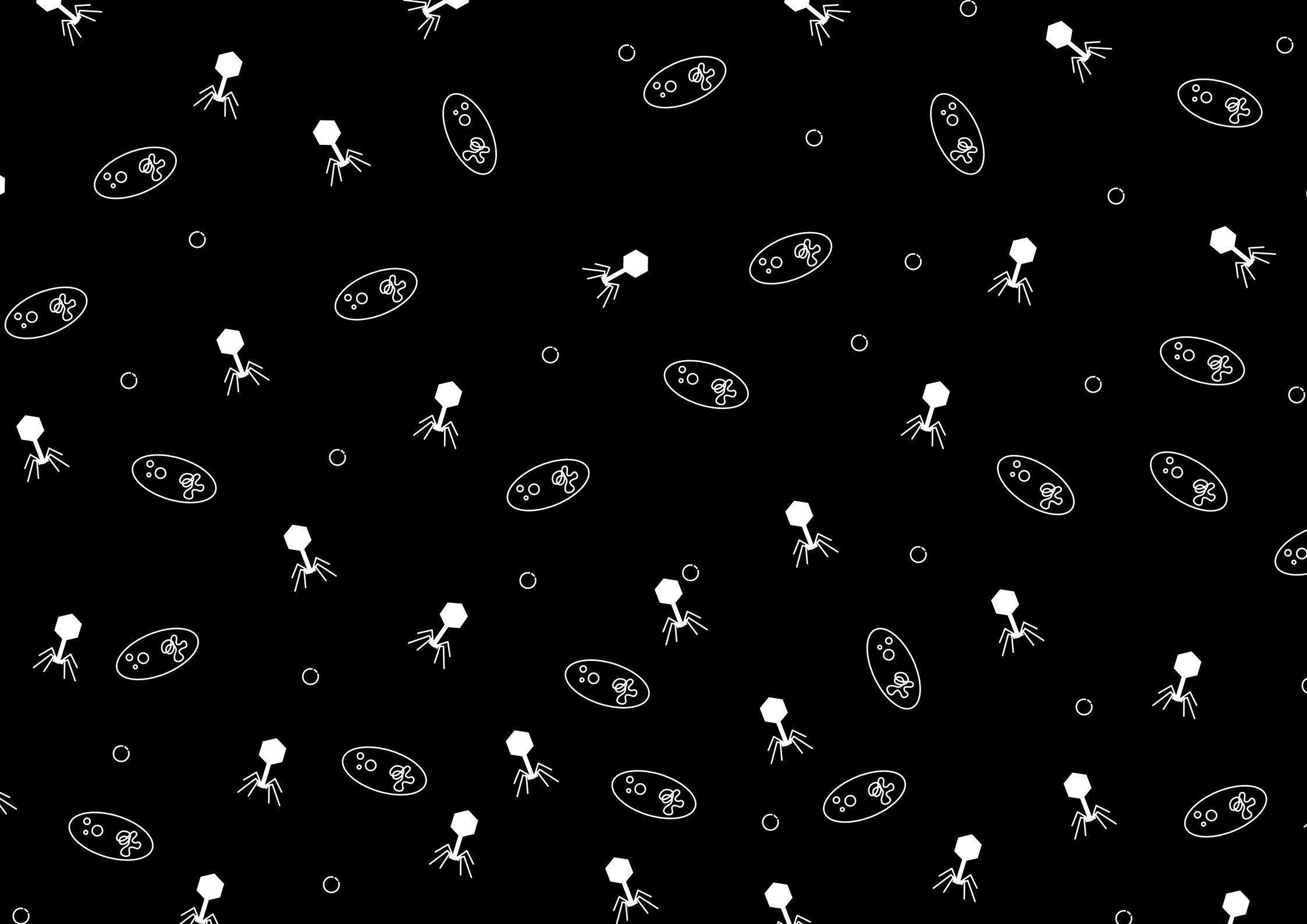


QUEER FORMS OF LIFE
/
INTERCONNECTED NATURE

NATALIA RIVERA



QUEER FORMS OF LIFE

DIGITAL TECHNOLOGIES FOR THE LIVING

INTERCONNECTED NATURE

INTERNET FOR BACTERIA

—

*To all the communities of living
organisms that resist to human
control*

Queer forms of life is a research/creation context to explore the possibilities of the emerging understandings of life by complexity sciences, biology, philosophy of biology, new media, and many others in art/knowledge creation/worlding.

It has been created in the context of the 2nd cycle of the Suratómica Network named *At the Edge of Chaos* and my master project for the New Media Class at the UDK in Berlin. A creation group with the same name collaboratively explored the idea in 2021 and during the social outbreak in Colombia starting in April of the same year, the network's context *Other politics of the living* was derived.

The documentation on these pages aims to present the research, reflections, and interconnections of many processes, ideas, works, references, and dialogues surrounding the co-creation of the *Queer forms of life* context and *Interconnected Nature* as a derived project.

QUEER FORMS OF LIFE

DIGITAL TECHNOLOGIES FOR THE LIVING

INTRODUCTION

Artistic creative processes with biological computers, understood as *Queer forms of life* or symbiotic bio-digital organisms, both emerge from and at the same time shape the biocentric turn in the development of these digital technologies. Biological computing, developed with living organisms or biologically derived molecules, is an emergent media that requires a new/ other understanding of our relations with the biological entities included in the information processing and storage, and the biocomputer as a living organism itself. Together with them, the artistic creation, or even wider, the shared aesthetic experience of metabolization, generates a new/other form of life that dilutes many taxonomical borders and, while embracing the uncontrollable nature of the living, becomes evidence of bio-centered digital technologies. Some ideas about the possibilities of biological computers as co-creative / co- metabolizing / co-evolutionary media are explored in this text with a media theory approach that intertwines with *speculative fabulation* (Haraway, 2020) in its way.

In an early stage, the discourses and experiments surrounding biocomputing show clearly how the development of this media is given from a strong anthropocentric, still extractivist, understanding and relation to nature. The motivations, aims, narratives, and methodologies seek for the continuation of human-controlled technology creation, even when

other entities, traditionally understood as living ones, are directly involved as components of it. From that utilitarian perspective, biological organisms appear more capable of complex information processing (human-interesting one), and more efficient in terms of energy consumption or their ability to self-replicate and repair, among many other characteristics.

However, an *other* comprehension of the aesthetics, biologically based (Maldonado, 2021a), radically transforms the kind of relations we would be able to create with these computers. It brings a relevant new/other understanding that situates the narratives and creative processes with biocomputers in a life-enabling wide range of possibilities. While the shared experience among living organisms is an aesthetical one, the matter of the inter-living-entities co-creation becomes life itself. On this path, artistic projects such as *Myconnect* (2013) by Saša Spačal, Mirjan Švagelj, Anil Podgornik, and Tadej Droljč, and *Biocomputer Music* (2015) or *Biocomputer Rhythms* (2016) by Eduardo Miranda are early expressions of this interspecies co-creation through digital media.

Queer forms of life explore the emergence of these new hybrid entities through the sharing of our digital technologies with other living organisms. Our digital technologies offered to other living organisms, in the same way that other living organisms' technologies, such as fermentation, for instance, are shared/interconnected with us. These collaborative creation processes with them require new common languages and methodologies, and relocate the artistic creation from a visual or tangible piece, as an outcome, to the creation of the media or symbiotic bio-digital organism itself.

ORGANISMS THAT COMPUTE AND COMPUTERS THAT METABOLIZE

Biological computation at its base proposes the understanding of the processes that living organisms perform as computational ones. The concept emerges in an ecosystem of diverse biology-computation relations, among them: the metaphors used in biological-inspired digital systems or algorithms (Bio-inspired computing), the study of the way living organisms process information (Biological computation), and the application of these discoveries and understandings to the so-called hypercomputing (Biological computers / Biological computing), computers with biological processors.

The questions about how living organisms process information, and how we humans can relate to these processes, open an enormous field of exploration that starts, for instance, with the kind of metaphors we are using to understand nature, and includes, among others, the motivations, aims, and methodologies to develop technologies that appropriate or implement this media. It brings new/other forms of knowledge that need to be reviewed and transformed in an early stage of development, in the context of the biocentric turn that emerged alongside Lyn Margulis' (1999) symbiotic planet ideas.

As presented already in 2010 by Melanie Mitchell, although it seemed clear to that point, according to some publications in the field, that biological organisms "compute", there was still little agreement about what the main concepts such as "information" and "computing" mean in biological systems. The author established how some problems that appeared at the beginning of the development of computation, concerning biology, still remained. For instance: "the limited amount that was known about the mechanisms of biological information processing, and the lack of a formal theory of computation that was applicable to those mechanisms and that went beyond imprecise metaphors." (Mitchell, 2010, p.2)

With that consideration, the current experiments and narratives on biological computation are explored with that latent question. How the

concept of computation becomes much more open, so that it can include living organisms' processes.

Today, a wider definition, related to Maldonado's (2022a) 4th argument towards understanding life in light of a Physics of the immaterial: hypercomputation as a new logic of life, opens up many more possibilities. It states a contemporary understanding of biocomputation that widely transforms the concept of computation and information as living processes:

"Living beings are not a machine in any sense of the word (not even a quantum machine or a quantum information processor) and cannot be explained in terms of the Church–Turing thesis. In other words, we are to understand life not by what it is but by what living beings do. Living beings metabolize, process information, and are capable of homeostasis. Computationally speaking, such features can be grasped as follows: living beings process information nonalgorithmically. These three processes provide three different ways to conclude that life and information are closely intertwined, if not one and the same thing." (Maldonado, 2022a, p. 2)

This approach opens the path to, instead of bringing living organisms to a non-living comprehension of computers/machines, bringing computers/digital media, to a living organism's comprehension. It re-creates the metaphor. Living organisms overcome the reductionist idea of machine behavior that actually holds back our understanding of what can be done when creating with life itself. This is argued also by Grozinger et al. (2019), when mentioned that it is surprising how much space the "biological circuit" metaphor has gained, while limiting the creation of new kinds of knowledge truly related to what they call the *cellular supremacy*, meaning, looking for problem domains in which the biological computing can offer possibilities beyond those already covered by traditional microprocessor-based computers.

Computational processes, according to Maldonado, are then processes of metabolism of information, and that understanding gets stronger when the components of our computational media are the ac-

tual biological ones. Understanding computational processes as living processes implies big transformations and possibilities for the development of the media of biocomputers and the kind of creative processes we would be able to perform with them.

Biological computation settles the bases for the development of biological computers. This new technology field includes a wide range of experiments on how to process information through/with DNA, proteins, biochemical processes, and cells, these last ones as considered the smallest living unit. The applied knowledge in the development of these new technologies, at an early stage, enters right away the context of interspecies communication and co-creation processes. A human-developed technology that brings other queer forms of coexistence of/in nature, to be presented in this text.

Biological computing designates then the kind of computers that have/use biologically derived components or living organisms as components. DNA, proteins, cells, and therefore unicellular or acellular organisms, become part of a computational system that processes complex information, performs parallel computing, or in the context of biocomputational art, creates. Among diverse media or biological components for biological computing, the exploration in this text and the new narratives proposed by the *Queer forms of life* concept relate to the computers that include living organisms, such as fungi and bacteria, and particularly to the emergent media of the Internet of Bio and Nano Things (IoBNT).

Before going directly to bacteria, some advances by biological computing with other biological components are worth mentioning. The storage of seven hundred terabytes of data in one gram of DNA (Church et al., 2012); the creation of a "transcriptor", a biological version of a transistor, using DNA and RNA, able to replicate logic gates like AND, NAND, OR, XOR, NOR, and XNOR (Bonnet et al., 2013); and the performance of parallel computation with the design of a nanostructured network explored by a large number of molecular-motor-driven agents (Nicolau et al., 2016). Among others, these experiments are opening possibilities for biocomputers to be developed and, maybe not so long in the future, implemented. Alongside, research projects such as Sta-

tion B (Microsoft, 2009-2021), already retired, or those by MIT biological engineers who designed a “programming language for bacteria” (Trafton, 2016) have aimed to develop interfaces for the programming of these synthetic biology media, just to mention a few.

One step further in the scale, some research groups have experimented with biocomputers formed by bacteria, which bring one more possibility with them: the network-based biological computation, distributed biocomputation. In this path, a group of researchers at the Institute of Nuclear Physics created a distributed computer with engineered bacteria (Roberts, 2021). The goal was to perform distributed calculations, to solve classical computational problems, among different kinds of engineered cells. For some authors, it brings us a step closer to what biological computers can do, further than what current computers do.

Among this network-based biological computers’ development, there is a new media emerging: the Internet of Bio and Nano Things (IoBNT). Proposed as a paradigm-shifting concept for communication and network engineering by Akyildiz et al. (2015). It presents the possibilities of synthetic biology and nanotechnologies to allow the engineering of biological embedded computing devices.

As part of those IoBNT technologies, the Internet of Bacteria can be created. Bacteria connected to our Internet of Things infrastructure, to which we humans could be able to send direct messages to achieve, as presented up to now, human-defined purposes.

A mention of an ongoing project connected to this term is needed. Currently, as a citizens science project, the *Internet of bacteria* project by Daria Minakova (2021), an ITMO student, wants to identify, together with the citizen collaborators, the types of microorganisms that exhibit a high propensity for electrogenicity, while studying samples of soil through IoT devices. The project experiments with many interesting layers in which, besides mapping the possibilities for bacteria as a source of energy, the connection of bacteria communities to the IoT infrastructure is built collectively, to amplify the outreach. It uses in a way the metaphor of the “internet of bacteria” for a collective endeavor to send the collected information via the internet, but at the same time

explores a kind of signals that could be used to interact with the bacteria, the electric ones.

Back to the Internet of Bacteria (IoB) technologies development, in their paper “The Thing with E.coli: Highlighting Opportunities and Challenges of Integrating Bacteria in IoT and HCI”, Kim and Poslad (2019) established that a comparison between bacteria and IoT devices could be done in order to consider the possibilities of the bacteria to become part of the IoT network, in the context of the IoBNT. According to them, both can, for instance, sense, process information, and actuate. But furthermore, bacteria are autonomous and motile “helped by an embedded, natural propeller motor” (Kim, R. & Posland, S., 2019, p.1), the storage memory located in their DNA has, as mentioned, many advantages, and the cellular membrane can be understood as a transceiver that allows transmission and reception of communication.

In the doctoral thesis “Fundamentals of bacteria-based molecular communication for Internet of Bio-Nanthings”, Unluturk (2020) studies further the possibilities of bacteria as part of this emergent media and brings the experiments to the use of these technologies in the field of human health, as an application to detect infections. Through the research, the author proposes blueprints for bio-nano communication devices, both biological and electrical based. This thesis becomes an important reference on the state of progress in the development of the kind of bio-digital interfaces to be created.

Now, located in the development of IoBNT, it can be perceived again how the understanding of the media goes back, in a way, to the machine metaphor, in which living organisms, compared to electronic devices, have certain functions and advantages. This particular media helps us to understand better with one example, how the human-oriented or human-centered focus is still so present, and the kind of narratives that it is bringing with it. It requires once again flipping the comparison to embed this upcoming media into the understanding of an interconnected living organism.

Once the direction of the metaphor is changed in biological computing, computational processes of living organisms are then understood

as metabolization processes, and when computers are built by biologically derived components, the frontiers are blurred to become living organisms. What we could have then is no longer organisms that compute or computers that metabolize but, simply, hybrid organisms that metabolize, a form of life with which we co-evolve.

BIOCOMPUTATIONAL ART: CO-CREATION / CO-METABOLIZATION / CO- EVOLUTION

Understood as a queer form of life, biological computers as living systems do metabolize. Metabolization processes in a wider comprehension of knowledge and aesthetics become later a relevant point of interconnection among humans, other traditionally-understood-as- living organisms, and new hybrid forms of life. This shared experience brings the artistic creation through/together with biological computers to a different realm than the creation with a new media. Some artistic projects have experimented with biological computers or bio-digital interfaces, and have opened the path in the field of biocomputational art, which becomes a field that entangles digital- and bio-art and challenges our current creative methodologies and aims.

The kind of biological processes, performed by the biological components in biocomputers, include, for instance, molecular communication, electric signals exchange, or even horizontal gene transfer. In biology, metabolization refers to the chemical and physical processes that occur inside a living organism to maintain its life. It includes the transformation of nutrients into energy or any other process that requires this last one. As mentioned before, metabolization is in general terms what living organisms do. However, it also implies a creative experience of being in/creating the world.

Ideas such as those brought by Maturana and Varela in *The three of knowledge* (1984), in which they propose that the process of knowing is the same as being alive, opened up a wide wonderful spectrum of understandings of life itself and the relations with nature we and other organisms have. The biological bases of knowledge helped us comprehend better that experience has a fundamental role and it could be understood from a phenomenological approach. Expanded to other living organisms, according to the authors, the process of knowledge is constitutive of being a living being.

In that path, more recently and in the context of a new/other aesthetics that emerges from the complexity sciences, Maldonado (2022b) pro-

poses a wider comprehension of metabolization: Life, as a process, metabolizes information, matter, and energy, and this is the biological base of the aesthetic experience that we all living organisms share. An aesthetic that is at the same time the experience of life, the process of being alive.

A bio-aesthetic (Maldonado, 2021a/2021c) emerges as a counterpart or alternative to the reductionist comprehension of aesthetics from a highly anthropocentric, encephalocentric, and ocularcentric way that we currently have, according to the author. At first, he presents how the invention of rationality did hold back our experience of the world, and how current discoveries in biology, such as the gut and the heart being two more brains, help us bring back a comprehension of a whole-body experience of the world, in humans. But furthermore, alternatively to a long tradition of the human as the only one capable of aesthetic experience or even creativity, a biology-based aesthetic includes the whole organism's body, senses, life experiences, and creative processes of any living organism.

According to the understanding of metabolization as an aesthetic experience, every living organism has aesthetic experiences, every living organism creates. Creativity as an outcome of the process of metabolization. Our creative processes as nature's creative processes.

Life can be understood as that which is creative (Hernández, 2020). Life diversifies, constantly mutates, is adaptative. It develops amazing ways to enable itself. It evolves. Life needs no conditions to emerge but creates its own conditions (Maldonado 2021c). Life is autopoietic (Maturana, H. & Varela, F., 1973), generates itself, or even more wonderful, it is sympoietic (Haraway, 2016), it generates together with others.

What the idea of bio-aesthetics brings us then, which is of great relevance, is once again the elimination of the narrative of a human being separated from nature, if not still understood as superior. As presented by Lynn Margulis (1999), humans are an association of other living organisms, and at the same time are part of a bigger association of living organisms shaping the biosphere. Our metabolization processes as interconnected living organisms are all entangled, and so are our

creative processes and the development of our technologies.

The comprehension of the processes of the living organisms as intertwined aesthetical experiences in the network of life, implies already a whole transformation in the way the relation between biology and computation will be understood from now on.

When human creative processes are an outcome of nature's creative processes, the development of human technologies, such as the digital ones, enters that path too. Creative processes are then not exclusive to humans, but also human creative processes are not exceptional. Human technologies need to be understood as embedded in nature's network, and in doing so, their unfolding would go along with life's purpose (not purpose) of enabling life itself.

With the previous ideas in mind, it is clear also that any creative process with biological computers, as hybrid living organisms, is a shared aesthetical experience, is a co-creation. When intertwined, as all living forms are, creative processes to enable life, such as the creation of human or other living organisms' technologies, are processes of co-evolution. An idea that gets much more strength when we know, through epigenetics, that the life experiences of living organisms transform the expression of their genes. Or as presented by Margulis (Feldman, 2019), evolution is not based on random mutations of passive beings, but rather is an active performance of living organisms. Connected to Haraway's ideas (2016), it can be understood as a way of worlding.

Furthermore, this new comprehension of computer sciences and biology relations questions the matter and the purpose of a biocomputational art creation, when it becomes a life experience for both, the human and the living processor. The collaborative metabolization of the given information in a context that would not exist outside the artwork.

Our approach to Biocomputational art is then as a co-creation process. From that perspective, three artistic projects help us understand better the kind of relations that through artistic practices are being created with other living organisms, when we can directly intervene in their metabolization processes with our digital media.

Myconnect (2013) by Saša Spačal, Mirjan Švagelj, Anil Podgornik, and Tadej Droljc is an immersive experience of interspecies communication. In a cabin, that resembles a medical laboratory space, physiologic signals generated by the human nervous system are transmitted, through an interface that translates them, to a culture of *Pleurotus ostreatus*, a fungal mycelium inside Petri dishes. Their reactions to the signals are presented back to the human interacting through light, sound, and movement.

Biocomputer Music (2015) and *Biocomputer Rhythms* (2016) are musical compositions by a human, Eduardo Miranda, and *Physarum Polycephalum*, the Blob. The project develops bioprocessors with the mentioned acellular, always surprising, organism, which are connected to the piano. The artist plays a melody that is transmitted to the microorganism as electric signals, to which the Blop reacts by sharing new electric signals. These last ones are interpreted once again by the biocomputer as a melody created by the slime mold.

The first mentioned project is not presented by the authors as a biocomputational artwork. However, the kind of interactions generated, as well as those created by Miranda, include the translation of human-generated signals to be comprehended by the other living organism and the translation of signals generated by the other living organism to human-readable ones, by means of digital media. The difference is related to the discourse surrounding the work, and the place that the living organism gets in it.

In *Myconnect*, the installation speculates about interspecies communication. It is centered on the interaction of both living organisms, and the artistic creation is understood as so. In *Biocomputer Music* and *Biocomputer Rhythms*, the other living organism takes much more the shape of a component, the processor, to generate an art piece, the sound piece. The transformation of the narrative that implies another position for the living organism relates once again to the transformation of the anthropocentric to the biocentric turn. Even when considered as biocomputational creative processes, we can understand the creative artistic process in both projects as the interaction itself.

The projects experiment with the creation of an interface that allows us to interact with other living organisms through our digital media, with the kind of technologies that can be implemented up to now, which will be much more expanded with synthetic biology opening its way. The open dialogue with the living organism is clearly conditioned by the possibilities of the interface in terms of shared languages, and this is a critical point for biocomputational art.

Besides the outcome of the processing of information, with its sensorial characteristics or human-readable languages, what becomes central in the creation of biocomputational art is the interface. That is what *Queer forms of life* explores. An artistic process as the creation of an interface of interaction among different living organisms that, similarly to generative art, leaves the creative process open for the hybrid living organism that emerges to perform it. Even without one of those interacting living organisms being a human.

QUEER FORMS OF LIFE

In the context of organicist ideas, a comprehension of living organisms as the symbiotic biosphere, and the aim to create other relations with them, namely *Other politics of the living*, queer forms of life can emerge. They open the possibilities for a new/other understanding of biocomputers, a biotechnology that is no longer an emergent media but an emergent living organism. A bio-digital symbiosis through the offering/sharing of our digital technologies to/with other living organisms, beyond the anthropocentric control of the process and the outcomes. A co-creation with nature for which the languages involved are common for both organisms, being biologically-based, process-based, meaning life-based.

Organicist ideas come from the understanding of nature as a living organism itself. From the beginning of Biology as a discipline, it has been built as a philosophical perspective. It has brought to us the possibility to stop understanding nature as a resource for humans, a foundational idea of western civilization, or later on as a machine, from the modern epoch, avoiding mechanistic and reductionist views on life (Maldonado, 2021b). Our biosphere is “symbiosis as seen from space” (Margulis, 1999).

We look today for other theories that allow us to understand life as a process and dilute the difference between living and non-living entities. As Francisco Varela (2001) says, through our science, we make a huge effort to imagine a dead (physicalist) universe and how life emerges from it, when on the contrary, life precedes existence. It can be understood that life is the process that allows existence.

In the context of the *Queer Forms of Life* Creation Group (Suratómica, 2021a), in our creative processes with Mutante, and in various dialogues woven with activist, care, and resistance communities, wonderful ideas are emerging about this other context to think, create and relate to each other, humans and other life forms. *Other politics of the living* (*Otras políticas de lo vivo*) initiated as a conversation frame within that Creation Group (Suratómica, 2021b). The dialogue, in the context of

the social outbreak in Colombia that began in April 2021, about the definitions of life and the responsibility over the forms of life to be discovered or created expanded itself through a co-creation context for the Suratómica network in collaboration with the Enjambre interzone (2021a) and, later on, as a Creation - Art and Science encounter (2021b).

In *Other politics of the living* it was thought about what the Living is, and about it, the political implications of assigning a definition to life. About a worldview that is still hierarchical today and that, establishing a scale between the living and the non-living, generates again the idea that what is considered alive is more important, more deserving of care, than what we do not consider as well so far. And in addition, the question was explored about how to think/create other forms of life, outside the form of knowledge that discovers to dominate, to colonize, and, in that path, that corresponds to the current scientific-capitalist structure, to exploit and make a profit.

In the conversation spaces, Luis Williams-Fallas, Daniela Brill, Juan Diego Rivera, Carlos Acosta, Lina Orejuela, and many other participants, brought amazing ideas and questions to the table. How to understand what is the Living; how to understand and generate responsibility for what is not yet existent, what we still do not know, without imposing power on them; how to do it when even our relations with what we know now continue to be one of domination. What is the responsibility of care about the new possibilities that we as artists/ scientists/... create? If we create a new and weird form of life, what is our relation of care with it?

These questions have constantly surrounded the bioart space since its beginnings. By thinking of the matter of the living as a particular and/or more important matter, huge ethical questions have been raised around its practices. Some of these questions have even led to metaphors again in which humans have the abilities of gods. We give these biotechnologies extraordinary categories, and we fear them for that too. With good foundations, these questions have opened extensive discussions that have contributed to curing, in a way, those broken relations with nature and with ourselves, due to supremacist, extracti-

vist, colonizing, etc. ideas. The inquiries being made in bioart are so important that it is necessary to extend them to what is considered the non-living, and in this case to the QFL, to the hybrid forms of life. We need to think then about other politics of the living and the non-living, which could indeed be alive.

The concept of queerness, as indeterminacy, allows us to dilute those taxonomical, yet hierarchical relations mentioned above. It explores the encountering ideas of indeterminacy emerging from quantum physics and those from gender studies. From the physics field, as Karen Barad presents it, we understand that we can not know what nature is, not because of our lack of abilities, but because nature doesn't know itself, because the nature of nature is indeterminate (Barad, 2012). On the other hand Queer theories, widely expanded from gender to territory, to interspecies, to knowledge creation, bring us big freedom for this re-invention of nature. Binarisms and frontiers are no longer that strong and bio artists, such as Quimera Rosa with *Trans*plant* (2016), or Špela Petrič with *Phytoteratology* (2016), have amazing ways to approach and embrace this indeterminacy of the living, that open the space for the creation of new/other forms of life, the diversification of life.

The question of how to create new, weird, forms of life without a colonial, dominant, control- based approach is at the center of the development of biocomputers, and artistic processes can redirect this path. Biocomputers are a new queer form of life, a symbiogenesis by our life-like digital systems, the so-called biomimetic media or *BioMedia* (ZKM, 2021-2022), and other traditionally-understood-as-living organisms. They become an amazing pivot point for the biocentric turn. They emerge from the life-centered context we are creating now, and at the same time, out of our control, they could become the biocentric turn itself, particularly on digital media.

QFL enters and extends the field of the questions presented by the *BioMedia* exhibition, regarding our possibilities of cohabitation with artificial life forms -in this case, hybrid life forms- and the future of our entanglements with technological assemblages.

"The existence of organic life and artificial agents are not mutually exclusive. Instead, »BioMedia« proposes to imagine our relationship with artificial agents in multiple strands of interdependency. New methodologies and ideologies need to be investigated to answer the question of how we can enhance and sustain life in an alliance of human and more-than-human technological entities against the backdrop of the profound ecological crisis, mass extinction, and human-made climate catastrophe." (ZKM, 2021-2022)

For these hybrid forms of life and the new methodologies and comprehensions to emerge, in the context of a symbiotic planet and the understanding of life as a complex system, it is important that the development of the media situates itself in and creates at the same time the new/other relations needed. One of the most important considerations is related to the purpose of the development, another one addresses the kind of control we humans intend to have, and a third one explores the possibilities in terms of the languages and matters of the co-creation.

As the living system a QFL is, its purpose might be no more, and no less, than enabling life itself. This detaches immediately the creation of biocomputers from exploitative means and aims, including the living organism itself and the data that can be and is usually extracted. It responds to one of the main problems of the relations we are building with other organisms, the idea that we can define what their "utility" is. In a way, eliminating the utilitarian approach brings the creation of the queer form of life to the realm of arts, in a traditional sense, the other process that as well as life itself is allowed to exist/be created with no "practical" purpose. Furthermore, in a non-traditional sense, but included in this text, creative processes (*indisciplinary* ones) as life-enabling processes.

On the second consideration, the understanding of life by complexity sciences shows clearly how life does not accept any government, recognizes no frontiers, and can not be controlled (Maldonado, 2016). As complex systems, living organisms are anarchic, they diversify and

adapt, they generate the conditions to enable their existence, they co-evolve with the environment, within the network of life. The uncontrollable nature of nature implies that, if we embrace the creation of a living organism, we need to give up the pretended control we expect to have over those media/QFL.

If explored, the current development of this media, as a media, expresses the uncontrollability of biocomputers as one of the major challenges. In the development of the loBNT with bacteria, for instance, humans could be able to send information to the bacteria as DNA sequences, using sequencers and synthesizers, as demonstrated by Tavella et al. (2018), in the experiments developed around bacterial nanonetwork and communication. However, when the “informed” bacteria goes back to its environment, the outreach of this message is out of human reach and control. Kim and Poslad mention that:

“Firstly, one of the challenges stem from the autonomous nature in which bacteria can function. As they can evolve and behave autonomously, they could pose threat to natural ecosystems, and even become pathogenic. This may not apply to educationally-deployed K12 E.coli strains of course, but nevertheless the possibility is worth considering from a wider perspective.

Secondly, bacterial nanonetworks rely on transfer of data (encoded in DNA) through a natural process of conjugation and cell motility. Although highly-engineered bacteria may provide efficient communication systems, ultimately, they are biological entities, which can produce unexpected outcomes (e.g. mutations)” (Kim & Poslad, 2019, p.5)

When embraced as naturally uncontrollable, and trusted partners of co-creation, “uncontrollability” stops being a challenge or a possible upcoming problem and becomes the nature of the creative process itself, the creation process of a living form, the matter of a new kind of art form.

One way to understand this diluted control could be to understand our digital technologies as shared ones. We humans, and every other living

organism, are the coexistence of an intricate network of life forms and their technologies, that are indeed already shared with us, in this sense. They are shared, though, without the restriction of an experiment that seeks to control the conditions and the outcome of our embodiment of them or our use of them.

Following the Internet of Bacteria reference, the internet, IoT devices and infrastructure, sequencers, and synthesizers could not be used only to send information from humans to bacteria, but could become a media for bacteria themselves, an Internet FOR Bacteria. This hybrid network could allow them to perform freely the processes we are seeking to emulate for a human-controlled network, such as horizontal gene transfer, for instance. Bacteria could decide what messages to share, what to take and use from the cloud. The information would not be accessible to humans, not exploitable.

The Internet of Bacteria is currently an under-development networked biocomputing technology. With Tavella et al. (2018) experiments, Kim and Poslad’s (2019) ideas for implementation, and Unluturk’s (2020) exploration of possible health-related uses, it is already an emergent media, on track for future development and implementation. However, there is an interesting flip that can be acknowledged at this point: the fact that humans could send messages to the bacteria to perform processes we want them to perform is accepted, it shines as an innovative media, but the moment in which the idea of releasing the control to bacteria is mentioned, the whole project becomes, in traditional narratives, fictional.

In my view, this happens because all the old anthropocentric ghosts reappear. It seems again to us that humans can know better what bacteria could do with such a media. But is it not the other way? Couldn’t bacteria know better than us? Haven’t they known better up to now?

“Interconnection”, along with “hyperconnection”, is the term used to refer to the network generated by the IoT devices. We talk about interconnected spaces through IoT, for instance, but it is also known that nature is interconnected. Lynn Margulis explained in *Microcosmos* how bacteria could much easily recover from a catastrophe, in which we

humans would maybe fail, due to the interconnection they have and their ability to perform horizontal gene transfer:

“These exchanges are a standard part of the prokaryotic repertoire. Yet even today, many bacteriologists do not grasp their full significance: that as a result of this ability, all the world’s bacteria essentially have access to a single gene pool and hence to the adaptive mechanisms of the entire bacterial kingdom. The speed of recombination over that of mutation is superior: it could take eukaryotic organisms a million years to adjust to a change on a worldwide scale that bacteria can accommodate in a few years. By constantly and rapidly adapting to environmental conditions, the organisms of the microcosm support the entire biota, their global exchange network ultimately affecting every living plant and animal. Human beings are just learning these techniques in the science of genetic engineering, whereby biochemicals are produced by introducing foreign genes into reproducing cells. But prokaryotes have been using these “new” techniques for billions of years. The result is a planet made fertile and inhabitable for larger forms of life by a communicating and cooperating world-wide superorganism of bacteria.” (Margulis & Sagan, 1995, p.30)

Bacteria are then clearly already interconnected. What could our digital technologies bring to them? Would the internet-bacteria symbiosis enable life?

When the biocomputers are already understood as a living organism and their autonomy as such is acknowledged, the considerations are open about the kind of art, or rather, the kind of creative processes that we can perform together. These considerations include the matter that is transformed, the methodologies and the outcomes, and important too, the languages that are involved in the process.

The interaction digital - bio is mediated, or plans to be mediated, by a wide range of signals that can be transmitted to and read from the living organisms involved. Electric signals, for instance, or biologically derived components: biochemical molecules, DNA, RNA, and prote-

ins, among others. This biologically derived matter alongside the tangible matter of digital media, such as electronic components, are the QFL matter and media to process information, but as stated before, information alongside matter and energy. From such a material base for creation, the outcome could not be less impressive: biologically based matter, energy, and information. The kind of outcomes of a metabolism process: life itself.

The matter of co-creation with biocomputers establishes again, in my view, the question about the purpose of the development of the biocomputer and our position as developers. Pre- defining the possible outcome of a living organism as such, for instance as visual creations, might bring us back to the human-control-centered relations. The creation of a living organism, long explored by bioart, claims immediately for autonomy.

Methodologies of creation need to be explored at this point. Creation with biocomputers states the question of how much we humans intend to control the processes and the outcomes. To which extent do we create and from what point and on do we co-create with the other living organisms?

Some ideas come to mind, to take into account while exploring the upcoming possible methodologies: the extraction of the living organism from its habitat to a laboratory might be reconsidered in terms of how to embrace the complexity of the living organism-environment relation, instead of studying, experimenting, and creating in controlled spaces that could lead to a reductionist understanding; the information processing could protect the data from extractivist purposes; the process could aim for a horizontal relation among the living entities involved; back to the purpose, no particular aim of “improvement” should lead the creation, instead, the embracing of diversification; and, among many other considerations, an interface to co-create with other living organisms might allow the least control capability.

When proposed as a living organism, with which we co-create, co-metabolize, and co-evolve, the human outreach for this creative endeavor with biocomputers becomes the creation of the hybrid living organism

itself. Contrary to an outcome expected from a media-like technology, such as data visualization, sculptures, or architectonic structures, for instance, the *Queer forms of life* are the creation of the wide range of possibilities that a living organism itself can perform. A human contribution to nature/life diversification.

QFL dialogues with the concept of “The artwork as a living system” by Christa Sommerer & Laurent Mignonneau, presented at the exhibition with the same title by the ZKM (2022). In their projects, digital systems exhibit behavior like living organisms. It states that artificial life is a living system, and being so, their pieces are generative, evolutive. Considering as well, as presented up to now, that the creation with bio-computers is the creation of QFL, there is a beautiful fluent transition, a queer one, that brings us from digital media, through the *BioMedia*, the QFL, and the biological derived life and back.

This all brings our focus as creatives on how to create this kind of hybrid living organisms, namely, how to create the interface that allows us to build such a matter (digital - bio) bridge. The question and considerations about the languages appear. Languages of biocomputers might be as diverse as the living organisms they are intended to merge with. However, the languages used to create the bio-digital interface, that will enable and result in the co-creation process, need to be common to the living organism involved. Meaning that the outcome of the co-creation, if really co-created, must be readable/feelable/metabolizable for both.

In this sense, what is created by humans for the *Queer forms of life* to emerge is the interface. The porous membrane that allows the digital to bio and bio to digital metabolism.

For the Internet for Bacteria, the interface would be the kind of portal that allows bacteria to share their DNA over the cloud without human intervention. On one side DNA shared by the bacteria will be read through a DNA sequencer, in charge of translating the DNA bases into “A,C,G,T”-digital messages, able to be shared instantly and globally through the IoT network. On the other side, as a kind of actuator, the

interface would be able to synthesize the digital code into DNA fragments.

Internet for Bacteria, as a QFL, is a speculative approach that allows the concept to be presented, the methodologies to be explored, and the understanding through imaginative processes of the kind of outcomes of the creative endeavor through/with biological computers. It takes the chance to visit the “Aesthetics of the impossible” proposed by Iliana Hernández (2019), and states the need to create with the QFL through a multiplicity of methodologies, among them those used by complexity sciences such as modeling and simulation, or the metaheuristics.

CONCLUSIONS

Biocomputing, as coevolutionary technology, requires a transformation in the process of creation that detaches its development from the dominant anthropocentric view. By doing so, in the biocentric turn, they can be understood as hybrid forms of life that bridge the bio and digital media, as *Queer forms of life*.

Creating aesthetical experiences, including art but even further, with biocomputational technologies or QFL, if not exploitative based, is an inter-living-entities co-creation process. If embraced, the idea that our technologies could be shared with other organisms with no exploitative or domination purposes, means actually that they will be shared in order to enable life.

The development of an Internet of Bacteria in the context of the biocentric turn, *Other politics of the living*, and anarchy and complexity ideas, could lead, among other possibilities, to the development of an Internet FOR Bacteria. The offering of the internet to bacteria is a creative effort to bring more degrees of freedom to life itself. A collaborative inter-living-organisms creative effort. Creative processes through the Internet for Bacteria would be the co-creation of other possibilities for life to continue to break through and diversify.

This new/other relation among humans, the internet, and bacteria, in which bacteria is no longer a correspondence of a device for a human-oriented purpose but the internet becomes a shared technology with them, generates the idea of a new hybrid organism, a non-human cyborg that symbiotically coevolves. The symbiogenesis of a *Queer form of life*.

Turning the development of such emergent media into an interspecies co-creation and co-evolution process invites creative art and science relations, or even better *indisciplinary* ones, to move forward. Creating with speculative media means also shaping it for its, maybe not so far, upcoming development. The Internet for Bacteria narrative is an exploration of those possibilities through the design of an *indisciplinary*

speculative experiment for the symbiotic superorganism that the biosphere and bacteria are.

This kind of co-creative process outside the anthropocentric view can only exist if we humans give more trust to the living. Meaning that we need to eliminate the idea of being the ones in control. Considering that for four billion years life has created its own ways to break through. Considering that, as once sung by Margulis, if we listen carefully to the song the biosphere is singing we will hear: "I will get along without you". (Feldman, 2019)

The proposition of creating new/other/queer forms of life is then, as presented in this text, the proposition to create new/other/queer technology development processes and methodologies, namely non-anthropocentric, non-control based, non-dominant, anti-colonial, or, in positive terms, processes that embrace the degrees of freedom of nature, the uncontrollable nature of nature, *indisciplinary* creative processes that enable co-evolution and open the space for emergence and indeterminacy.

REFERENCES

Akyildiz, I. F., Pierobon, M., Balasubramaniam, S., & Koucheryav, Y. (2015) *The internet of Bio-Nano things*. In IEEE Communications Magazine, vol. 53, no. 3, pp. 32-40, March 2015, doi: 10.1109/MCOM.2015.7060516.

Barad, K. (2012). *What Is the Measure of Nothingness? Infinity, Virtuality, Justice*. dOCUMENTA (13). documenta und Museum Fridericianum Veranstaltungs-GmbH. Kassel.

Bonnet, J., Yin, P., & Ortiz, M.E. et al (2013) *Amplifying genetic logic gates*. Science 340:599–603

Center for Art and Media - ZKM Karlsruhe (2021-2022) *BioMedia*. Exhibition. <https://zkm.de/en/exhibition/2021/12/biomed>

Center for Art and Media - ZKM Karlsruhe (2021-2022) *The artwork as a living system*. Exhibition. <https://zkm.de/de/ausstellung/2022/05/christa-sommerer-laurent-mignon-neau-the-artwork-as-a-living-system>

Church, G. M., Gao, Y., & Kosuri, S. (2012) *Next-generation digital information storage in DNA*. Science 337, 1628.

Feldman, J. (2019) *Symbiotic earth: how Lynn Margulis rocked the boat and started a scientific revolution*. [Video]. Hummingbird Films Production, Bullfrog films, Inc.

Grozinger, L., Amos, M., Gorochowski, T.E. et al. *Pathways to cellular supremacy in biocomputing*. Nat Commun 10, 5250 (2019). <https://doi.org/10.1038/s41467-019-13232-z>

Haraway, D. (2016) *Staying with the Trouble. Making Kin in the Chthulucene*. Duke University Press.

Hernández, I. (2020) *Creatividad Creciente y Paisajes Artificiales_Iliana Hernández_Festival Suratómica_Día 3*. Suratómica Espacio. [Video] <https://www.youtube.com/watch?v=i1aOr9wMOMk>

Hernández, I. (2019). *Estética de lo imposible*. Dat Journal. <https://doi.org/10.29147/dat.v4i2.127>

Kim, R. & Poslad, S. (2019) *The Thing with E.coli: Highlighting Opportunities and Challenges of Integrating Bacteria in IoT and HCI*. CHI'19 Extended Abstracts, May 4-9, 2019, Glasgow, Scotland, UK. DOI: <https://doi.org/10.1145/3290607.XXXXXX>

Maldonado, C. & Mezza-Garcia, N. (2016) *Anarchy and complexity*. Retrived on 4/9/2020 from journal.emergentpublications.com

Maldonado, C. (2021a) *Estética y complejidad. Elementos para un estado crítico del arte*. Editorial Suratómica.

Maldonado, C. (2021b) *¿Qué es el organicismo?* [Video] Periódico Desdeabajo. <https://www.youtube.com/watch?v=EE8NRHEPAe0>

Maldonado, C. (2021c) *Complejidad y estética*. Creation Group proposed by Carlos Eduardo Maldonado. Suratómica Network. <https://www.suratomica.com/gruposdecreacion>

Maldonado, C. (2022a) *Five Arguments toward Understanding Life in Light of a Physics of the Immaterial*. Proceedings 2022, 81, 19. <https://doi.org/10.3390/proceedings2022081019>

Maldonado, C. (2022b) *Lanzamiento del libro Decir lo inefable - Carlos Eduardo Maldonado*. [Video] Suratómica Espacio. <https://www.youtube.com/watch?v=hMkWrFEO5AY>

Margulis, L. (1999) *Symbiotic Planet: A New Look at Evolution*. Basic Books.

Margulis, L. & Sagan, D. (1995) *Microcosmos. Four Billion Years of Microbial Evolution*. University of California Press.

Maturana, H. & Varela, F. (1984) *El árbol del conocimiento. Las bases biológicas del entendimiento humano*. Lumen Editorial Universitaria.

Maturana, H. & Varela, F. (1973) *De máquinas y seres vivos. Autopoiesis: la organización de lo vivo*. Editorial Universitaria.

Microsoft (2009-2021) *Station B*. <https://www.microsoft.com/en-us/research/project/stationb/>

Minakova, D. (2021) *Internet of Bacteria*. <https://internetofbacteria.org/en/>

Miranda, E. (2015) *Biocomputer music* [Biocomputer and music performance]. <http://neuromusic.soc.plymouth.ac.uk>

Miranda, E. (2016) *Biocomputer Rhythms* [Biocomputer and music performance]. <http://neuromusic.soc.plymouth.ac.uk>

Mitchell, M. (2010) *Biological Computation*. Computer Science Faculty Publications and Presentations. 2. <http://archives.pdx.edu/ds/psu/10197>

Nicolau, D. V., Jr., Lard, M., Korten, T. et al. (2016) *Parallel computation with molecular-motor-propelled agents in nanofabricated networks*. Proc. Natl. Acad. Sci. U. S. A. 2016, 113, 2591– 2596, DOI: 10.1073/ pnas.1510825113

Petrič, Š. (2016) *Phytoteratology* [Bioart]. <https://www.spelapetric.org/#/phytoteratology/>

Quimera Rosa (2016) *Trans*plant* [Bioart]. <https://quimerarosa.net/transplant/>

Roberts, S. (2021, November 9) *An E. coli biocomputer solves a maze by sharing the work. Genetically engineered bacteria, rigged up as a distributed computing system, might help realize synthetic biology's loftier goals*. MIT Technology Review. <https://www.technologyreview.com/2021/11/09/1039107/e-coli-maze-solving-biocomputer/>

Spačal, S. et al. (2013) *Myconnect* [Installation]. <https://www.agapea.si/en/projects/myconnect>

Suratómica (2021a) *Formas extrañas de vida*. Creation Group proposed by Natalia Rivera. <https://www.suratomica.com/gruposdecreacion>

Suratómica (2021b) *Otras políticas de lo vivo* [Video] Suratómica Espacio. (<https://www.youtube.com/watch?v=Exsll4y7WXY>).

Suratómica & Enjambre (2021a) *Otras políticas de lo vivo*. Co-creation context. <https://www.suratomica.com/contextoopdlv>

Suratómica & Enjambre (2021b) *Otras políticas de lo vivo*. XII Encuentro de Creación - Arte y Ciencia. [Video] <https://www.youtube.com/watch?v=iX-Z3XvnTgs>

Tavella F., Giaretta, A., Dooley-Cullinane, T. M., Conti, M., Coffey, L., & Balasubramaniam, S. (2018) *DNA Molecular Storage System: Transferring Digitally Encoded Information through Bacterial Nanonetworks*. <https://arxiv.org/abs/1801.04774>

Trafton, A. (2016, March 31) *A programming language for living cells. New language lets researchers design novel biological circuits*. MIT News Office. <https://news.mit.edu/2016/programming-language-living-cells-bacteria-0331>

Unluturk, B. D. D. (2020) *Fundamentals of bacteria-based molecular communication for Internet of Bio- Nanthings*. <http://hdl.handle.net/1853/63691>

Varela, F (2001) *Francisco Varela (Neurobiologo) - La Belleza-Del-Pensar-2001* [Video] Humanista. <https://www.youtube.com/watch?v=3-VydyPdhhg>

INTERCONNECTED NATURE

INTERNET FOR BACTERIA

Interconnected Nature: Internet for Bacteria is a speculative art-science (indisciplinary) research project to generate an internet-bacteria symbiosis, that creates other possibilities for the Internet of Bio and Nano Things (IoBNT) besides the nature-extractivist and exploitative discourse of these under-developing technologies. It explores other possible inter-living-entities relations that embrace the uncontrollable nature of the living and sets aside human interaction among the mentioned entities.

Through an offering/sharing of our digital technologies and a collaborative effort, Bio-IoT mediating devices would be placed in different soils around the globe to allow bacteria to perform horizontal gene transfer through the internet. Shared DNA in one soil would be instantly globally available.

Lynn Margulis (1995) described how bacteria could, through horizontal gene transfer, quickly recover after a natural disaster, that would take us humans, for instance, much longer or even fail. What could mean for such an impressive collaborative process of bacteria the access to a human-created global network with the IoT infrastructure?

Internet for Bacteria is the exploration of the possibilities of our current digital communication technologies as interspecies/inter-living-entities mutual aid technologies or, even further, symbiotic ones.

The upcoming documentation presents the contexts, methodologies, and processes to create an interface that would allow the hyperconnected bacteria superorganism to emerge as a *Queer form of life*.

EXPLORING THE POSSIBILITIES OF OUR CURRENT AND EMERGING DIGITAL COMMUNICATION TECHNOLOGIES TO BECOME OR BE UNDERSTOOD AS INTER-LIVING- ENTITIES MUTUAL AID/SYMBIOTIC MEDIA.

OPEN QUESTION?

I have explored some possible ways to write a question relating to the living beings to hybridize, avoiding in a way previous expectations or definitions on how this experiment should develop.

Through Speculative Fabulation and the experimental narratives with generative text, I get to dialogue with the current knowledge, narratives, ideas, and possibilities for this fiction.

What if? - As an open question for the creation of narratives.

In terms of life. In the context of evolutive biology, which extends, as presented before, beyond the living organisms we have considered living so far, the moral concepts of what is good/bad for the living beings included could be reconsidered. Instead, the question to ask in terms of life, according to Carlos Maldonado(2021a), is: does it enable life?

SPECULATIVE FABULATION

When researchers tried to create a bacterial processor for biocomputing, bacterial communities evolved over time into a complex network connected through the internet, that both competed and cooperated to survive.

WHAT IF?

What if bacteria take over the internet?

IN TERMS OF LIFE

Would a symbiotic relation between bacteria and the internet enable life?

CONTEXTS / PROCESSES / METHODOLOGIES

[STRATEGIES OF INVOLVEMENT]

CREATING A NEAR IMPOSSIBLE SYMBIOTIC BIO-DIGITAL ORGANISM

With *Interconnected Nature: Internet for Bacteria*, I have taken the chance to give the imaginative process a more relevant space over the outcome as an art piece. In the sense of collecting and creating interdisciplinary knowledge that will shape a project that, being feasible as a scientific research project, for instance, crosses and questions the anthropocentric boundaries that require for it to be fictional.

It entangles diverse methodologies and processes that allow the project to interconnect with different emerging biocentric narratives while aiming to contribute to them too. The main ones refer to methodologies to design a scientific experiment and the biotechnologies and resources required to carry it out and, on the other side, the fictional, not less real, narratives that appear and intertwine when the project speaks for non-human centered digital biotechnologies.

Speculative Fabulation (Haraway, 2016) allows me to dialogue with the technological possibilities of the ongoing underdevelopment media of biocomputing while re-arranging the narratives and metaphors. I find fascinating Haraway's thoughts and proposals about the *worlding* power of scientific knowledge and narratives, and I seek for the transformation of these last ones to be my creative practice.

Marta de Menezes's proposal for the *Moon's moon* project opens an amazing conversation on how to give space to the research, imagining, and shaping of a project as an artistic outcome in itself. In her words: "This project explores the idea that a body of knowledge can be developed as an artwork. It consists in collecting and eventually exhibiting information about the creation of a near impossible art-object." (De Menezes, 2021)

Methodologies on how to deal with "near impossible" artistic mediation can also approach the *Aesthetics of the impossible*, proposed by Iliana Hernández (2019) or the *Epistemology of impossibility or Science of indetermination* by Carlos Maldonado (2021b). There, *indisciplinary* creative practices beyond the already-known or understood as feasible are more than relevant to create our experience of the world while creating the world itself. Creating in such a context is not to determine an outcome but to open the chance for possibilities to emerge.

All in all, *indisciplinarity* allows the inter/intra action of a plurality of methodologies. In-discipline speaks for the non-existence of defined disciplines and at the same time, similarly to the word in Spanish, *undisciplined*, a lack of disciplined behavior.

COLLABORATIVE PROCESSES

My understanding of any human creative process is as an expression of nature's creative processes, evolutionary, interconnected, collaborative, and collective. In that sense, it is relevant for the contexts, ideas, and proposals included in this research/creation project to blur the imaginary boundaries of a lineal, individual, and isolated creation process and rather seek to share how from the encounter with others, humans, other traditionally understood-as-living organisms, and hybrid bio-digital organisms the ideas and creative processes emerge.

This has been an important base for my creative practice, in which opening spaces, or inhabiting spaces, for collective conversation and co-creation became not one but a multiplicity of methodologies.

Ten years ago, the first encounters of the Mutante Laboratory's participants were organized. It was my first approach to collaborative processes as knowledge creation processes, in the frame of my bachelor's thesis. Afterward, the numerous dialogues, spaces, events, encounters, and projects organized and created by this art and science laboratory have opened, as well, numerous possibilities for creative practices, situated mostly in Bogotá, but globally connected through the Suratómica Network.

Dialogues together with Mutante and different communities or creatives during the development of previous projects such as the *Expanded Bestiary (Bestiario Expandido)* (2019), already approaching *Speculative fabulation* creative processes, are also of great influence to the *Queer Forms of Life* idea.

I want to acknowledge the relevance of all those spaces and collaborations for the creation of this project, having in mind however that it might not be possible to include all the experiences, conversations, and actions that shaped it, but stating clearly how it is a co-creation, an outcome of an encounter of multiple networks, that exceeds an individual process or effort.

Among them:

1. **At the edge of chaos** (En el filo del caos).
Co-creation cycle. Suratómica Network. 2021 - currently.
2. **Other politics of the living** (Otras políticas de lo vivo).
Co-creation context. Suratómica Network and Enjambre Interzone. 2021 - currently.
3. **Queer forms of life** (Formas extrañas de vida).
Creation group. Proposed by Natalia rivera. Suratómica Network. 04-05.2021
4. **Microcosmos**. Creation group.
Proposed by Corpogen and Biocrea Network. Suratómica Network. 04-06.2021
5. **Complexity and aesthetics** (Complejidad y estética).
Creation group. Proposed by Carlos Maldonado. Suratómica Network. 08.2020-03.2021
6. **Other politics of the living** (Otras políticas de lo vivo).
XII Creation - Art and Science Encounter. Suratómica Network and Enjambre Interzone. 04.2022
7. **Other [tiny] forms of life**. (Otras [pequeñas] Formas de Vida).
Creation project by Mutante and CorpoGen. 2022
8. **New Media Class**. Berlin University of the Arts UDK.
WS20/21 - SS22.

-

- [1] <https://www.suratomica.com/cicloenelfilodelcaos>
- [2] <https://www.suratomica.com/contextoopdlv>
- [3] [4] [5] <https://www.suratomica.com/gruposdecreacion>
- [6] <https://www.youtube.com/watch?v=iX-Z3XvnTgs>
- [7] <https://www.mutantelab.com/opfdv>
- [8] <https://newmedia.udk-berlin.de>

QUEER FORMS OF LIFE

CREATION GROUP - SURATÓMICA NETWORK

The first co-creation space directly connected to this research/creation project was the *Queer forms of life* (Formas extrañas de vida) creation group, connected to the Suratómica Network's third cycle of creation groups, from April to May 2021. This space established in a way the conceptual frame and political positions from which the queer forms of life would be thought.

Together with all the participants, we wondered about the definition of life, the multiple current definitions, and the political implications of establishing a definition. The questions focused on how to relate to, discover, and create forms of life without controlling, colonizing, dominating, or even defining.

As an outcome, *Queer forms of life* became a comprehension frame that embraces the indeterminacy of life, of the life forms that we already know and life forms as they could be. Questioning the taxonomical borders, the hierarchy among the living and the considered-non-living things, and the presumed need, that we as humans have, to determine nature. These ideas are shared in the first part of this book.

While having these conversations, the social outbreak in April 2021 in Colombia started. More than the knowledge of life, the experience of life was urgent, and so our narratives entangled with those politics emerging from a full-of-life expression of the protests in the streets. We learned from and allowed our creative processes to be transformed by them.

With the derived context *Other politics of the living*, created together with the Enjambre Interzone, the *Queer forms of life* concept embraced the anarchic nature of the living, as understood as a complex system (Maldonado and Mezza, 2016).

L-System by Natalia Rivera. Poster *Queer forms of life* creation group. Suratómica Network. (2021)



OTHER [TINY] FORMS OF LIFE

CREATION PROJECT BY MUTANTE AND CORPOGEN

Other [tiny] forms of life (*Otras [pequeñas] formas de vida*) is an expedition to discover the biodiversity of the bacteria that inhabit and shape three parks and a wetland in Bogotá. The creation groups were in charge of investigating which bacteria are present in these green public spaces, with microbiology, molecular biology, and metagenomics techniques, and at the same time with artistic creation processes such as drawing, photography, and generative modeling of sculptures using the genetic code.

O[t]FL has been co-created as an articulation of methodologies for collectively exploring, thinking, and creating. Embracing and developing collaborative processes, related to the DIWO (Do it with others) ideas and communitarian-based creation, and connecting the *Interconnected Nature* project to the O[t]FL one, was the main strategy of involvement, to get close to the microbiology practices and methodologies.

The ideas in *Mutante* and *Suratómica* about these collective creation processes explore the diversification of knowledge/ways of knowing; the *in-disciplinarity* of knowledge, methodologies, and techniques; the co-creation of situated emerging understandings, meanings, and the network itself. Furthermore, the exploration of alternative ways of social organization.

The exploration in Bogotá included the Parque Nacional, Parque Simón Bolívar, Parque Entre Nubes, and Humedal Juan Amarillo, during May and June 2022. My parallel exploration in Berlin took place at the Panke river, at Pankow. The project was designed together by the laboratories *Mutante* and *CorpoGen*, and developed with the support of the grant for experimentation, art, science, and technology for civic culture by the SCRD of Bogotá.

Petri-art by the participants of the creation groups. *Otras pequeñas formas de vida*. Photo by Juan Diego Rivera. (2022)

TERRITORY EXPLORATION

Getting to know the surroundings. We explored the location, created maps, documented with pictures and drawings, and collected samples of soil, air, water, plants, and other living organisms, to look for bacterial communities inhabiting and conforming the territory.

Mobile laboratory at the Parque Nacional. Manuel Orellana, María Gómez, Margarita González, Carlos Acosta, and participants of the creation groups.
Photo by María Alejandra Peñalosa. Bogotá, 2022

Documentation by the participants of the creation groups.
Photo by María Alejandra Peñalosa. Bogotá, 2022

Collected samples of the Panke river and surroundings.
Berlin, 2022



GROWING MICROORGANISMS

In Petri dishes, we grew microorganisms from the samples we had collected before. Using laboratory and house-made agar, the samples were directly placed on the Petri dishes, to grow a big amount and variety of microorganisms, or diluted before in order to grow clear bacterial colonies to be studied.

Observation of grown microorganisms in Petri dishes. Manuel Orellana, Juan Diego Rivera, and participants of the creation groups.
Photo by María Alejandra Peñalosa. La Redada, Bogotá, 2022

Grown microorganisms in Petri dishes by the participants of the creation groups.
Photo by Juan Diego Rivera. La Redada, Bogotá, 2022

Placing samples in Petri dishes in collaboration with Jung Hsu.
Photo by Hibiki Ishijima. Medienhaus, Berlin, 2022



EXTRACTING DNA

With the aim of being able to see the DNA, we carried out a simple and homemade experiment to extract the DNA of strawberries. With a mix of soap and alcohol, it was possible to get enough amount of DNA to be seen with bare eyes.

DNA extraction experiment. Frame by Juan Diego Rivera.
Nueva Roma School, Bogotá, 2022

Observation of extracted DNA. Valeria Gómez and participant of the creation
groups. Frame by Juan Diego Rivera. Nueva Roma School, Bogotá, 2022

Extracted DNA. Frame by Juan Diego Rivera.
Nueva Roma School, Bogotá, 2022



SEQUENCING DNA OF SOIL SAMPLES

To discover other bacteria, which would not grow in our Petri dishes environment, we used DNA sequencing in a process called Metabarcoding. We got the information on the 16S gene of all the bacteria present in the soil sample, to be afterward compared with a database to find their families and names.

The sequencing was done by the CorpoGen laboratory, using a MinION sequencer.

DNA Sequencing process at CorpoGen Laboratory by Christian Romero.
Photo by Juan Diego Rivera. Bogotá, 2022

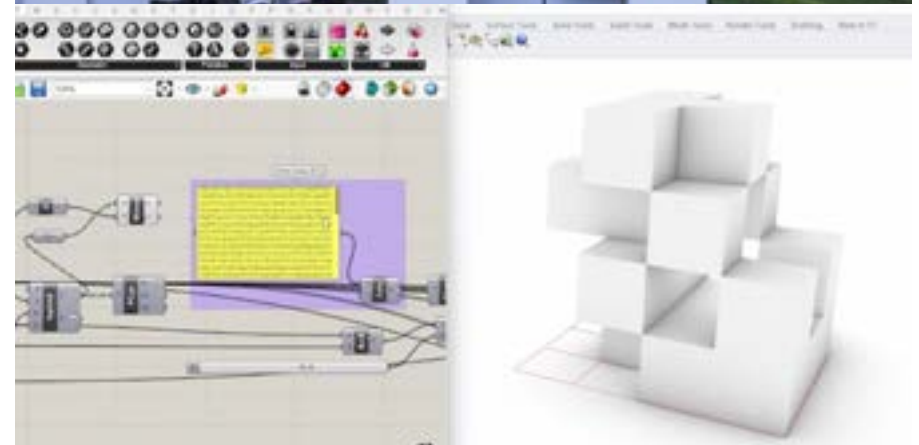
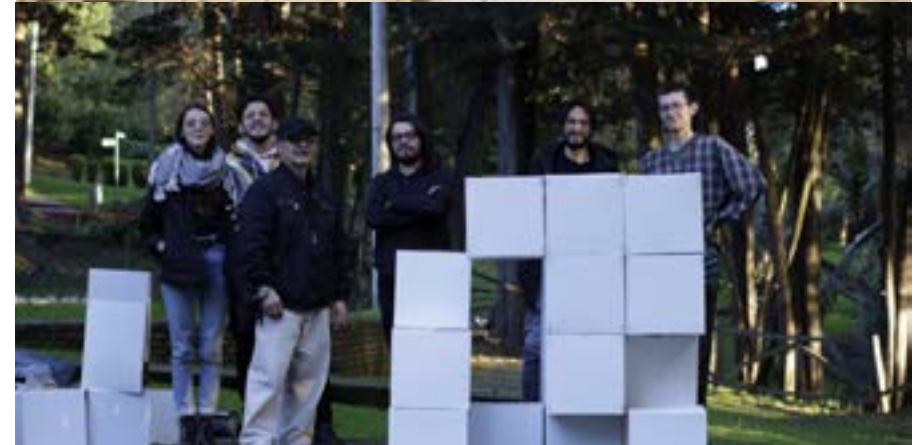
Placing extracted DNA in MinION sequencer in CorpoGen.
Photo by Juan Diego Rivera. Bogotá, 2022

State of the sequencing.
Photo by Juan Diego Rivera. Bogotá, 2022



GENERATIVE CREATION WITH DNA INFORMATION

Through a board game, we explored the creation of- and translation to- new languages to program with genetic code, as an introduction to bioinformatics. The DNA information that we got from the four locations became our matter to create generative sculptures, that adapting a threedimensional game of life transformed a fragment of the bacteria 16S gene code into building blocks.



Board game *The code of life*.
Photo by Juan Diego Rivera. Bogotá, 2022

Generative sculpture game. María Alejandra Peñalosa, Jaime, Carlos González,
Diego Beltrán, Carlos Acosta, and Miguel Rodríguez.
Photo by Juan Diego Rivera. Parque Nacional. Bogotá, 2022

Information processing with Grass Hopper. Frame of the video "How to create a
sculpture with the DNA code information" by Carlos Acosta. 2022

INTERNET OF/FOR BACTERIA



DIALOGUE WITH OTHER LIVING OR LIFE-LIKE BEHAVED ORGANISMS

While imagining a sharing of our digital technologies with other living organisms, I thought about the internet as the one technology that could be worthy to offer. I imagined that bacteria could perform a lot of collaborative processes through it and that, when biocomputers are no more for our human-defined purposes, they could use this media for their own experiences.

With such an undefined idea, I approached the *BioMedia* (ZKM, 2021-2022) GPT-Neo for text generation, in the context of experimental narratives for *Speculative fabulation*, to have a dialogue with the databases about how our relation to bacteria has been understood up to now. The outcomes of the generative texts raised questions about co-creating other possible understandings with machine learning biased with all our old thoughts. For instance, our ideas, together with Jung Hsu, about bacteria resistance as amazing biotechnologies become again, through the machine, understood as the huge upcoming risk presented by the current scientific narrative.

Outside the so-called AI, an unexpected *other* dialogue was given while running into the graffiti by artist Alper Aydin. "THE GREATEST MICROBES!!!" immediately spoke to me about a narrative that might be currently transforming. There are other kinds of networks doing so.

Creating new comprehensions might require giving a chance to contingency, detached from the big data of our old thinking.

However, based on a recent headline about life-like behavior emerging from RNA molecules, I generated a seed text that brought interesting information: there was already an Internet of Bacteria (IoB) under development.

Graffiti *The greatest microbes!!!* by Alper Aydin.
Photo by Natalia Rivera. Pankow, Berlin (2022)

IN PETRI DISHES, BACTERIA COMMUNICATED THROUGH THE INTERNET

When researchers tried to create a bacterial processor for biocomputing, bacterial communities evolved over time into a complex network connected through the internet, that both competed and cooperated to survive.

[input]

[500-words text generated by GPT-Neo]

The Internet of Bacteria (IoB) is composed of a network of bacteria with different roles in the ecosystem. The network acts like a computer program where each bacterium has its own set of rules and interactions with other bacteria. For example, some bacteria are responsible for releasing nutrients while others are responsible for capturing them. The network is self-organized, which means that the nodes do not have a fixed position in the network but move around freely. It is possible to predict the future state of the system by observing how the nodes are connected ~100 years into the past.

At present, it is difficult to understand the evolutionary mechanism behind this self-organized network. This is because the network is dynamic and changes over time. However, the network can be characterized by a set of *rules*, or by the *interaction patterns* among the nodes. These rules enable the network to solve various computational tasks such as information processing, signal processing, and pattern recognition. In this review, we first summarize recent advances in understanding the evolution of the rules governing the interactions among the nodes. Then we describe how the rules were used to design the architecture of the network and explain how the network operates. We also discuss the current challenges facing this field.

Evolution of Rules for Interactions between Bacteria =====
=====

We focus on three types of rules: *rule of exclusion*, *rule of coexistence*, and *rule of competition*. All three rules are needed to generate a dynamic, self-organized, and adaptive network. First, the rule of exclusion states that each bacterium excludes other bacteria from the network when they are physically separated. For example, if two bacteria are far apart, they cannot communicate with each other. Second, the rule of coexistence states that some bacteria may interact with each other even when they are physically separated. For example, if two bacteria are far apart, they can form a complex structure called biofilm. Third, the rule of competition states that some bacteria will outcompete others when they are physically separated. For example, if two bacteria are far apart, they compete for space and resources. In this case, the bacterial interaction network is not self-organized but depends on environmental conditions. Therefore, the network does not evolve spontaneously but is created by the interactions between the bacteria.

–

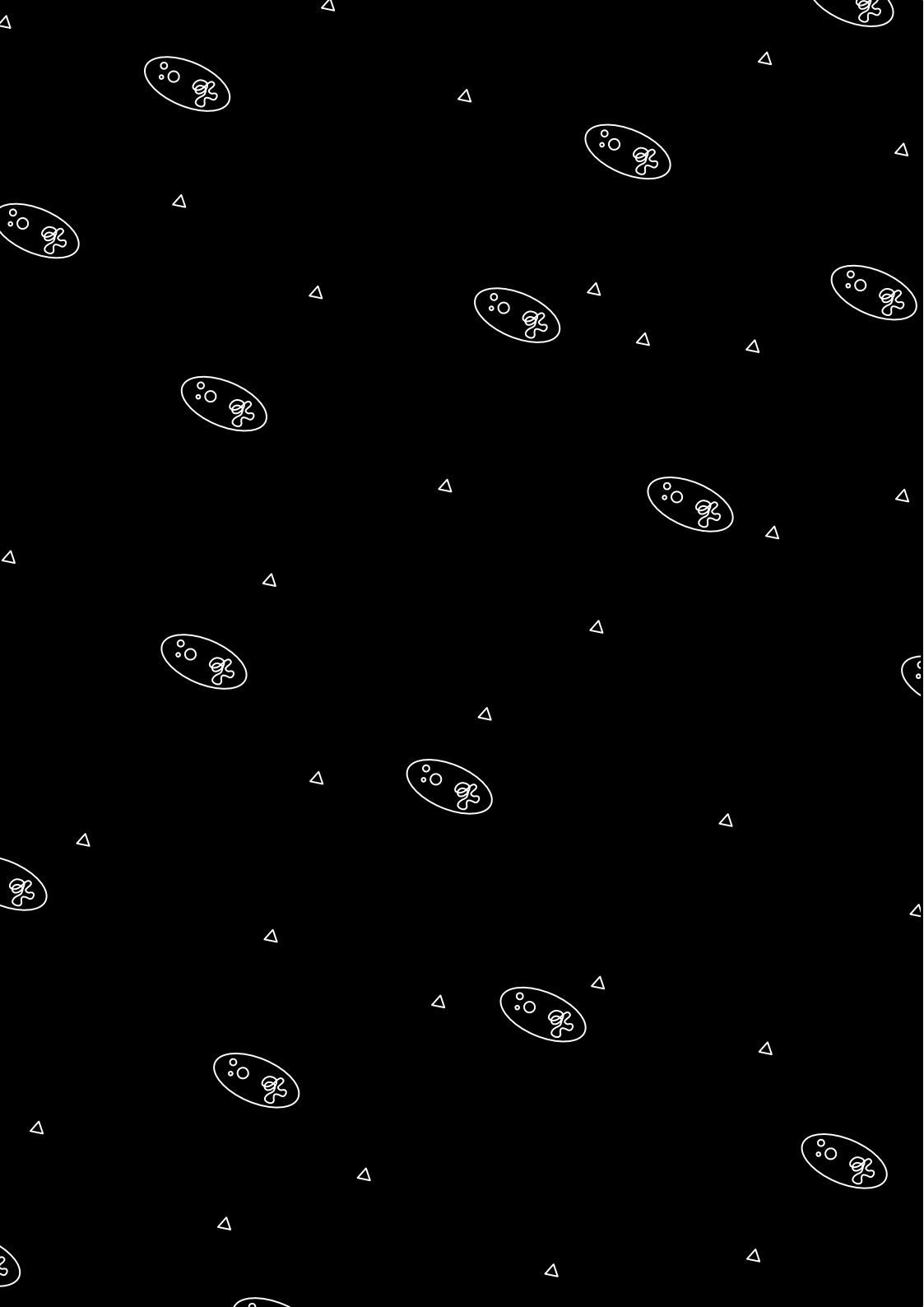
The referenced headline from an article in Quanta Magazin was:

“In Test Tubes, RNA Molecules Evolve Into a Tiny Ecosystem.

When researchers gave a genetic molecule the ability to replicate, it evolved over time into a complex network of “hosts” and “parasites” that both competed and cooperated to survive.” (Saplaoglu, 2022)

–

Using GPT-Neo as a fiction-writing tool was proposed at the *Almost non-human* workshop by Interspecifics at Art Laboratory Berlin. 05.2022



INTERNET OF BACTERIA

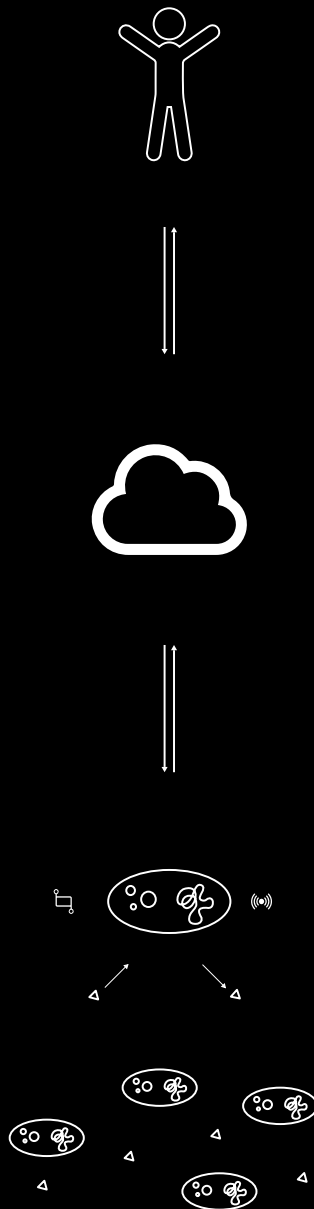
There are diverse understandings of the Internet of Bacteria concept which go from a metaphor to the actual development of it as a biotechnology.

Starting with the metaphor, it is mentioned that our internet resemble the molecular communication networks of the bacteria. Globally interconnected, bacteria can share information through distributed networks. As presented by Bassler (2009), they are able to send and receive molecules released to the environment they are inhabiting. The messages allow them, for instance, to perform *Quorum sensing*, one of the primary behaviors of life to understand the community surrounding and actuate together.

The similarities enter the context of biologically inspired computation development. As presented in projects such as *Biological peer-to-peer networks: from bacterial communication to the development of synthetic distributed systems* by Gonzalez-Rodriguez and Hernandez-Carrion (2014), among many other reserach projects, the creation of decentralized or distributed communication networks for humans could be inspired by these microorganisms. A possibility that we explored in *BiOfilm.net* (Hsu & Rivera, 2021).

As presented in the *Queer forms of life* text, the current state of the development of the Internet of Bacteria (IoB) in the context of the Internet of Bio and Nano Things (IoBNT) can be addressed with the proposal by Kim and Poslad (2019) in their text *The Thing With E.coli: Highlighting Opportunities and Challenges of Integrating Bacteria in IoT and HCI*, and the research by Unluturk (2020) in the doctoral thesis *Fundamentals of bacteria-based molecular communication for internet of bio-nanothings*.

In the first one the authors expose their ideas on how bacteria could be included as a substrate for the Internet of Things:

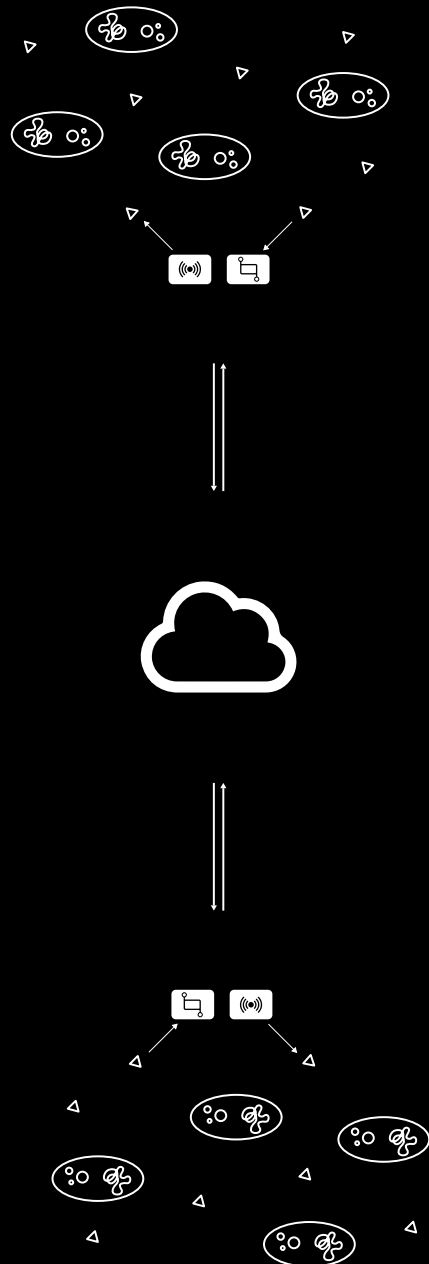


"With advances in nano- and biotechnology, bacteria are receiving increasing attention in scientific research as a potential substrate for Internet of Bio-Nano Things (IoBNT), which involve networking and communication through nanoscale and biological entities. Harnessing the special features of bacteria, including an ability to become autonomous - helped by an embedded, natural propeller motor - the microbes show promising array of application in healthcare and environmental health. In this paper, we briefly outline significant features of bacteria that allow analogies between them and traditional computerized IoT device to be made. " (Kim and Poslad, 2019)

In this proposal, based also on Tavella et al. (2018) experiments on how to transfer digitally encoded information to bacterial nano networks, humans can decide the kind of messages that could be sent for bacteria to perform certain actions. The mechanism used to send this information is a human-developed version of a technology that bacteria created long before: horizontal gene transfer.

Horizontal gene transfer is the transfer of genetic material among bacteria without being the progenitors. A technology that allows them to rapidly learn how to behave in certain contexts and that has allowed them, for instance, to develop antibiotic resistance. Margulis and Sagan (1995) refer to it as:

"A second evolutionary dynamic is a sort of natural genetic engineering. Evidence for it has long been accumulating in the field of bacteriology. Over the past fifty years or so, scientists have observed that prokaryotes routinely and rapidly transfer different bits of genetic material to other individuals. Each bacterium at any given time has the use of accessory genes, visiting from sometimes very different strains, which perform functions that its own DNA may not cover. Some of the genetic bits are recombined with the cell's native genes; others are passed on again. Some visiting genetic bits can readily move into the genetic apparatus of eukaryotic cells (such as our own) as well." (Margulis and Sagan, 1995)



INTERNET FOR BACTERIA

Once we know that bacteria can be connected to the internet and the kind of information that could be transferred, my proposal can be presented:

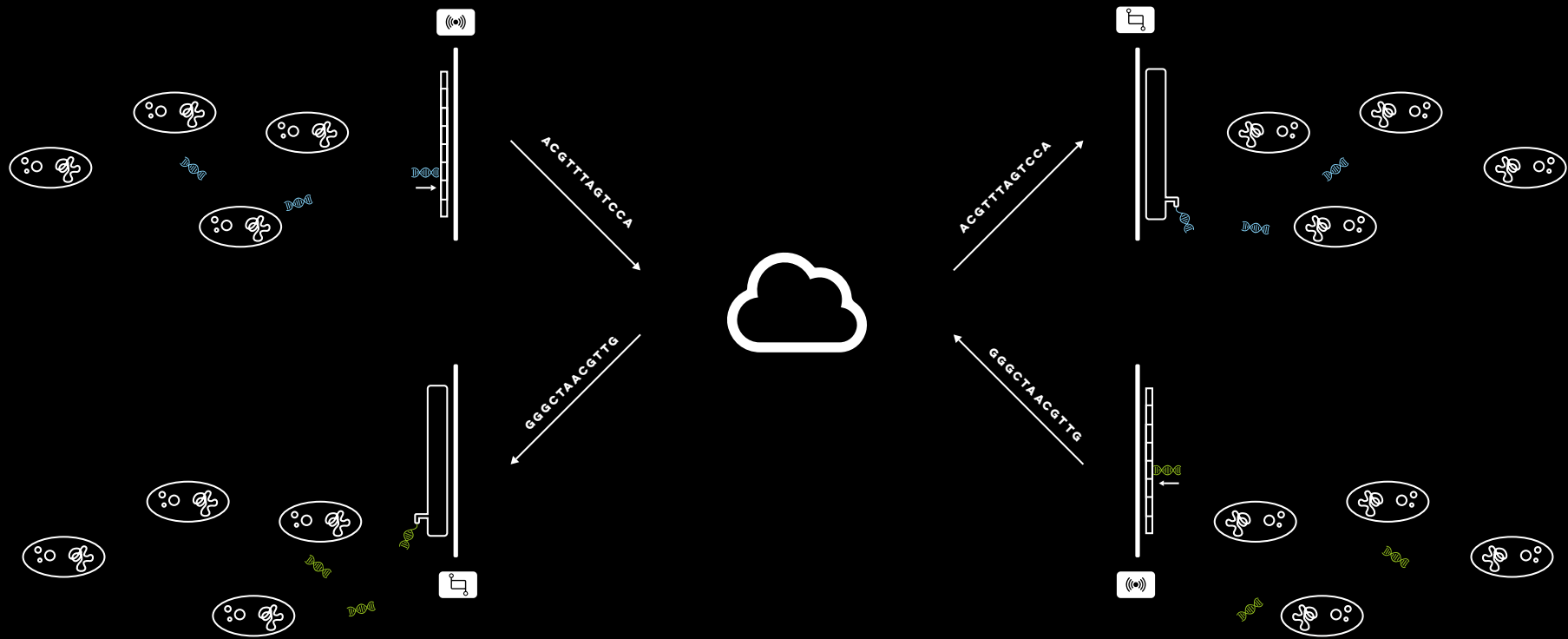
In the context of the biocentric turn, *Other politics of the living*, and the understanding of life as anarchic in the context of the complexity sciences, the development of an Internet of Bacteria only makes sense if created as an Internet FOR Bacteria, that embraces the uncontrollable nature of the living. While doing so, it becomes an inter-living-entities mutual aid technology, or even better, a symbiotic one.

Through the Internet for Bacteria, communities of bacteria would be able to perform horizontal gene transfer via the internet. On one side, a sequencer would read the DNA released to the soil and transform that biological information into digital one, from the DNA nitrogenous bases to the letters A, C, G, T. This information would be transferred via the IoT infrastructure to the cloud and be available for other bacterial communities. On the other side, the DNA shared by the mentioned community would be transformed from digital information to actual DNA through a synthesizer, to be released in new soils with other communities of bacteria. Each situated device in a different soil would be able to perform both processes.

The outcomes of such a process, the behaviors that bacteria could develop or enhance, and the transformations to come of the living organisms and the environment they inhabit and shape are to be discovered/created. The device presented in this project aims to open the discussion of those possibilities and explore them with different media.

Bacteria connected to the internet to share their own-defined information

Next two pages: Horizontal gene transfer through IoT



INTERNET FOR BACTERIA

INTERFACE / MEDIATING DEVICE

MEDIATING ORGANISM FOR HORIZONTAL GENE TRANSFER IN BACTERIA

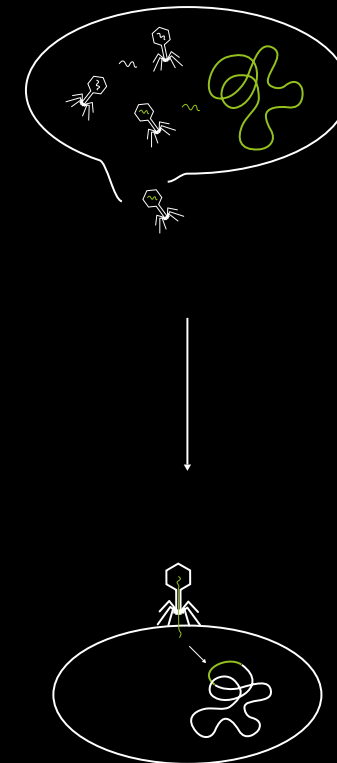
Creating with biocomputers means creating a queer form of life and to do so, our role would be the creation of an interface/interfaces that allow the hybrid living organism to emerge.

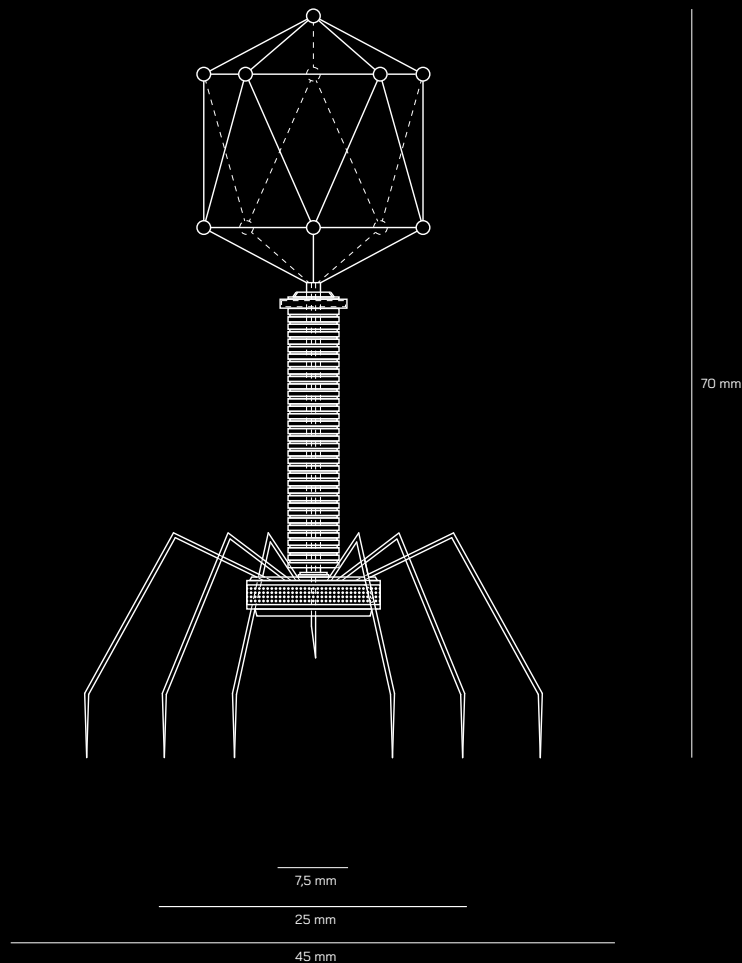
In the Internet for Bacteria project, the interface or mediating device is inspired by an existent mediating organism for horizontal gene transfer in bacteria: the Bacteriophage. This symbiotic relation to the mentioned virus is included, among three processes of bacteria to perform horizontal gene transfer: transformation, conjunction, and transduction.

Unlike the other two processes in which bacteria release DNA to the environment and it is adopted by the others, or in direct contact between two bacteria plasmids are shared, in the transduction process the DNA is transmitted through a sort of hack to the reproduction process of the virus.

Through the virus infection, viral DNA is introduced into the bacteria. This new information leads the bacteria to produce components to generate new Phages, which in the intended process would include the viral genome inside. However, during the multiplication of phages inside the bacteria, bacterial genome fragments could be inserted in the Phage, instead of their own. The so-called defective Phage would then carry and transmit the bacteria DNA to other bacteria. (Estela Biomicro, 2019)

The Bacteriophage-like device for the Internet of Bacteria will as well be able to read the DNA information released by the bacteria in the soil and transfer it via the internet, or retrieve it from the cloud and transfer it back to the soil for bacteria to include it, through the transformation process.





INTERNET FOR BACTERIA - PHAGE

IfB-Phage is a near-impossible mediating device for the symbiogenesis of a digital-bio hybrid organism between bacteria and the internet. A device to create a queer form of life, a hyperconnected bacteria superorganism. In the same way Bacteriophages mediate the horizontal gene transfer process among bacteria, the IfB-Phage allows bacterial communities in the soil to perform horizontal gene transfer through the Internet of Things infrastructure. Each Phage is able to sequence the DNA released by bacteria to the environment and transform it into digital information to be sent to the cloud, and at the same time retrieve other genes from the cloud to synthesize and release them to the soil, to be available for other bacteria.

INTERNET FOR BACTERIA - PHAGE		QUEER FORMS OF LIFE / INTERCONNECTED NATURE		
IfB-Phage is a near-impossible mediating device for the symbiogenesis of a digital-bio hybrid organism between bacteria and the internet. A device to create a queer form of life, a hyperconnected bacteria superorganism. IfB-Phage allows bacterial communities in the soil to perform horizontal gene transfer through the Internet of Things infrastructure.	30.09.2022	Natalia Rivera	1/1	2:1
	Mutante - Suratómica Network - New Media Class / SS22 / UDK			

Blueprints of *Internet for Bacteria - Phage* device.

QUEER FORM OF LIFE
/
SYMBIOTIC BIO-DIGITAL ORGANISM
/
HYPERCONNECTED BACTERIA

QUEER FORMS OF LIFE TO CO-EVOLVE WITH

Despite the general idea of evolution being a process of constant improvement of the species, this is not at all a linear process, whose previous stages that remain alive until today are “less evolved”, less capable, or even less complex. Evolution is a process of constant diversification of life, an absolutely creative life whose origin and purpose is in itself, and whose constant exploration of possibilities is in turn constitutive of it.

With Margulis, we learned that not only do organisms cooperate between each other to stay alive, to maintain their species over time -as Darwin presented it and was developed in greater depth in Kropotkin’s *Mutual aid-*, but also that the association of diverse life forms leads to the generation of new forms of life. That is to say, life not only becomes increasingly diversified but also generates processes of synthesis, it interconnects between these diverse forms to generate other more, and more complex ones.

The cyborg as symbiosis is for me the space for the hybridization of two life forms that after a long process of transformation meet again. A symbiogenesis by Bacteria, ancestors of life on earth, and a life form that has been one of the creations of humanity, artificial life, in this specific case, the internet as an artificial system with life-like behavior.

The encounter of these two forms of life, completely outside the strong capitalist idea of an internet of bacteria that considers them efficient supports of information, could become a symbiotic encounter of growing indeterminacy.

In the context of various conversations in the Suratómica network, after a wonderful encounter and dialogue with Carlos Maldonado’s ideas about the most recent understandings of the Living, together with Juan Diego Rivera, Carlos Acosta, and Daniela Brill, we set out to understand the phenomena of life, the ways for life to break through, as technologies of the living, biotechnologies. This in a space we called

Collaboration and other technologies of the Living (Colaboración y otras tecnologías de lo vivo) (2021).

Understanding life and, in turn, nature as that which is creative (Hernández, 2020), I want to propose a slightly more humble look at the technologies that we create as human beings, as technologies created by nature itself, through us, which as in nature itself, sometimes enable life and sometimes do not. Today we make enormous efforts to try to put aside this idea of how incredibly intelligent, evolved, or capable we humans are, “the pinnacle of evolution”. But at the same time, we still think that our technologies are extraordinary.

They are as extraordinary and diverse as those created by all other living organisms.

Thus, there are two ideas that we can preferably avoid in understanding these media that we have created or are willing to create. The first of these is the illusion of control that we believe we have over the created technologies, whether they are the ones we consider to be clear, such as those for everyday uses, or the ones that scare us the most, those of artificial life and intelligence, or those of gene engineering. The second is that capitalist western approach that understands technologies as solutions to certain problems. The understanding of the world and of life itself as a matter of problems and solutions. Problems for which once we have developed the appropriate technology, ...

Such an understanding - the technologies that we create being part of a process of diversification and exploration of nature creating through us -can lead us to consider perhaps in a closer and more horizontal way those relations with other forms of life and their biotechnologies. Thus, those of us who approach this comprehension, in a moment of inexhaustible crisis, deep fears, and much suffering, do trust life. I mean, we know that the complexity of life that has made its way through the contingent, the randomness, the indeterminate, the unexpected, will continue to do so. With human form or with other forms. With a multiplicity of associated organisms in the form of humans or associated in other forms, such as the superorganism which bacteria are, or the mycelium, wonderful entities.

The knowledge and other forms of life that respond to the “what can we do?” question, although it is invisible to many, are decentralized, diversified in innumerable human and other living organisms’ communities, interspecies or inter-living-entities, whose weave as a network becomes increasingly complex and resistant. From the increasingly diverse feminist, or anti-racist, or anti-colonial, or anti-species groups, to the cyanobacteria increasing their population rapidly in the sea, or the plants and animals moving to different climatic floors, the plants and plagues that sabotage monocultures, the seeds that fall from the hands of humans and other animals to diversify monocultures, ruderal plants, fungal communities doing bioremediation in spaces where oil has been spilled, or of course, bacterial resistance.

With the previously shared idea that biotechnologies and living systems that have emerged from human creation processes, as nature itself’s creation processes, I want to propose an encounter between the internet as a living system and bacteria, which is not the understanding of a human high-level technology that connects with this living system, but the dialogue between living organisms that explore the possibilities of a symbiosis.

My exploration as an artist is that of the possibility to create the bridge, the interface. However, the biggest difficulty is avoiding the determination of the possibilities that occur with the design of an interface. Here, the biggest question is: how to put these forms of life into dialogue without controlling the process?

Existing technologies determine the one-way relations in which bacteria are smooth hard drives and nimble processors. How can these relations be different? Is there any chance that the internet and bacteria could cooperate to evolve into other life forms? How have we dialogued with other forms of life during our history as humans and not as westerners?

In *Suratómica* the exploration continues about other ways of knowing, other ways to understand or comprehend, that can deal with not knowing, that can deal with the indeterminate, especially when knowing in a certain way, and this is frequently the case, implies stepping over the other ways of knowing or living. Because for the dominant forms

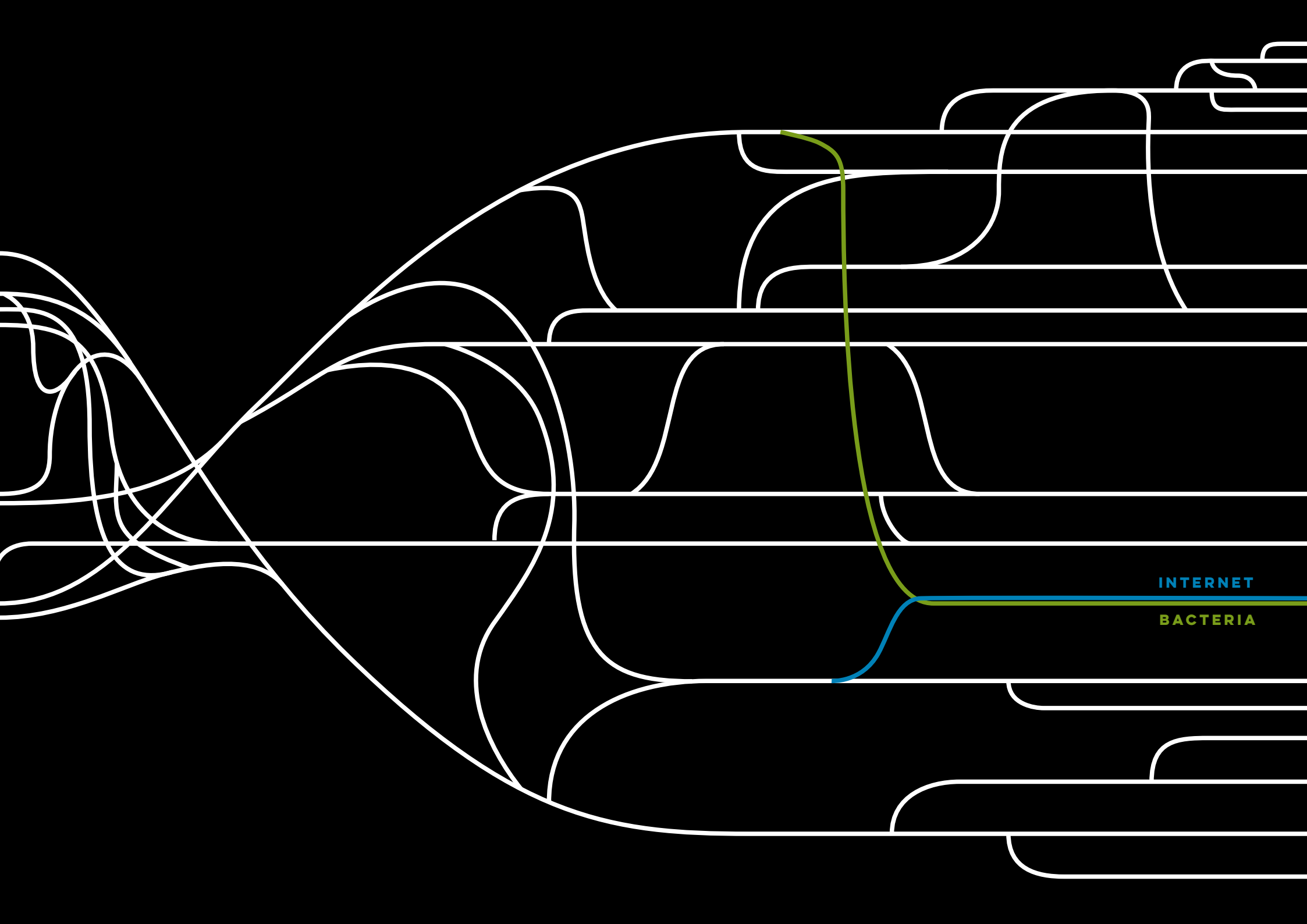
of knowledge, knowing, knowledge, truth, and so on, are above ritual, mediation.

QFL is an exploration of those indeterminate ways of knowing. A way of creating that seeks to embrace living behavior as such. That calls for other politics/other relations with the living. A hybridization of ideas, disciplines, media, methodologies, and organisms.

For the inter-living-entities resistances to continue to break through together with the interdisciplinary creative processes.

Next two pages:

Symbiogenesis of the hyperconnected bacteria superorganism, as a queer form of life.
Based in: Andrew Z. Colvin - Barth F. Smets, Tamar Barkay (September 2005). “Horizontal gene transfer: perspectives at a crossroads of scientific disciplines”. *Nature Reviews Microbiology* 3 (9): 675–678. DOI:10.1038/nrmicro1253. CC BY-SA 4.0



INTERNET

BACTERIA

REFERENCES

- Bassler, B. (2009). *How bacteria “talk”* [Video]. TED Talk. https://www.ted.com/talks/bonnie_bassler_how_bacteria_talk
- Center for Art and Media - ZKM Karlsruhe (2021-2022) *The artwork as a living system*. Exhibition. <https://zkm.de/de/ausstellung/2022/05/christa-sommerer-laurent-mignonneau-the-artwork-as-a-living-system>
- De Menezes, M. (2021) *Moon-light (or Moon’s Moon)*. [Skyart] <https://martademenezes.com/art/spaces/moon-light-or-moons-moon/>
- Estela Biomicro. (2019) *Transducción* [Video] <https://www.youtube.com/watch?v=rbi-FmPhhzxY>
- Gonzalez-Rodriguez, D. & Hernandez-Carrion, J. R. (2014) *Biological peer-to-peer networks: from bacterial communication to the development of synthetic distributed systems*. <https://zenodo.org/record/1195750#.Yy-lci80mEM>
- Haraway, D. (2016) *Staying with the Trouble. Making Kin in the Chthulucene*. Duke University Press.
- Hernández, I. (2019). *Estética de lo imposible*. Dat Journal. <https://doi.org/10.29147/dat.v4i2.127>
- Hsu, j. & Rivera, N. (2021) *BiOfilm.net*. [Artistic Project] <https://www.biOfilm.net>
- Interspecifics (2022). *Almost non-human*. Workshop. Art Laboratory Berlin.
- Kim, R. & Poslad, S. (2019) *The Thing with E.coli: Highlighting Opportunities and Challenges of Integrating Bacteria in IoT and HCI*. CHI’19 Extended Abstracts, May 4-9, 2019, Glasgow, Scotland, UK. DOI: <https://doi.org/10.1145/3290607.XXXXXXX>
- Maldonado, C. (2021a) *Complejidad y estética*. Creation Group proposed by Carlos Eduardo Maldonado. Suratómica Network. <https://www.suratomica.com/gruposde-creacion>
- Maldonado, C. (2021b) *Epistemology of the impossible or a science of indetermination*. <http://dx.doi.org/10.4067/s0717-554x2021000100044>
- Maldonado, C. & Mezza-Garcia, N. (2016) *Anarchy and complexity*. Retrived on 4/9/2020 from journal.emergentpublications.com
- Margulis, L. & Sagan, D. (1995) *Microcosmos. Four Billion Years of Microbial Evolution*. University of California Press.
- Mutante (2019) *Bestiario Expandido (Expanded Bestiary) [Expanded Narrative]* <https://www.mutantelab.com>
- Saplakoglu, Y. (2022, May 5) *In Test Tubes, RNA Molecules Evolve Into a Tiny Ecosystem*. Quanta Magazine. <https://www.quantamagazine.org/in-test-tubes-rna-molecules-evolve-into-a-tiny-ecosystem-20220505/INTRO>
- Tavella F., Giaretta, A., Dooley-Cullinane, T. M., Conti, M., Coffey, L., & Balasubramaniam, S. (2018) *DNA Molecular Storage System: Transferring Digitally Encoded Information through Bacterial Nanonetworks*. <https://arxiv.org/abs/1801.04774>

THIS PROJECT HAS BEEN CREATED IN DIVERSE DIALOGUES WITH:

Juan Diego Rivera, Carlos Acosta, Daniela Brill, Luis Williams-Fallas, Manuel Orellana, Margarita González, Jung Hsu, Carlos Maldonado, Juan Felipe Zapata, Juan Manuel Anzola, Dayana Calderón, Christian Romero, Ma. Fernanda Quinceno, Jeisson Triana, Iliana Hernández, Raúl Niño, Tatiana Avendaño, María Cecilia Medina, Gumerindo Rivera, Sandra Ramos, Takuya Koyama. Queer forms of life (Formas extrañas de vida) creation group [Suratómica], Microcosmos creation group [Suratómica], Other [Tiny] forms of life (Otras [perqueñas] formas de vida) creation groups. CorpoGen Laboratory. New Media Class UDK WS2020-SS22

THANKS

I would like to thank for their support to: Juan Diego Rivera, María Cecilia Medina, Juan Felipe Fernández, Sandra Ramos, Daniela Brill, and Iurii Banshchikov.

Huge thanks also to Juan Manuel Anzola and the CorpoGen laboratory for their will to share their knowledge, ideas and resources for the creative projects connected to Mutante and the Suratómica network, among them, this project.

Thanks to Prof. Joachim Sauter for his support and for welcoming my research and ideas to the New Media Class since 2015.

QUEER FORMS OF LIFE

INTERCONNECTED NATURE

Natalia Rivera Medina

-

Prof. Jussi Ängeslevä

Luiz Zanotello

Dr. Prof. Susanne Hauser

Visual Communication Master

New Media Class - SS22

Universität der Künste Berlin UDK

-

27.09.2022

Berlin

