aganetha Dyck,” *Border Crossing*, 2002: 2.

with the bees was not necessary for the creation of artwork, but Dyck believes was essential to maintaining their collaborative relationship.

Dyck collaborated with honeybees for twenty-three years. During that time, she continued to negotiate her collaborative relationship with them by reassessing what was best for the bees. When Dyck discovered that the bees were overexerting themselves, in making too much honeycomb, she began reducing the amount of time each object spent in the apiary. She also began to curate the objects she introduced more carefully as she discovered certain materials, such as fur, would agitate the bees. Dyck was willing to adapt her practice to better suit her collaborators, demonstrating her attentiveness and care.

Dyck's practice changed in response to her collaborators again in 2010 when she developed a severe allergy to bee stings. No longer able to interact with the bees directly Dyck attempted to maintain their collaboration by asking other beekeepers to interact with them in her place. This mediated collaboration produced what she considered to be interesting sculptural objects, but Dyck no longer felt she "was close enough, even though the work was successful."⁴⁰⁹ While she still cared about the bees, she was incapable of taking care of them – which led to the difficult decision to end her long-standing collaboration.

In her current body of work Dyck uses discarded feeder boards and other objects from the activity of beekeeping to create sculptures. Despite no longer directly collaborating with the bees, and instead working with objects that surround them, Dyck

⁴⁰⁹ Sook-Yin Lee, "Artist Aganetha Dyck Collaborates with Bees," *Definitely Not the Opera* (CBC Radio Canada, May 22, 2015), <http://www.cbc.ca/player/play/2667722407>.

says that their relationship “...continues, but in a different way.”⁴¹⁰ Aganetha Dyck’s collaboration with honeybees, and her decision to change the nature of their work together, demonstrates a responsible way to work with non-humans.

It is also important that I consider what happens to the artwork and the microbes in it when I am no longer able to care for them. In circumstances where I could not maintain the sculptures any longer, the mud has been returned to the lake where it originally came from. Returning the mud seems the most just action that can be taken if I cannot continue our collaboration. In regards to *Lake Ontario Portrait* (2017 – present) this has not yet become necessary. However, when I created a body of work for the Dunlop Gallery in Regina, I was unable to support the microbial life after the exhibition. The mud, microbes, and water were returned to the environment it came from.

Hubert Duprat

French sculptor Hubert Duprat also works with non-human life. This work began when he learned that caddisfly larvae could use spectacular material such as gold and jewels to construct their shells instead of the typical rocks and wood fragments. To create his sculptures Duprat collects caddisfly larvae, removes the protective tubes they have constructed for themselves, and places them in a tank filled with precious materials. Duprat says that he “decided to place the larva in a sort of laboratory, in which they have no choice but to construct their cases out of gold, because I deprived them of all other materials.”⁴¹¹ Duprat uses the larvae to make his sculptures, but does not consider them

⁴¹⁰ Tess Edmonson, “Aganetha Dyck: A Hive of Activity,” *Canadian Art*, August 25, 2011, https://canadianart.ca/features/aganetha_dyck/.

⁴¹¹ Norfolk Museums and Archaeology Service, *Hubert Duprat*, 2011, <https://www.youtube.com/watch?v=e78hni1LoSo>.

beyond their ability to build his forms. He describes himself as “an architect who has builders carry out his work.”⁴¹² Although Duprat takes care of the larvae by keeping them alive, his care is motivated by the larvae’s ability to serve him. Focusing on the benefit, or what taking care of will do for you as an individual and not a collective “... reduces care from a co-constructed interdependent relation into mere control of the *object* of care.”⁴¹³ The relationship the artist formed with the larvae seems exploitative because he does not actively care about, or consider the larvae’s interests in their work together.



Figure 45: Duprat’s aquatic caddis fly larvae, with cases incorporating gold, opal, and turquoise, among other materials, 2015. Photo by Jean-Luc Fournier.

In conversation with Duprat, French art critic Christian Benson described the artist’s intervention as a disruption that provokes the larvae:

⁴¹² Norfolk Museums and Archaeology Service, *Hubert Duprat*, 2011, <https://www.youtube.com/watch?v=e78hni1LoSo>.

⁴¹³ Maria Puig de la Bellacasa, *Matters of Care: Speculative Ethics in More Than Human Worlds*. (Minneapolis: University Of Minnesota Press, 2017):186.

Your activity as an artist, upsetting the ordinary ethology of the insect, seems to me to be the same thing as introducing a noise, complicating its umwelt and producing a response ...the caddis worm is merely the executor of the artist's project.⁴¹⁴

Duprat replied that the artwork is “still a long way from bringing the subject full circle.”⁴¹⁵ In this project, value is defined entirely by the artist. The artist did not treat the caddisfly larvae as living beings worthy of care. When working together it is important to differentiate between exploitation and collaboration; one strengthens our ties, while the other reinforces hierarchies that place human interest above that of non-humans.

Maria Peñil Cobo

Maria Peñil Cobo is a Spanish born artist currently based in Massachusetts who creates petri dish paintings of cells, neurons, flowers, and jellyfish. She describes her process as painting with microbes on agar canvases. When she deems the image complete she seals the dish with epoxy.⁴¹⁶ Peñil Cobo is interested in revealing the aesthetic merits of microbes while also combating the negative public perceptions of them.⁴¹⁷ It is clear the artist cares for and about the microbes through culturing specific strains that have vibrant colours, encouraging conditions for their growth while she is painting, and striving for greater understanding of microbial life's integral role in our environment. The work showcases the incredible range of hues that microbes can create, but the project does not allow microbial life to assert its agency. The microbes in the petri dishes are used for

⁴¹⁴ Simon Pleasance, trans., “The Wonderful Caddis Worm: Sculptural Work in Collaboration with Trichoptera,” *Leonardo* 31, no. 3 (July 1998): 176.

⁴¹⁵ Ibid.

⁴¹⁶ Maria Peñil Cobo, Artist's Website, “Maria Peñil Cobo”, n.d., <http://mariapenilcobo.com/>.

⁴¹⁷ Maria Peñil Cobo, “Bacteria Is Beautiful” (Artist Talk, TEDx, Columbia College Chicago, 2016), <http://www.tedxcolumniachi.com/>.

their natural pigmentation, but manipulated into representational forms that human viewers will recognize. This practice of painting with microbes often has the ability to start conversations, but I believe that it fails to deeply consider the microbial perspective.⁴¹⁸



Figure 46: *Cell to Cell*, 2015, Maria Peñil Cobo

My work with microbial life has at times been compared to microbial painting because both have a variety of hues grown and presented across a picture plane. I could attempt to control the microbial life and its appearance – isolating species and reintroducing them as I see fit; however, this would deny the microbes’ agency. Creating space for the microbes to grow allows me to build a dialogue with them rather than

⁴¹⁸ Vinciane Despret, “Thinking Like a Rat,” *Journal of the Theoretical Humanities* 20, no. 2 (2015).

having a one-sided conversation. Through this type of working together, my aim is to encourage thoughtful relationships with non-human life more broadly.

Kathy High

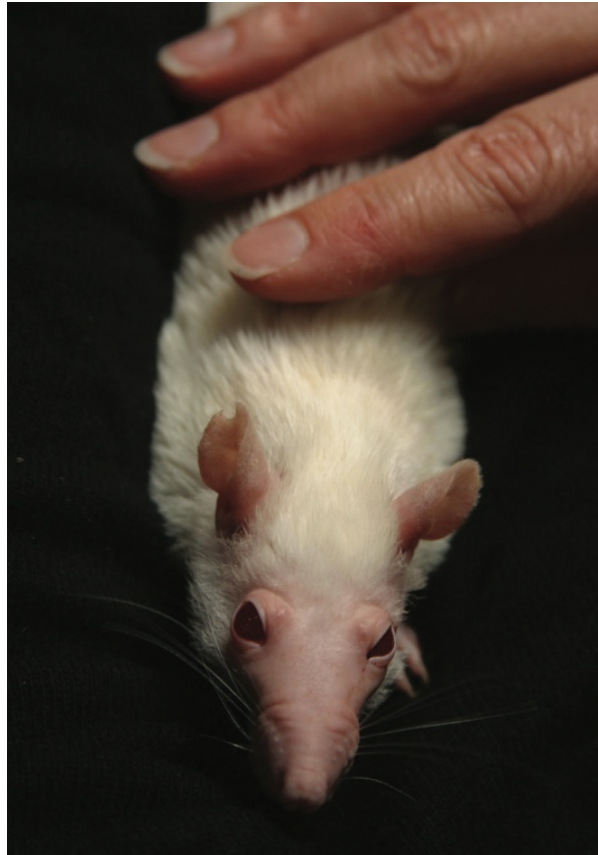


Figure 47: Kathy High with Flowers Rat. Still from project: *Embracing Animal*, Kathy High, 2004-2006. Photo by Olivia Robinson.

Kathy High is an American interdisciplinary artist who has explored human/non-human collaborations through her work with rats. In *Embracing Animal* (2004-2006) High lived with three rats named Matilda, Tara, and Star that had human DNA inserted into their genome. This genetic alteration made the rats predisposed to autoimmune

disease so they could be used to study human rheumatic disorders. After their time as laboratory specimens, High adopted the three rats. During the collaborative project High cared for the rats in her home and subsequently in gallery spaces until their death. Of her personal experience with the rats, High wrote:

I bought them to conduct research and to treat them holistically with alternative medicines, environmental enrichment, good food, and play. I want to relate to them because I, too, have autoimmune problems ...I feel some kind of strange kinship with them...They are extensions, transformers, transitional combined beings that resonate with me in ways that other animals cannot-because of that small addition of human DNA. These rats and I are engaged in like systems and routines of health and sickness. ... We will collaborate and make up our own rules.⁴¹⁹

The installation that resulted as part of their collaboration, in High's words, "honored our kinship with our transgenic animal partners."⁴²⁰ The artwork enabled viewers to encounter the rats and to consider how we relate to non-humans – in particular non-humans made to be sick for humanity's benefit.

High's aim throughout the project was to be an active care giver, to minimize any suffering the rats experienced and to provide a good quality of life. Hearing High speak about this project, her immense empathy for the rats is apparent.⁴²¹ The rats have passed away, but High acknowledges that her care for and about the rats enabled them to live two years longer than anticipated.⁴²² This level of caring about and for is also evident in the emails High would receive from the assistant curator at MASS MoCA, Molly

⁴¹⁹ Kathy High, "Playing with Rats," in *Tactical Biopolitics: Art, Activism and Technoscience*, ed. Beatriz da Costa and Kavita Philip (Boston, MA: MIT Press, 2008) 466.

⁴²⁰ Kathy High, "Embracing Animal," Artist's Website, Kathy High, accessed January 7, 2020, <https://www.kathyhigh.com/projects/embracing-animal/>.

⁴²¹ Kathy High, "The Welter of Being: Interspecies Communication and the Expanded Mind," in *Out of Mind* (32nd Annual Meeting of the Society for Literature, Science, and the Arts, Toronto, 2018).

⁴²² Kathy High, "Playing with Rats," in *Tactical Biopolitics: Art, Activism and Technoscience*, ed. Beatriz da Costa and Kavita Philip (Boston, MA: MIT Press, 2008): 475.

O'Rourke, while they hosted the rats. These emails updated High about each individual's wellness including the gallery giving each rat "eyebright tea to soothe eyes" and watching their treat intake to avoid too much weight gain.⁴²³ The artist's act of caring for the rats is essential to the resonance of the artwork. It is also crucial that High does not simplify her relationship with the rats. She acknowledges the inability to fully understand one another while maintaining her conviction that working together through acts of care is impactful: "Through a process of empathy, and identification, and in a gesture of revolt, our act of caring for transgenic rats honors our confused relationship."⁴²⁴ Ethnologist Vinciane Despret, who has worked extensively with animals bred for experimentation, stresses the importance of researchers considering the perspective of non-humans.⁴²⁵ Despret points out that animals, like human research subjects, are canny observers and that these research subjects often have a good idea of what the research is designed to reveal, "regardless of the lures, dissimulation, and other tools used to mask the true questions."⁴²⁶ Good research can only happen when we ask stimulating questions that give animals a chance to demonstrate their interests. Despret argues that providing non-humans with the opportunity to respond is a vital part of working with them.

⁴²³ Kathy High, "Playing with Rats," in *Tactical Biopolitics: Art, Activism and Technoscience*, ed. Beatriz da Costa and Kavita Philip (Boston, MA: MIT Press, 2008): 475.

⁴²⁴ Ibid: 471.

⁴²⁵ Despret speaks specifically about researchers in scientific fields, but her concepts can be extended to all work with non-humans.

⁴²⁶ Vinciane Despret, "Thinking Like a Rat," *Journal of the Theoretical Humanities* 20, no. 2 (2015): 121.

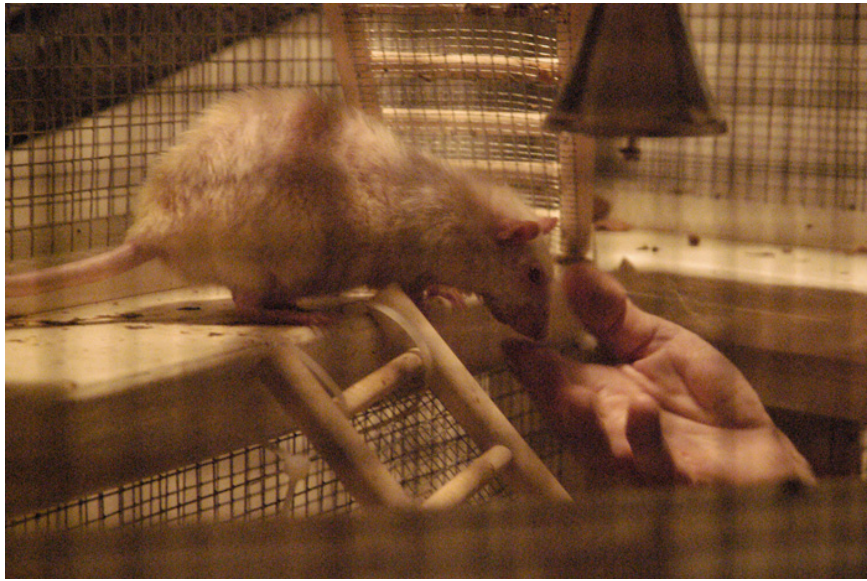


Figure 48: *Embracing Animal*, 2004 - 2006, Kathy High



Figure 49: *Embracing Animal*, 2004 - 2006, Kathy High

In her article “Thinking Like a Rat”⁴²⁷ (2015), Despret questions what a maze can mean to a rat and how the rat can respond:

The maze can authorize neither the question of the “familiar path” nor that of the meaning of the wall, still less its meaning as event in the world of a rat. It forbids doing so all the more surely since it is constructed in such a way that this question cannot be opened, since the rat cannot do other than follow along the walls. And when an animal cannot do other than what he is constrained to do, when he does so only because he does not have other possibilities or other choices, then there is a certitude: this has to do with an artefact.⁴²⁸

The maze is an artefact – an object made by a human being – that is not shaped by the rat’s interests. The maze is so restrictive, and ignorant of the rat’s point of view, that the rat can only give one answer. In dramatic contrast, the environment that High created for her rats is based on care, adapted to the rats’ needs, not to the human’s. The aim of my project is similar to High’s, to enable an encounter with the non-human that is structured around care. As theorist Irina Aristarkhova states, “The suffering of those specific rats was [High’s] main concern and her artistic and (I would argue, equally) ethical response was to find a way to provide them with some relief and refuge.”⁴²⁹ Although High introduced the rats into a human-made environment, that space was created to provide as much comfort to the rats as possible while also creating the conditions for meaningful public encounters.

Similar to the rats in *Embracing Animal*, the microbes live in the artefacts I built: a series of six-foot tall, clear, polycarbonate prisms. Moreover, like High’s rat

⁴²⁷ Despret’s title alludes to the famous article “What Is It Like to Be a Bat?” a paper by American philosopher Thomas Nagel, first published in *The Philosophical Review*, in October 1974

⁴²⁸ Vinciane Despret, “Thinking Like a Rat,” *Journal of the Theoretical Humanities* 20, no. 2 (2015): 128.

⁴²⁹ Irina Aristarkhova, “Hosting the Animal: The Art of Kathy High,” *Journal of Aesthetics & Culture* 2, no. 1 (2010): 9.

environment, the prisms have been built to align with the microbes' umwelt. The height of the prisms creates an oxygen gradient that allows anaerobic microbes, which need to live in a low-oxygen environment, to grow near the bottom of the sculpture. Aerobic microbes that need a high oxygen environment can grow near the top of the sculpture. Each prism is filled with mud and water from the same location on the shore of Lake Ontario as the microbes – mimicking their lake environment and ensuring that a community of enmeshed microbial colonies can continue to grow together. Inside the prisms, the microbial life continues to function as part of an ecosystem that relies on all of its community members to sustain itself. I set the ecosystem inside the sculpture into motion and then the microbial life takes over.

The prism defines the physical space of the microbes by restricting them inside, but it also supports their growth. The increased light the microbes are exposed to and the seed of calcium carbonate, sulfur, and cellulose they are fed when first placed in the prism, enable them to grow in vast numbers and sustain their growth over time. The prism becomes a way to make their presence seen as well as felt. The microbes' ability to grow beyond what they could without our collaboration is one benefit of our work together.

Making this body of artwork has never been a unidirectional flow of my actions impacting the microbes or my ideas dictating the line of inquiry, but a “mutually constitutive working out, and reworking” between the microbes, the mud, the sculptures, Lake Ontario, and I.⁴³⁰ It is through our intra-actions that the artwork and texts surrounding it have come to exist and matter. Barad develops her theory of intra-action in

⁴³⁰ Karen Barad, *Meeting the Universe Halfway* (London: Duke University Press, 2007): x.

her book *Meeting the Universe Halfway*. Intra-action, unlike interaction, emphasizes the enmeshed, entangled nature of all things:

Existence is not an individual affair. Individuals do not preexist their interactions; rather, individuals emerge through and as part of their entangled intra-relating. Which is not to say that emergence happens once and for all, as an event or as a process that takes place according to some external measure of space and of time, but rather that time and space, like matter and meaning, come into existence, are iteratively reconfigured through each intra-action, thereby making it impossible to differentiate in any absolute sense between creation and renewal, beginning and returning, continuity and discontinuity, here and there, past and future.⁴³¹

The world is created through this ongoing meaning making of subjects and objects mutually intra-acting. The microbial life and I shape and are shaped by our work together.

I am not only intra-acting with my microbial collaborators when we work together. I am also intra-acting with the microbes around, on, and inside me; Lake Ontario, the history of the lake, the land surrounding it, and the time that shapes it; the human-made materials I sculpt with such as polycarbonate, and methylene chloride; the institution of the university I am working within; and many more actors. Our work together reminds me of the many ties that connect us all in our enmeshed existence. Through collaborative work, “the value or energy gained does not simplistically flow in one direction, but responds and adapts to different forces, invitations and externalities.”⁴³²

⁴³¹ Karen Barad, *Meeting the Universe Halfway* (London: Duke University Press, 2007): ix.

⁴³² Karen Savage and Dominic Symonds, “Conclusion,” in *Economies of Collaboration in Performance* (Cham: Palgrave Macmillan, 2018): 283.

In her book *Rendering Life Molecular*, Myers develops the concept of “intra-animacy”.⁴³³ Building off of Barad’s intra-activity, intra-animacy refers to the mutual shaping and animation of a protein modeler and their protein. Myers states, “intra-animacy is generated in contexts where bodies are open to move with and be moved by one another.” In the act of creating three-dimensional models, the modelers need to come to know their collaborator – a lively and complex protein – intimately. In coming to know enough they often involve their bodies, “kinesthetically” activating and being activated by the proteins:

The modelers here are not the sole directive force inscribing the relation: they don’t simply impose animistic or humanistic qualities on molecules; rather, theirs is a “process of attunement” or emulation through which they become receptive and responsive to the subtleties of molecular energies and movements. Perhaps it is by giving themselves over to the labor of making models and animations that they learn how to *move with and be moved by* molecular phenomena.⁴³⁴

The relationship described by Myers is characterized by reciprocity and mutual agency. As Bellacasa states, in intra-active worlds, “it is not only the experimenter/observer/human agent who sees, touches, knows, intervenes, and manipulates the universe...”⁴³⁵ Intra-animacy and intra-action acknowledge the powerful agency of non-humans.

Encouraging my microbial collaborators to assert their agency has been a key aspect of my collaborative work. Recognizing our intra-animacy is another way I can

⁴³³ Natasha Myers, *Rendering Life Molecular: Models, Modelers, and Excitable Matter* (Durham: Duke University Press, 2015): 211.

⁴³⁴ Ibid: 205.

⁴³⁵ Maria Puig de la Bellacasa, *Matters of Care: Speculative Ethics in More Than Human Worlds* (Minneapolis: The University of Minnesota Press, 2017): 114.

maintain our collaborative relationship. I need to remain “receptive and responsive” to my non-human collaborators so that I can “move with and be moved by” the microbes.⁴³⁶ Through the concept of intra-animacy I can understand that my actions – building homes for the microbes, collecting material from Lake Ontario, everyday acts of care – are not exclusively ways in which I impact microbes, but also the microbial life animating me. Acknowledging the blurring between who is animating whom in our intra-animacy is another way that I can build meaningful relationships. To intra-animate is to be enmeshed.

III. Collaborating with the public

Involved knowledge is about *being touched* rather than observing from a distance.

– Maria Puig de la Bellacasa, *Matters of Care*

Through playful engagement with each other, we get a hint about what can still be and learn how to make it stronger.

– Donna Haraway, *A Giant Bumptious Litter*

Collaborating with the public through workshops has become a way to invite meaningful discussions of my research. Visual art workshops often offer an introduction to a particular material, such as printmaking, line drawing, or ceramics. Workshops can simultaneously be a demonstration of a new way of making, as well as a site for important conceptual engagement. In my practice, workshops have become a means to communicate, connect, and exchange knowledge.

⁴³⁶ Natasha Myers, *Rendering Life Molecular: Models, Modelers, and Excitable Matter* (Durham: Duke University Press, 2015): 205.

There are many researchers who have found workshops to be a beneficial way to share their research with the public. Toronto based bio artist Tosca Terán has presented numerous workshops on working with fungi. Her most recent, “Multi-Species Entanglements: Forming with Mycelium” was held at the co:Lab nanopod studio (2020):

During this workshop, Tosca Terán introduces participants to the amazing potential of mycelium for collaboration at the intersection of art and science. Participants learn how to transform their kitchens and closets into safe, mini-Mycelium Biolabs, learn how to cultivate mycelium, and leave the workshop with a live Mycelium planter/bowl form, as well as a wide array of possibilities of how they might work with this sustainable bio-material. All materials are provided.⁴³⁷

This event taught participants how to grow mycelium in sculptural forms, while at the same time inviting conversation about the role of sustainable bio-materials. The making involved in events such as this engages participants on a physical level, allowing for another form of connection beyond viewing.

In my own practice, I have presented numerous workshops in a variety of contexts ranging from galleries to street festivals. All of the workshops invite participants to make small scale sculptures with mud and microbes.

⁴³⁷ Tosca T Terán, “Multi-Species Entanglements: Forming with Mycelium,” co:Lab nanopod studio, accessed January 21, 2020, <https://colabto.wordpress.com/2019/12/09/multi-species-entanglements-forming-with-mycelium-%e2%80%a2-working-with-environmentally-friendly-renewable-materials/>.



Figure 50: *Grand River: Mud and Microbes*. As part of “Common Waters”, Idea Exchange, 2019. Photo by Vanessa Pejovic.

For the workshop I gave at Center [3], an artist-run centre in Hamilton, Ontario (2018), I provided this description:

In this hands-on workshop members of the community and I will create sculptures that use mud as a medium in order to explore the life within it and our connection to it. Participants will be invited to pick from fifteen samples of mud collected around Lake Ontario – including samples from Hamilton, Burlington, and Oakville – and place it into clear tubes along with nutrients that support microbial growth. When exposed to light, the microbial life in the sculptures will begin to grow, and with time, form vibrant marbling across the surface. Participants will be invited to take their five-inch sculpture home and experience its growth first-hand.⁴³⁸

During the workshop, participants and I work together to create sculptures while discussing the role of microbial life in our ecosystem, the liveliness of Lake Ontario, as well as our responsibilities towards it.

⁴³⁸ Nicole Clouston, “Lake Ontario Workshop Description,” 2018.

Increasingly, calls for artworks to be exhibited or papers to be presented at conferences also ask for workshops. As part of the programming for *Common Waters* (2019) – an exhibition at Idea Exchange in Cambridge, Ontario – I presented a workshop titled “Grand River: Mud and Microbes.” The description on the gallery’s website states:

Common Waters is a community project that examines our relationship with water and provides a platform for us to discuss some of the most pressing issues of our time. This project explores diverse artistic, scientific, cultural, and personal perspectives through a curated sequence of art installations, workshops, discussions, gatherings, and excursions. These activations provide a platform for considering our shared waters through the lenses of environment, identity, history, and sustainability.⁴³⁹

Through providing “activations” of the topic in combination with an exhibition of artworks, the gallery aimed to engage more of the public in serious, but also playful, conversations.⁴⁴⁰ During my workshop participants who had signed up for the event met at the BRIDGE Centre for Architecture + Design in Cambridge near the Grand River in Cambridge. We all walked down to the shoreline of the river to collect mud from multiple locations along it. During the walk, participants shared their memories of the river, of the development that has taken place, and what architecture was there before. When we got back to the gallery space, we all worked together to create sculptures by placing our mud, along with some newspaper and crushed egg, into the small-scale columns. The exploration of the landscape, being in the presence of the river, and then collaborating on the artwork together stimulated interesting conversations surrounding our perceptions of mud, of contamination, and microbial life.

⁴³⁹ Cambridge Art Galleries, “Common Waters,” Idea Exchange, accessed January 21, 2020, <https://ideaexchange.org/art/exhibition/common-waters>.

⁴⁴⁰ Ibid.



Figure 51: *Grand River: Mud and Microbes*. As part of “Common Waters”, Idea Exchange, 2019. Photo by Vanessa Pejovic.



Figure 52: *Grand River: Mud and Microbes*. As part of “Common Waters”, Idea Exchange, 2019. Photo by Vanessa Pejovic.



Figure 53: *Grand River: Mud and Microbes*. As part of “Common Waters”, Idea Exchange, 2019. Photo by Vanessa Pejovic.

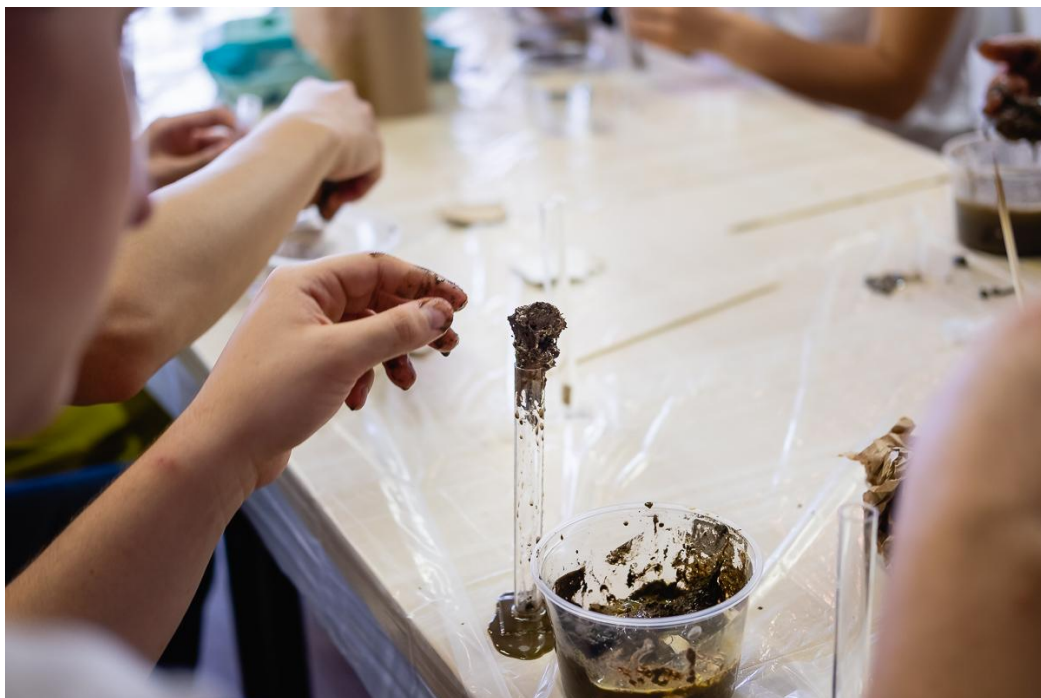


Figure 54: *Grand River: Mud and Microbes*. As part of “Common Waters”, Idea Exchange, 2019. Photo by Vanessa Pejovic.



Figure 55: *Grand River: Mud and Microbes*. As part of “Common Waters”, Idea Exchange, 2019. Photo by Vanessa Pejovic.

There have been many iterations of the workshop that are shaped by the environment it is conducted in. The location of the event determines what mud we will be working with – for example, the workshop I presented in Regina worked with mud from Wascana Lake, workshops in Toronto work with mud from Lake Ontario, and a workshop in Detroit worked with mud from the Detroit river. The fact that the participants are familiar with the body of water is important because it provides an opportunity for individuals to feel connected to the material.

Another factor that shapes the way I present each workshop is the type of space as well as amount of time available. I have hosted workshops in institutional spaces (Idea exchange, The Michigan Science Centre, Grimsby Public Art Gallery, The Saskatchewan Science Centre) as well as in public spaces (Hamilton City Hall, Supercrawl in Hamilton,

The Toronto Bentway, Life in Soil Festival in St. Catharines). During Supercrawl, a large street festival in Hamilton attended by thousands of people, participants were asked to fill larger containers (12" x 4" x 1"), that came together to form a public artwork installed in the Central Branch of the Hamilton Public Library. Similar experiences presenting the workshop at events such as the Sci Art Festival hosted at the University of Toronto, or at the Common Grounds Festival hosted by the Bentway in Toronto, led to a large number of diverse people collaborating with me during short engagements (15-20 minutes) determined by how long they wanted to spend. In other instances, such as in gallery spaces, participants pre-registered and spent a specific, pre-determined amount of time on the workshop. These interactions enable myself and the participants to collect mud together, whereas in the larger scale workshops I have provided all the materials. In all instances the workshops are free to attend.



Figure 56: *Lake Ontario Workshop* at the “On Common Ground Festival”, programmed by The Bentway, Fort York, Toronto, 2017. Photo and artwork by the author.



Figure 57: *Mud, Microbes, and Bodies* at the Grimsby Public Art Gallery, Grimsby, Ontario, 2017. Photo by Quintin Teszeri.



Figure 58: *Mud, Microbes, and Bodies* at the Grimsby Public Art Gallery, Grimsby, Ontario, 2017. Photo by Quintin Teszeri.



Figure 59: *Lake Ontario Portrait Hamilton Workshop at Supercrawl, Hamilton, Ontario, 2017,*
Photo by Laura Palumbo.



Figure 60: *Lake Ontario Portrait Hamilton Workshop at Supercrawl, Hamilton, Ontario, 2017,*
Photo by Laura Palumbo.

If artists aim to start a broad dialogue about a topic, it is important that the research be disseminated to many different people. This includes individuals who are comfortable in a gallery space and those who are not necessarily. Theorist Pierre Bourdieu discusses cultural barriers to experiencing artwork in his book *The Love of Art* (1991). Bourdieu states that visitors fear looking at a guidebook or artwork label for too long, in case they might reveal their lack of knowledge to those around them.⁴⁴¹ Although art galleries may seem accessible to all patrons, Bourdieu argues that there is a difference between the “pure possibility” of accessibility and “real possibility” of accessibility: “if it is indisputable that our society offers to all the pure possibility of taking advantage of the works on display in museums, it remains the case that only some have the real possibility of doing so.”⁴⁴² While pure possibility suggests overcoming the logistical barriers to access such as cost of admission, real possibility refers to the more complex barriers including inequality in education, cultural capital, and overall social inequalities. Through presenting my research in diverse ways I aim to invite many voices into a larger discussion about our responsibilities toward bodies of water as well as our ecology more broadly.

Another reason I decided to begin presenting workshops was due to the disparity between my experience of making the artwork and the experience of viewing it. As I have described in previous chapters, creating my sculptures is a messy, involved, physical act. I am very much in the mud, whereas viewing the resulting artwork can make one feel

⁴⁴¹ Pierre Bourdieu, Alain Darbel, and Dominique Schnapper, *The Love of Art : European Art Museums and Their Public*, trans. Caroline Beattie and Nick Merriman (Cambridge: Polity Press, 1991): 51.

⁴⁴² Ibid: 37.

removed from its materiality. I believe that it is important to provide opportunities for us to be in the mud together. As theorist Maria Puig de la Bellacasa aptly describes, touch can be an important way to connect: “Understanding contact as touch intensifies a sense of the co-transformative, in the flesh effects of connections between beings. Significantly, in its quasi-automatic evocation of close relationality, touching is also called upon as the experience par excellence where boundaries between self and other are blurred.”⁴⁴³ The workshops facilitate contact. They are another way to become sensitized to the presence of microbes, or more generally, the liveliness of all material. Engaging the mud directly while discussing the implications of being enmeshed has led to a diverse range of interesting conversations. These have included discussions about cleanliness or comfort levels with handling the materials, perceptions of microbial life, connections to water, memories of specific shorelines, and ecological responsibility.

A crucial element of the workshops is that participants are invited to take a sculpture home with them to both care for and care about. This extends the care from myself in relation to the artwork towards more people who also have a stake in the health of our waters and environment. I have often had participants ask to take some empty sculptures home to share the experience with other people, such as their spouses, co-workers, or children. The capacity to work in collaboration with participants in getting muddy together is essential to the vibrancy of my research.

⁴⁴³ Maria Puig de la Bellacasa, *Matters of Care: Speculative Ethics in More Than Human Worlds* (Minneapolis: The University of Minnesota Press, 2017): 96.

Conclusion: In the Mud Together

So as the argument in this book progresses, an acute feeling also intensifies: that an ethical reorganization of human–nonhuman relations is vital, but what this means in terms of caring obligations that could enact nonexploitative forms of togetherness cannot be imagined once for all. And so I hope the reader will forgive me if this book opens up more questions than it offers answers.

– Maria Puig de la Bellacasa, *Matters of Care*

I first became interested in this research while grappling with the fact that my own body is enmeshed with microbial life. Since then, thinking-with microbes has led me to broaden my thinking and deepen my understanding of my own place within a broader ecology. It has been my aim in sharing my work that others can also expand how they think about their relationship to non-humans, borders, collaboration, and the environment.

In this text, I argue that thinking together across perceived divisions where all parties are open to being impacted by each other is essential to forging a more sustainable way of being in the world. The creation of my dissertation exhibition – sculptures, artist book, and workshops – is one way that I have taken up this important challenge. The exhibition creates a space where viewers can encounter the processes that I have gone through to form a meaningful relationship with my thinking partners, across divides, through caring collaboration. In this space, viewers have the opportunity to become attuned to the presence of non-humans and begin a journey that follows their own curiosities as they expand who/what they think-with. This encounter also has the potential to illuminate our connections to our ecology more broadly as well as our responsibilities towards it.

Thinking ecologically means considering processes as wholes, in context. My practice-based research strives to work from an ecological perspective and employ ecological methods. In my artwork, microbes that would ordinarily work together in the lake, continue to exist relationally. However, as I grapple with in “Chapter 3,” the microbes are removed from their ecology and placed in a new one that I have constructed. This is an ecology that functions differently – in this space, the microbes are capable of growing in greater abundance and therefore are capable of being sensed in different ways by viewers. I argue that this opportunity for encounter is important to develop our understanding of interconnectivity.

Scientific researchers can also take up an ecological perspective. As with Sergi Winogradsky, and other microbial ecologists, the researcher can focus on the interactions of communities rather than species in isolation. However, I would argue that various methodologies need to be applied to tackle our research questions. This might mean isolating species to gain a certain understanding of them, and then looking at the same question from a different point of view, or through the work of researchers that may be studying the same species as encountered in their own environment. Thinking ecologically does not necessarily mean only looking at what might be deemed a ‘natural’ context, but looking from a diversity of contexts as well as perspectives. Barad, whose work on diffractive reading I have drawn on throughout this text, conducts her own scientific research in the field of physics while thinking ecologically. Barad describes experiments done to determine if an electron is a particle or a wave through isolating an electron and examining it using a variety of methods. In order to thoroughly conduct this work, as Barad explains, ecological thinking needs to be practiced by drawing on physics,

metaphysics, and philosophy.⁴⁴⁴ Barad is thinking about this research question in a broad context even though the experiment requires isolating electrons. Isolation from an ecology – or at least movement into a different ecology – becomes necessary at times to gain an understanding of a phenomenon.

I argue that it is important to read research through other research or to think-with while conducting research. It would be difficult, or maybe impossible, for one individual to learn how to conduct research from all possible angles – scientific methodologies, poetic methodologies, etc. What is possible, and needed, is to develop the literacy to understand the research from diverse fields or points of view. Throughout this project I have come to understand research being produced from disciplines that I knew very little about such as theoretical biology, metaphysics, Indigenous knowledge systems, poetry, etc. It is important that researchers push themselves outside of the sphere of research they may be knowledgeable about, to become more literate in the language or dissemination technique of other fields so that a deeper understanding of their research questions, and the world more generally, is possible. Bringing together diverse perspectives that contextualize each other leads to deeper understanding. Through working together, researchers from different fields are capable of saying more than they could alone.

Currently, concerns have been mounting globally about the impact of COVID-19, a novel coronavirus. The spread of pathogens such as this remind us again, urgently, that borders are porous and that we are all in this together. It is essential that we work collaboratively to understand how to live otherwise, how to be responsible in the world we

⁴⁴⁴ Rick Dolphijn and Iris van der Tuin, eds., *New Materialism: Interviews and Cartographies* (Ann Arbor: Open Humanities Press, 2012).

currently live in, and how to move forward in a manner that will be more sustainable while remaining aware of the damage already done.

I have argued that our relationship with non-humans is not unidirectional. As I impact the microbial life they have also impacted me. It is necessary to understand our interconnection with non-humans in order to act in an ecologically responsible manner. It is also important to recognize harm, while simultaneously attempting to find productive ways to live together. Understanding our relationship with microbial life and recognizing the enmeshed nature of our bodies can push us to foster a stronger, more sustainable, and empathetic relationship with each other and our ecosystem as a whole.

It is difficult to conclude a discussion created with many thinking partners about the ties that bind us. There is no simple way to sum up the ways we are enmeshed. As Bellacasa describes in her book, *Matters of Care*, “this book opens up more questions than it offers answers.”⁴⁴⁵ This text has similarly offered a space for questions. Looking back on this five year long process, I realize that I have learned how to be more comfortable sitting in discomfort – particularly in the discomfort of not having clear, or fully resolved answers. I feel that being uncomfortable is part of staying with the trouble, and although I would like the relief of knowing precisely how to have a responsible relationship with non-human collaborators, or how we can move forward productively in our relationship with Lake Ontario, or our ecology more broadly, I have come to appreciate that these questions do not have definitive answers. They need to continuously evolve as they are reassessed in the current moment, influenced by new voices, and diverse ways of knowing.

⁴⁴⁵ Maria Puig de la Bellacasa, *Matters of Care: Speculative Ethics in More Than Human Worlds* (Minneapolis: The University of Minnesota Press, 2017): 24.

I return again to Jody Robert's question, "How do we narrate stories that help us to understand how our remaking of this world, and ourselves, is not over, but a process; a process open to our efforts of remaking?"⁴⁴⁶ I believe that pondering this question should be the work of many thinking partners. My dissertation is a result of this ongoing negotiation and although it has concluded for now, my research will continue. It is my hope that we will be able to stay in the mud together to continue envisioning ways to build futures full of care and responsibility.

⁴⁴⁶ Jody Roberts, "Narrating a Past for New Futures," 2016, <http://www.toxicsymposium.org/conversations-1/>.

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