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Social Inclusion (ISSN: 2183–2803)
2023, Volume 11, Issue 3, Pages 51–64
https://doi.org/10.17645/si.v11i3.6609

Article

Co-Creatively Producing Knowledge With Other-Than-Human Organisms in a (Bio)Technology-Controlled Artistic Environment

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Submitted: 14 December 2022 | Accepted: 16 February 2023 | Published: 24 July 2023

Abstract
Along with the increasing awareness about the destructive force of humankind on nature, existential questions about how to create a more sustainable relationship with the natural world have emerged. To acquire a more eco-friendly attitude, we need to go beyond the well-established knowledge cultures that highlight a nature versus culture dichotomy. This study focuses on bio art as an epistemic vehicle to re-imagine our understanding of and connection to the natural world. Drawing on the theoretical stance of philosophical posthumanism, we discuss how artistic co-creation processes involving humans and other-than-humans hold the potential to introduce a shift in our worldview from anthropocentric to ecocentric. We further question what this shift might imply for how we approach the complex relationship between humans and other-than-humans in our own research. We conducted a within-case and cross-case analysis of five bio art projects that previously won the Bio Art & Design Award (2018–2020). To analyze the data, we used a combined approach of visual and context analysis and material semiotics. Qualitative interviews were used as a data collection technique to investigate the lived experiences of both artists and scientists involved in the projects. Our findings suggest that bio art's epistemic significance can primarily be found in its multispecies perspective: By following the wills and ways of bio-organisms, bio art makes the invisible connection between nature and culture visible. Bio art can provoke our thinking about how to include and approach other-than-human agency in the context of socially engaged research practices.

Keywords
bio art; ecocentrism; epistemology; other-than-human agency; posthumanism

Issue
This article is part of the issue "Resisting a 'Smartness' That Is All Over the Place: Technology as a Marker of In/Ex/Seclusion" edited by Karin Hannes (KU Leuven) and Fred Truyen (KU Leuven).

1. Introduction

Since the mid-20th century, the arts have shown an increasing interest in nature and ecology. Artists have taken the natural environment as their playground for artistic ideation and creation. Ecological art, or eco art, gained momentum during the 1960s and refers to artistic practices that center the natural environment, ecology, and sustainable development (Ardenne, 2019; Woynarski, 2020). Eco art can take many forms, from paintings and photography to installations and public interventions, and focuses on sustainable practices. Socially engaged artists, for instance, started creating community-based art interventions to preserve or restore ecology. Joseph Beuys' interventions in which he, together with local communities, cleaned the Elbe River in Hamburg (1962) or planted seven thousand trees in Kassel in *7000 Oaks: City Forestation Instead of City Administration* (1982) are keen examples of ecological works of art in which the social and natural environment collide (Woynarski, 2020). Besides eco art, the emergence of the art movement land art (also known as earth art or environmental art) in the 1960s also raised awareness about nature and ecology. Land artists started

using elements and landscapes to create works of art (Ballard & Linden, 2019; Ryan, 2007). Robert Smithson and Richard Long, both land art pioneers, extended the boundaries of the art world by elevating natural materials to the field of the arts (Ballard & Linden, 2019).

Two decades after artists began incorporating nature as a medium in their artistic endeavors, the boundaries of the natural world became resketched through the emergence of biotechnology. Biotechnological progress provided a new perspective on nature because living matter became manipulable and moldable, for example through techniques of genetic engineering, cloning, tissue regeneration, interspecies communication, cross-pollination, and such (Kac, 2007a, 2007b). Artists responded to the biotechnological evolution and took the acceleration in life science and technology as their main source of inspiration (Andrews, 2007; Kac, 2007b; Melkozernov & Sorensen, 2021; Stracey, 2009; Zylinska, 2014). These so-called bio artists engage with "biomedia," living matter such as mammals, plants, tissue, algae, bacteria, viruses, DNA, and so on. As such, bio art fits into the art-nature tendency. Similar to land artists, bio artists create artworks with natural elements. However, in the latter one, the natural elements live, are kept alive, or their liveliness is changed (Kac, 2007a).

The origin of the term "bio art" is ambiguous as it comprises various, hardly distinguishable sub-categories including, but not limited to, transgenic art, art that involves "wet" biology, semi-living art, art together with machine learning and computer modelling, life-modulated art, and so on (Anker, 2014; Catts & Zurr, 2007; Kac, 2007b; Stracey, 2009). Bio art also closely relates to "sci-art," referring to the introduction of scientific processes in the arts (Anker, 2021). Another connected field is bio design. The fields of bio art and bio design are narrowly interwoven, making it nearly impossible to categorize the two practices. Bio designers, for instance, take experimental and conceptual pathways instead of only focusing on function. At the same time, many bio artists have stepped away from their *l'art pour l'art* approach to take part in knowledge production and reflections on science and create functional outputs (Mateus-Berr, 2014; Myers, 2018). There is no consensus about what bio art exactly entails, besides including other-than-human organisms in artistic practices.

The current trend to focus on nature and ecology is inseparable from the increasing social awareness about the looming climate crisis (Reiss, 2019). As humankind's destructive force on the planet has become apparent, and technological innovation has even enabled us to interfere with natural processes, major existential questions about our position towards nature and other-than-human living matter have arisen. To move beyond an anthropocentric viewpoint to approach nature, new ways to understand the relationship between the human and the other-than-human are urgently required. As a liminal space between the arts and the sciences, Anker (2021) has argued that bio art and its hybrid practices can redesign contemporary knowledge cultures. Bio art provides insights into our kinship with other-than-human organisms, which might guide us towards a more sustainable and eco-friendly relationship with nature (Radomska, 2016; Van den Hengel, 2012). In this article, we focus on bio art as a potential epistemic vehicle that emphasizes ecocentrism in research-oriented explorations of reality.

2. Objectives and Research Question

This study describes the potential of bio art as a multispecies and ecocentric inquiry to study reality. We approach bio art as an epistemic avenue that goes beyond well-established knowledge cultures that render nature manipulable. We aim to acknowledge the agency of other-than-human actors. New ways to understand nature invite us to reflect on how we, as humans, ought to study other-than-human bio-organisms. Therefore, we examine bio art from a posthuman, multispecies perspective as part of the overall goal to develop a relational ontology that works together with nature in developing responses to major social challenges.

We assume that new epistemic approaches for understanding nature as a partner can be found in the methods and approaches bio artists employ when engaging with other-than-human bio-organisms. For this reason, we study how artistic co-creation processes involving humans and other-than-humans alike hold the potential to introduce a shift in our worldview from anthropocentric to ecocentric. Furthermore, we question what this shift might imply for how we approach the complex relationship between humans and other-than-humans in our research.

3. Theoretical Framing

This study draws on philosophical posthumanism to analyze and conceptualize the data. Posthuman theory seeks to dismantle the conventional distinction between humans, other-than-human living beings, and non-human materials. While other-than-human entities refer to all living matter and organic entities beyond the human body, non-human entities refer to non-living things such as technology (Braidotti, 2013; Haraway, 2016; Latour, 2014). Posthumanism draws on the theoretical and philosophical stance of new materialism which acknowledges the self-organizing capacity of living (i.e., other-than-human) and non-living (i.e., non-human) matter that fluctuates, is dynamic, and meaningful (Braidotti, 2022).

In this article, we specifically focus on humans' relationship with and connection to other-than-human organisms. Posthuman theorists highlight the agency of other-than-humans, meaning that they possess the capacity to co-influence and co-shape reality. Humankind engages in a reciprocal relationship of interdependence with other-than-human organisms.

Based on these insights, posthumanism seeks to move beyond anthropocentrism, emphasizes interconnectivity between all matter, and argues for "relational ethics of mutual dependence and care" (Braidotti, 2022). Nature and culture are not two opposites but shape and are shaped by each other (Latour, 2017). Agency is not necessarily linked to intentionality, which can be ascribed to humankind. Rather, all organisms alter the world we are living in, think of bacteria living in our body and trees producing oxygen. Posthumanism acknowledges this intimate entanglement between nature and culture and advocates for a relational approach (Ferrando & Braidotti, 2020).

To obtain a more sustainable and eco-friendly attitude towards nature, the feminist and cultural theorist Donna Haraway argues for *storying otherwise*: the need for other kinds of stories, for other perspectives to narrate about nature, and for *multispecies storytelling* (Terranova, 2016). She argues that storytelling about the natural and animal world shape the way we perceive nature and other-than-human organisms: "It matters what ideas we use to think other ideas with….It matters what thoughts think thoughts" (Haraway, 2008, p. 12). Haraway's (2008) writing *When Species Meet* is a compelling example of multispecies philosophy in which the entanglement of the human with other living organisms is discussed. She states that "we have never been human" because our bodies mainly consist of and relate to a range of natural organisms such as fungi and bacteria. She essentially argues that "we are a knot of species co-shaping one another" (Haraway, 2008, p. 42). Humankind engages in processes of *thinking-with, making-with*, and *becoming-with* our other-than-human colleagues. In other words, the human engages in collective ways of doing, meaning that both the human and the other-than-human work together to create reality (Haraway, 2016). We use Haraway's call for storying otherwise as a guiding principle throughout this study as we consider bio art to be a relevant pathway for multispecies storytelling.

Posthumanism has been adopted in various studies as a framework to examine bio art, highlighting bio art's potential to re-imagine humankind's relationship to nature and other-than-human living matter (Radomska, 2016; Van den Hengel, 2012). Many bio artists are inspired by posthuman writings themselves and employ posthuman concepts when engaging living matter in their artistic endeavors (e.g., Baum & Leahy, Michael Sedbon, among others). While learning how other-than-human agency manifests itself, we challenged ourselves to try and avoid anthropomorphizing other-than-human agency (Hornborg, 2021). With our situatedness of being human, the risk of anthropomorphizing bio-organisms remains. What we can do, however, is highlighting and acknowledging other-than-human agency and enshrining rights for nature (e.g., the nine rights of the Magpie river in Canada).

We acknowledge bio art's ambiguous position towards living matter and experimentation which has been critiqued by Wolfe (2010, 2020) among others. Rather than highlighting potential instrumental and problematic associations to other-than-humans, Braidotti (2013) argues for affirmative relationships: broadening the understanding of the self by embracing radical relationality with other-than-human organisms. In line with Braidotti's (2013) reasoning regarding affirmative ethics, we aim to highlight that the experimental nature of bio art precisely sparks imaginative processes that can guide toward renewed understandings of nature and culture.

4. Methodology

To study bio art's epistemic value, we used a case study approach. We have conducted in-depth and holistic examinations of specific cases of bio art. Each art project represented a separate unit of inquiry and consisted of a consortium of human and other-than-human actors working together. The art projects were examined by employing various methods for data collection and data analysis in a well-defined setting (Dasgupta et al., 2020).

4.1. Setting

The study was conducted in the context of the Dutch Bio Art & Design Award (BAD Award), an international competition that encourages young artists and designers to experiment with living matter and to "push the boundaries of technological and artistic possibilities" (Lagerweij, 2016). The competition wants to urge discussions concerning life sciences by combining cutting-edge research with creative practices. The award further aims to stimulate interdisciplinary collaboration at the intersection of technology/science and art/design, and it intends to explore cultural and ethical dimensions of science through artistic practices (Bio Art & Design Award, 2023). Artists and scientists apply to participate in the BAD Award. After a match-making event in which artists and scientists connect and form duos, they collaboratively write a project proposal. An international, independent jury awards the three most promising and original proposals a grant of 25.000 euros to realize their proposed project within six months. During the collaboration, scientists receive the opportunity to join the ideation and creation process of artistic projects, and artists are welcomed into renowned Dutch science and research centers in life sciences and biotechnology to collaborate with experts. The final outputs of the collaboration are displayed to the public during an exhibition at MU Hybrid Art House in Eindhoven (Van Donselaar, 2016).

4.2. Sample

We analyzed five projects that have won the BAD Award between 2018 and 2020. Table 1 demonstrates an overview of the selected bio art projects. To select

Table 1. Overview of selected bio art projects.

Project Title	Year	Artist(s)	Scientist(s)	Other-than-human organisms
Microbiocene: Ancient Ooze to Future Myths (Figure 1)	2018	Baum & Leahy	Stefan Schouten, Julie Lattaud, Laura Schreuder, Gabriella Weiss	Marine algae: Emiliania Huxleyi
CMD: Experiments in Bio-Algorithmic-Politics (Figure 2)	2019	Michael Sedbon	Raoul Frese	Algae: Cyanobacteria
Funkee: Fungal Supercoating (Figure 3)	2019	Emma Van der Leest	Paul Verwije, Sybren De Hoog, Aneta Schaap-Oziemlak	Fungi stemming from a human patient
Fur_Tilize (Figure 4)	2020	Dasha Tsapenko	Han Wösten	Mycelium: Schizophyllum Commune
Becoming a Sentinel Species (Figure 5)	2020	Sissel Marie Tonn	Heather Leslie, Juan Garcia Vallejo	Artist's blood

projects for analysis, we took into account the role other-than-human living organisms played in the artworks, as well as the artworks' foregrounding of the connection between humans and other-than-humans, nature, and culture. The five bio art projects were the units of analysis in this study, essentially representing places where human (i.e., artists and scientists) and other-than-human bio-organisms come together, co-create, and engage in a collaborative process of making-with one another.

4.3. Analysis

We used a within-case and cross-case analysis of the five selected cases as our overall research design. In the within-case analysis, we intended to understand each case in its own terms by describing the case as a whole entity. We identified various dimensions and examined them to generate an overall explanation of the selected cases. Subsequently, a cross-case analysis was carried

Figure 1. *Microbiocene: Ancient Ooze to Future Myths*. Source: Baum & Leahy (2018).

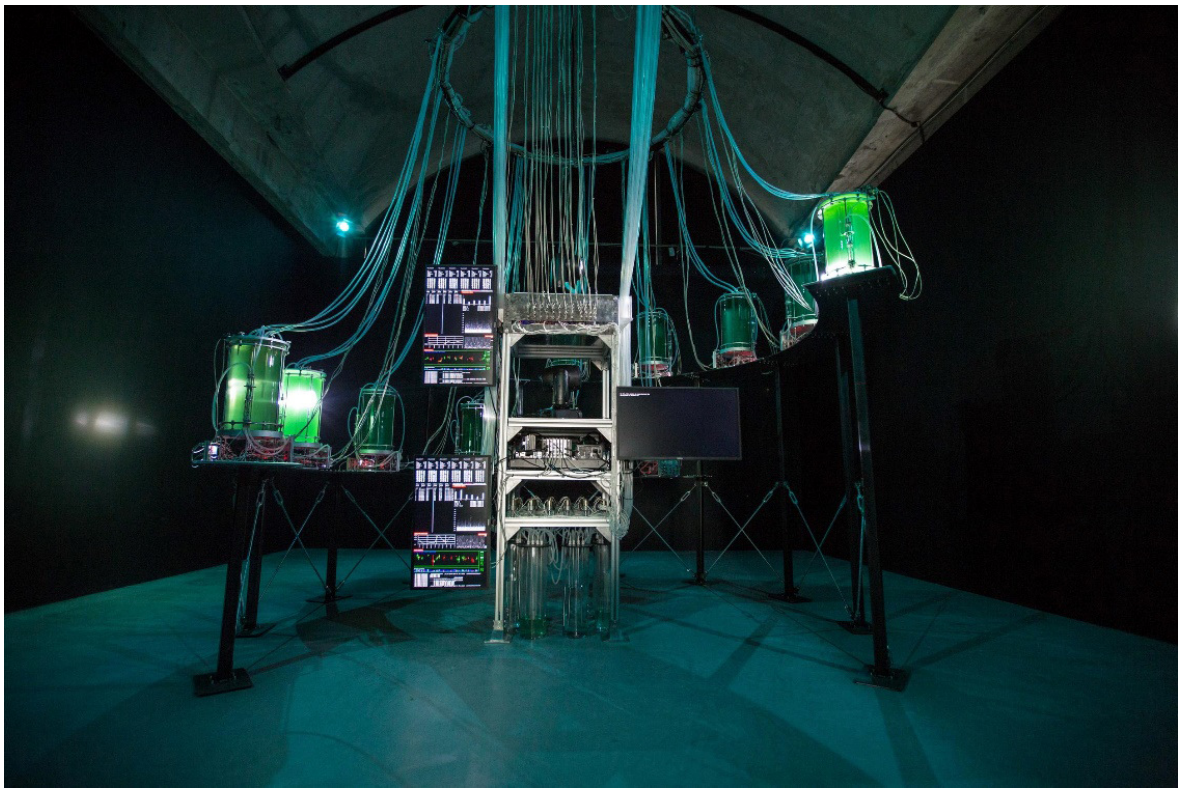

Figure 2. *CMD: Experiments in Bio-Algorithmic-Politics.* Source: Sedbon (2019).

Figure 3. *Funkee: Fungal Supercoating*. Source: Van der Leest (2019).

Figure 4. *Fur_Tilize*. Source: Tsapenko (2020).

Figure 5. *Becoming a Sentinel Species*. Source: Tonn (2020).

out to identify processes and ideas across different cases (Huberman & Miles, 1994). In the cross-case analysis, a comparative approach was adopted, aiming to pinpoint more systemic patterns in bio art. As such, we learned from different cases and provided overarching insights into bio art as an emerging artistic genre (Huberman & Miles, 1994; Khan & Van Wynsberghe, 2008).

We aimed to analyze the art projects from a multispecies perspective in which both human and other-than-human actors were acknowledged to be creators of the projects. In doing so, we combined a visual and context analysis with semiotic materialism to approach the data. The visual and context analysis focused on visual imagery and video content of the selected art projects and consisted of three dimensions of appraisal: the formal characteristics of inquiry, the positional stance, and posthuman concepts and practices. First, we examined the formal characteristics of inquiry of the works of art by focusing on what scientific and artistic methods were employed and how humans employ them with other-than-human organisms. Second, we examined the positional stance of the projects. Bio art tends to address certain ethical, political, and cultural challenges in their creation (Stern, 2011; Vaage, 2016). Accordingly, we highlighted the projects' critical stance and their alternative reasoning. Third, we considered how the projects relate to posthuman concepts and practices such as other-than-human agencies and multispecies entanglement. Understanding these aspects was an essential part of decoding the meaning of the bio-based artwork.

We synthesized this stream of data through material semiotics. Semiotics focuses on how meaning is created, communicated, and decoded. In material semiotics, non-human (i.e., material), and other-than-human (i.e., living matter) actors can be involved in the process of meaning-making: The meaning of the bio art projects comes into being through the intimate entanglement between artist, scientist, bio-organism, and non-living materials (Bettany & Kerrane, 2011; Law, 2009). Material semiotics emphasizes that "no single social structure or form of patterning exists because these material and social webs and weaves come in different forms and styles" (Law, 2019, p. 1). Using material semiotics helped us to "story otherwise" and to generate a less anthropocentric perspective that allowed us to treat the other-than-human bio-organisms, the artists, and the scientists as co-creators (Law, 2019).

We complemented this hybrid analytical approach with insights generated from qualitative semi-structured interviews carried out with the artists and scientists involved in the creation of the projects. A total of twelve interviews were conducted, five with artists (including one artist duo) and seven with scientists. We focused on how the artists and scientists experienced the co-creation process and how they dealt with the notion of shared agency with other-than-human organisms. The interviews were transcribed, coded, and subjected to a thematic analysis. In the thematic analysis, a range of categories was identified and related to the three dimensions used in the cross-case analysis.

5. Findings

In this findings section, we make a distinction between descriptive and analytical layers of interpreting the projects. We first describe the formal characteristics and the artistic process of inquiry of the artworks. We then dive into the analytical layer by discussing the projects' positional stances and their connections to posthumanism. Table 2 shows an overview of the five selected bio art cases.

5.1. Formal Characteristics and Artistic Inquiry

The concepts and processes explored in bio art can be presented or displayed for audiences in a multiplicity of forms. While some projects result in an installation set-up, others present bio-based design or even audio-visual films. To describe different artistic approaches, we have built upon Wang et al.'s (2017) categorization of art and research forms to explain the different artistic pathways the selected bio art projects have taken, including new media, visual art (sculptures, digital storytelling), literary art, and sound art. Whereas most cases engage organisms such as algae or fungi, some use human bodily materials including blood, DNA, cells, and tissue. The scientific fields of study identified in Table 2 relate to the fields of expertise of the collaborating scientists.

5.2. Positional Stance of Bio Art

While the analyzed bio art projects all take other artistic and scientific pathways, engage different materials, and hold dissimilar goals, each project follows a storyline that counteracts anthropocentric worldviews. The projects oppose humankind's destructive force on the planet and/or rebel against human attempts to gain mastery over nature. They resist hegemonic, humancentric ways of perceiving reality and aspire to acknowledge the significance and power of other-than-human organisms and the environment at large.

The artist Sissel Marie Tonn and the artist duo Baum & Leahy especially oppose human exceptionalism. Both projects counteracted dominant narratives about humankind's place on this planet through storytelling. In *Microbiocene: Ancient Ooze to Future Myths* (Figure 1), Baum & Leahy constructed a more-than-human narrative about the Microbiocene, a speculative geological epoch in which microorganisms take center stage. The narrative is based on micro-organic biomarkers that store scientific data. In the project, the microorganisms are appreciated as a storage space for the history of the Earth. The artists created a new narrative in which the microorganisms became the main storytellers, aspiring to re-tell and re-imagine planetary history from the point of view of the other-than-human (Baum & Leahy, 2020).

Table 2. Overview of the five cases.

		Microbiocene: Ancient Ooze to Future Myths (2018)	*CMD: Experiments in Bio-Algorithmic-Politics* (2019)	*Funkee: Fungal Supercoating* (2019)	*Fur_Tilize* (2020)	*Becoming a Sentinel Species* (2020)
Descriptive: Formal characteristics and inquiry	Visual presentation	Installation of a future archaeological site in which a microbial monument/sculpture is found with symbolic writings on it ("mycroglyphs"), telling the story of Earth's history from a microbial perspective.	Installation of a series of tubes containing two sets of algae that share one light source connected to a genetic algorithm that is testing various financial systems of collaboration and competition between the algae.	Design of a biological coating to protect biomaterials, presented through a commercial and educational set-up explaining bio-based research process.	Design of five fur-like, living garments out of mycelium and hemp, each representing a different level of symbiosis between the mycelium and the hemp.	Science fiction film about two scientists who inject microplastics into their own blood, resulting in a series of hallucinations and delusions about their watery origins in the primordial sea.
	Material characteristics	Microscopic marine algae: Emiliania Huxleyi Sculpture out of sea sediments	Algae: Cyanobacteria Hardware: tubes for algae, light source, technological infrastructures Software: machine learning algorithm	Fungi, isolated from a human patient Conceptual branding: bottles, commercial	Hemp and mycelium	Microphages in human blood cells Microplastics Hardware and software to present the film
	Intention	Imagining and acknowledging microbes to be the main storytellers of the history of the Earth	Demonstrating the limits of human and technological mediation of nature	Illustrating possibilities of living matter in an approachable manner	Generating a renewed notion of care	Generating an emotional response and reflection on the microplastics flowing through our bodies
	Art form(s)	Literary art (fiction) and visual art (3D sculpture)	New media (AI)	Visual art (3D design and 2D branding)	Visual art (3D design)	Literary art (fiction), visual art (2D digital storytelling), and sound art (soundscapes)
	Scientific field of study	Palaeoclimatology	Biophysics	Mycology	Microbiology	Immunology and ecotoxicology

Table 2. (Cont.) Overview of the five cases.

		Microbiocene: Ancient Ooze to Future Myths (2018)	*CMD: Experiments in Bio-Algorithmic-Politics* (2019)	*Funkee: Fungal Supercoating* (2019)	*Fur_Tilize* (2020)	*Becoming a Sentinel Species* (2020)
Analytical: Positional Stance	Critical position	Countering humancentric storytelling about the history of the Earth	Opposing science and technology's attempt to organize the chaos of nature by rendering bio-organisms and nature manipulable	Opposing trends in the fashion industry, such as fast fashion, waste, plastic pollution, mass production, etc.	Opposing trends in the fashion industry and agriculture: mass production and waste	Denouncing hierarchies between humans and other-than-humans, and the unequal distribution of toxicity
	Alternative reasoning	We need to appreciate the agency of microorganisms that have set beneficial conditions for life to thrive on Earth throughout the past, present, and future.	The development of the material world (both hardware and software) should be aligned with the needs of other-than-human entities.	Chemical-free, eco-friendly alternatives for destructive products such as synthetic coating and animal leather should be created.	We must acknowledge and appreciate symbiosis between other-than-human and human actors.	We need to concede that humans are sentinel species too, as our bodies are contaminated as well.
Analytical: Posthuman concepts and practices	Other-than-human agency	The researched sea sediments represent a storage space of the story of the history of the Earth.	The algae determine the other material characteristics and the "speed" of the installation.	The risky, pathological fungus possesses valuable features and can be used to create functional objects.	The mycelium alters and guides the ideas and practices of the artist and scientists.	The macrophages in the blood fight the microplastics outside the artist's body.
	Multispecies entanglement	The project highlights communication across species and envisions ourselves as being part of a greater ecology.	The project demonstrates collaboration between human (i.e., artist), other-than-human (i.e., algae), and non-human (i.e., AI).	The project demonstrates a durable relationship between the human and other-than-human via ecologically friendly alternatives to readily available products.	The project demonstrates a fruitful symbiosis between other-than-human organisms and humans by re-imagining how we care for our clothing.	The project shows that the natural environment is having slow and invisible, yet harmful effects on our bodies, just like humankind has had on the natural environment.

Note: the within-case analysis is represented in the columns of the table and the cross-case analysis is represented in the rows.

This strategy of counteracting dominating human-centric pathways was also adopted by the artist Sissel Marie Tonn. In her science fiction film *Becoming a Sentinel Species* (Figure 5), the artist highlights issues regarding speciesism:

> The use of sentinel species [in research] indicates a hierarchy: There are always some bodies that are more exposed to, more vulnerable for, and more immersed in our contaminated world than others. Sentinel species are instrumentalized and we do not take into account that they have lives and places in the ecosystem as well. (S. M. Tonn, personal communication, March 30, 2022)

Sissel Marie Tonn approaches sentinel species differently by putting humankind in that exact place. Just like Tonn, the artist duo Baum & Leahy goes beyond one limiting epistemological system by storytelling through another lens. The bio art projects offer a new angle to comprehend the past and the present:

> *Microbiocene: Ancient Ooze to Future Myths* is about a multitude, about existing as many, and about how this creates an inherent earthly connection and responsibility to the planet's past, present, and futures. (Baum & Leahy, personal communication, May 19, 2022)

The underlying reasoning of the analyzed bio art projects is to shift towards a more sustainable and ecocentric approach. As one of the interviewed scientists noted, bio art can engender thinking about the urgency to find new ways of approaching the world, and the urgency of a more sustainable and responsible attitude towards the planet:

> Art and design do not need to lead to innovative findings. What it can do is stimulate reflexivity and show that we urgently need to start thinking of alternatives to our current material world….We can start thinking about new alternatives and possibilities. (Scientist, personal communication, April 6, 2022)

While Baum & Leahy and Sissel Marie Tonn use storytelling, Emma Van der Leest and Dasha Tsapenko demonstrate what a durable relationship between the human and other-than-human might look like through the creation of bio-based materials. Both Van der Leest's bio-leather and bio-based coating and Tsapenko's grown garments are a result of making-with other-than-human bio-organisms. In *Funkee: Fungal Supercoating* (Figure 3), Emma Van der Leest employed a fungus that was isolated from a human being. The artist demonstrates that certain types of fungi might be harmful to humankind but can nevertheless have valuable features, which can change humankind's perspective towards fungi. The project provides a new perspective on fungi: Instead of perceiving the fungi to be dangerous, meaningless, and needless, these attributes are being replaced by new qualities that demonstrate their relevance. In this case, the potentially risky, pathogenic fungus could contribute to sustainable change by making bio-based materials more durable (Van der Leest, 2019). These alternative ways of perceiving other-than-humans can complement scientific knowledge creation. As one of the interviewed scientists noticed:

> An artist or an artwork can show you another angle and, even as a scientist, make you can think or feel something different. They stimulate you, trigger your senses, and in this way, they indeed provide another type of knowledge that scientific reports cannot provide. (Scientist, personal communication, April 13, 2022)

Bio art does not only provide a different point of view to understand nature, but it also offers a new way of encountering nature and other-than-human bio-organisms.

5.3. Posthuman Concepts and Practices

The agency of other-than-human organisms is a common theme that runs through all of the analyzed artworks. As ecocentrism seemingly presents a shared reasoning in the analyzed project, it highlights bio art's aim to acknowledge other-than-human's capacity to shape and influence reality. Ecocentrism is also reflected in the creation process of the projects. The artists align their ideas and practices with the agency of the other-than-human bio-organisms. As one of the scientist notices, "bio artists do not just take a piece of marble and create a sculpture out of it. Instead, the material is guiding them and the way they process it" (scientist, interview, April 13, 2022). Indeed, the artists Dasha Tsapenko and Michael Sedbon both emphasize other-than-human agency in their projects. When growing the garments in *Fur_Tilize* (Figure 4), Tsapenko had clear goals and expectations for the project in mind, but the role of the living organism was much higher. She had to revise her questions and alter her attitude toward the other-than-human living beings:

> I was sure that in two months, we would actually achieve what we told ourselves. But then, when I started to work, I realized that it was far from what I imagined. The role of the living organisms is much higher. (D. Tsapenko, personal communication, March 29, 2022)

Tsapenko started to observe and value what the organisms offered: "According to the organism's behavior, the story should be told differently" (D. Tsapenko, interview, March 29, 2022). In doing so, the artist experienced a shift in her attitude towards the living beings; instead

of perceiving them as materials she was using to carry out her project, the living beings became collaborators. While artists have always been guided by the media they employ, the agency of materials in bio art is particularly evident because the materials happen to live. Even after a bio artist finishes working on the artwork, the living matter will continue to grow and therefore, will continue to shape the piece of art. For instance, Tsapenko's living dresses will look different two months after entering the museum.

While Tsapenko's work highlighted the agency of living organism during the creation process and thereafter, Sedbon ridiculed human mastery over nature in his project. Sedbon brought algae, hardware, and software together in *CMD: Experiments in Bio-Algorithmic-Politics* (Figure 2). As they all work at different speeds, they needed to find a way to communicate and align: While the genetic algorithm works extremely fast, the growth of the algae is dependent on the living organism itself. Although the controlled environment provides perfect growing conditions for the algae, the artist asserts that other-than-human living organisms are impossible to predict:

> There are always going to be some properties [of the organisms] that you cannot control. Of course, you can engineer biology to go a bit faster, you can grow them in the best conditions as you can. But ultimately, you cannot do magic. (M. Sedbon, personal communication, April 5, 2022)

By showing the complexity of living matter and acknowledging its ability to transform, shape, and influence, Tsapenko's and Sedbon's projects represent a knot of agents (i.e., human, non-human, and other-than-human) that engage in a co-creation process.

The acknowledgment and appreciation of the agency of other-than-human organisms in bio art projects also result in reflections on humankind's position in the larger environment. As we have seen before, bio art reacts against anthropocentric worldviews and means to provide a more ecocentric approach to understanding reality. This approach highlights the entanglement of all planetary inhabitants in a shared and active environment: Humankind is understood as just one species in a knot of other species. This multispecies entanglement is highlighted in Tsapenko's and Sedbon's projects but is also to be found in Sissel Marie Tonn's film *Becoming a Sentinel Species.* Tonn emphasized kinship between the human species and the natural surroundings by turning humankind into sentinel species. Tonn's project demonstrated not only that our behavior has had destructive effects on the environment, but also that these effects are bouncing back and starting to impact our bodies. In doing so, the artist illustrated the intimate interconnection between nature and culture: Humankind cannot be understood without considering the surrounding environment. Similar to Dasha Tsapenko's and Michael Sedbon's projects, Sissel Marie Tonn breaks down the hierarchy and brings the artist and the living matter, the human and the other-than-human on the same level. They all question human exceptionalism and generate insights into our relational ontology.

6. Discussion and Conclusion: New Epistemology Through Bio Art's Relational Ontology

The aim of this study was to explore bio art's potential to steer toward multispecies futures by generating new, ecocentric ways of knowing. The five bio art projects examined in this study provide compelling examples of new epistemic pathways to understand the other-than-human and nature at large. They acknowledge the agency of other-than-human organisms and highlight our entangled way of being. The cited examples demonstrate that artists are being guided by the living organisms and generate a co-creative outcome. The final art product is the result of a close collaboration between the human and the other-than-human: Other-than-human organisms determine the formal characteristics such as materials that are being used (e.g., to keep them alive), the artistic form, and the methodology of the artist, which all contribute to the artwork's eventual meaning. The organisms are dependent on the artist and vice versa. The organism and artist engage in a co-creative process of *becoming-with* and *making-with* one another. Bio artistic endeavors, therefore, represent physical testimonies of organisms' power to transform, create, and manipulate. They are physical testimonies of other-than-human agency.

As living matter is the protagonist in bio-based works of art, bio art breaks through well-established ways of knowing and provides other ways to understand the world we are living in. Bio art responds to Haraway's (2016) call for *storying otherwise:* by challenging human-centric ways of perceiving the world, by preparing new pathways to understand our place on the planet, and, essentially, by re-imagining our relationship with other critters and the natural environment at large. In other words, bio art projects narrate differently by breaking down the human versus other-than-human hierarchy and by intensifying a different type of relationship in our study and research work. Since the analyzed projects originate from close collaboration between the human and other-than-human, they resist human exceptionalism and highlight that the mind of the artist is impacted and even guided by the materials the artist utilizes.

When exploring reality, we can learn from these new ecocentric stories in which the human and other-than-human are intrinsically entangled. Haraway (2016) keenly questions what would happen "when human exceptionalism and bounded individualism, those old saws of Western philosophy and political economics, become unthinkable in the best sciences, whether natural or social" (p. 30). Located in between the arts, the natural sciences, and posthuman concepts, we believe that

bio art provides epistemic potential. Bio artists recognize the other-than-human organisms to be collaborators, which in turn renders interesting perspectives to recast methodological and socially engaged research practices. Including other-than-humans in research-oriented explorations of reality might guide us toward new ways of knowing that intrinsically comprise multispecies entanglement. This is particularly relevant because existing research methods are limited and do not allow us to take all critters on Earth into account (Probyn, 2015). To include other-than-human entities in our research, profound methodological innovation is required.

Finding multispecies methodological approaches to draw inspiration from is challenging. Yet, they are highly needed to respond to a range of questions: How do we translate other-than-humans' agency and include it in our research designs? Can we communicate with other-than-human entities and how do we find a common language? How can we make our research practices as inclusive as possible and go beyond the human? While the epistemological ideas are thoroughly discussed by posthuman scholars, and some of the far-reaching answers to these questions are currently featured in future study research projects (e.g., Hannes et al., 2022), more efforts are required to translate these ideas further into workable research approaches. At the same time, critical questions arise about engaging living matter for aesthetic purposes and about including other-than-humans in socially engaged research practices. New concerns and challenges occur, possibly encouraging critical reflections on contemporary research practices and stimulating the imagination of alternative pathways. The experimental studies "bringing [human and other-than-human actors] together ensure that we keep our eyes down and ears open" (Probyn, 2015). They provide us with options for new methodological approaches to be used in multispecies research.

Based on the examined bio artistic practices, we have taken our very first steps and tried to story otherwise by adopting a multispecies research approach in which humans and other-than-humans were considered to be equal creators of the examined artworks. We, as humans and as researchers, became more acquainted with the notion of collaborative research *with* other-than-humans. We consider our study of bio art as an invitation to move beyond the idea that the researching object is somehow divided from the researched subject and to approach a study process as a knot, an entanglement, a network in which we are only one actor. Drawing on these insights, we believe that there is much to learn from bio artists on how to engage with living matter. We intentionally have utilized the word "engage" here, and throughout the entire article, to limit and overcome a reductionist approach of "using," "studying," "employing," and "exploiting" living matter. We have learned to go beyond treating other-than-humans as passive entities and we have aimed to highlight them as active agents throughout the article. As Haraway (2016) highlights, "it matters what thoughts think thoughts…what descriptions describe descriptions" (p. 12).

As the life-sustaining boundaries of planet Earth are being crossed one after another and sustainable transformation is urgently required, bio art can pave new pathways for reconnecting with the natural world. These new ways of thinking essentially represent side alleys—speculative or not—that complement the rather human-centric knowledge cultures that depart from hierarchical binaries. Through the inclusion of other-than-human organisms, bio art can give a glimpse of what multispecies relationality looks like, which might engender a renewed sense of responsibility towards the natural world.

Acknowledgments

The authors would like to say a special thank you to Angelique Spaninks and Isolde Hallensleben from the Bio Art & Design Award for their support and Prof. Tsjalling Swierstra for his guidance throughout the study. We would like to express gratitude to all interviewed artists and scientists. We also want to thank the anonymous reviewers for their constructive feedback.

Conflict of Interests

The authors declare no conflict of interest.

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