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WHAT DO WE HEAR WHEN WE HEAR MICROBE SOUNDS

ABSTRACT

The concept of the Anthropocene, based on the premise that mankind has become a major geological force in its own right, has grown into a central theme with issues such as ecological crisis, climate change, or sustainable futures. On the other hand, posthumanist and new materialist approaches have developed philosophical insights that call into question the dominant position of humans in the universe and the anthropomorphic premises associated with it, particularly focusing on the unfolding of symbiotic modes that traverse the entire nature-culture continuum. This article, rather than directly engaging with Anthropocene debates, aims to explore how different modes of human-microbe interaction crystallize in different sound compositions through the conceptualization of "microbe-sounds." The notion of rhythm is central here, encompassing both the vital processes and the emergence of technical forms. Three different case studies—the work of *Interspecifics*, Anne Niemetz and Andrew Pelling's *the dark side of the cell,* and Victoria Shennan's *Anthropocene*—will be examined, and the ways in which they mobilize different technical means to plunge into a microbial level and activate its various electrical, chemical, physical, and/or vital properties in a particular sound composition. Gilles Deleuze and Félix Guattari's analysis of rhythm in *A Thousand Plateaus* (1987), and Gilbert Simondon's concept of transduction in his theory of individuation (2005), will be mobilized in order to examine how disparate elements of different rhythms operate in solidarity to produce a microbe-sound composition.

KEY WORDS: Anthropocene, microbe-sound, nature-culture, rhythm, transduction

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INTRODUCTION

It seems that Paul Crutzen and Eugene Stoermer's declaration in 2000 that the Earth had entered a new era, which they called the Anthropocene, was stuck in a deadlock from the very beginning. The "scientific" observation that the biosphere and geological time was fundamentally transformed by human activity brought forth the necessity of positing the "mankind" as "major geological force," which in turn entailed the necessity of developing a new conceptualization of geological time.[2] It is not hard to envision how this cascade of imperatives led to the International Geological Congress in August 2016 officially confirming that the impact of human activity had left its mark on the geology of the Earth itself. Coming two months later, a new estimate of the damage to animal life already evidenced in this new era was released,[3] in a sense sealing the fate of the Anthropocene with a sense of urgency.[4] The fact that human being has left its mark on every corner of the Earth, and as a geological force, coupled with the impression of impending catastrophe, is a call to resituate the humankind in two ways. Either human beings will, in fact, reassume the role of "shepherd," a role bestowed upon them by a kind of destiny, and mobilize all their forces, especially by technoscientific means, towards the reorganization of the Earth in the direction of a certain ideal, for the realization of a certain "good." Or, the humankind will engage in an endless effort to show the infinite relations of human beings with non-human beings and things, to attribute a certain subjectivity to them in an interminable analysis. It is perhaps this inherent dilemma that is the main reason why the term Anthropocene has been met with alternative proposals almost from the very first moment it was coined.

Scholars are incited to produce such a concept so that the aporia deriving from the human being's thinking of non-human beings and its relation to them in general are eliminated, and without ignoring the fact that the human being has become a geological force in its own right: Anthrobscene,[5] Econocene,[6] Technocene,[7]

2 Paul Crutzen and Eugene F. Stoermer, "The 'Anthropocene,'" *Global Change Newsletter* 41 (2000): 17–18.

3 World Wildlife Fund and London Zoological Society, *Living Planet Report 2016: Risk and Resilience in a New Era* (Gland: WWF, 2016).

4 See, for example, John Bellamy Foster, Richard York, and Brett Clark, *The Ecological Rift: Capitalism's War on the Earth* (New York: Monthly Review Press, 2010); James Edward Hansen, *Storms of My Grandchildren: The Truth About the Coming Climate Catastrophe and Our Last Chance to Save Humanity* (London: Bloomsbury Press, 2009); Christian Parenti, *Tropic of Chaos: Climate Change and the New Geography of Violence* (New York: PublicAffairs, 2011); Naomi Klein, *This Changes Everything: Capitalism vs. The Climate*, Reprint (New York: Simon & Schuster, 2015).

5 Jussi Parikka, *The Anthrobscene* (Minneapolis: University of Minnesota Press, 2014).

6 Richard Norgaard, "The Econocene and the Delta," *San Francisco Estuary and Watershed Science* 11, no. 3 (2013), https://doi.org/10.15447/sfews.2013v11iss3art9.

7 Alf Hornborg, "The Political Ecology of the Technocene," in *The Anthropocene and the Global Environmental Crisis*, ed. Clive Hamilton, François Gemenne, and Christophe Bonneuil (New York: Routledge, 2015), 57–69.

Misanthropocene,[8] Manthropocene,[9] Capitalocene,[10] Chthulucene.[11] All these proposals, while acknowledging the plurality of factors that determine the basic parameters of the epoch we live in, are in search of a decisive focus as a center of gravity within which they are absorbed. On the other hand, these debates have also triggered research and artistic endeavors towards the depiction of plural, hybrid, transversal, symbiotic, and fusional relations between humans and non-humans. This article is situated along the lines of such approaches and aims to make a "modest" contribution to the problematic terrain assumed by the Anthropocene debates through an analysis of "microbe-sounds," produced presumably for artistic purposes. I use the word modest both in the sense of the relativity of the contribution and in the sense of maintaining a certain critical perspective in all these discussions. The hyphen in the term "microbe-sounds" refers to the problematic relationship between microbes and sound production processes. In this sense, the use of the word microbe is not an adjective qualifying the status of artistic engagement with microbes. Rather, microbe and artworks come together in the hyphen, which separates and connects them in the problematics of "microbe-sounds," gesturing an immanent critique in the sense of grasping the criteria of evaluation of three different cases in their self-relation to the elements that compose their dimensions. This gesture should pay as much attention to how microbes as non-human beings are situated in these sound compositions as to how, in the underlying conditions of production, different elements, especially the digital media and interfaces, participate in the process, not as passive tools but as environment (*milieu*) organizing components. What do we hear in sounds assumed to be related to microbes and what in sounds produced by the help of technical tools or procedures? What is it that we hear in this sound, if not an analogy obtained through the refinement of human knowledge and made sense by mediation of the human ear? The purpose of this article is to place these questions in a problematic framework through three case studies without falling into aporias that would get us stuck between human speciesism and the bottomless wells of animalism (between reason and feeling, action and passion, order and disorder, receptivity and spontaneity, etc.).

Each case study has a particular way of engaging with a particular conception of microbe to produce sound phenomena and employing certain techniques to reveal a set of rhythms that compose them. It is this mode of accessing to the microbial level and activating the various electrical, chemical, physical, and/or vital properties in a certain composition that constitutes a listening experience. In order to examine how each case dives into this layer of different rhythms contained at the microbial level, I

8 Raj Patel, "Misanthropocene," *Earth Island Journal* 28, no. 1 (2013), http://www.earthisland.org/journal/index.php/eij/article/misanthropocene/.

9 Kate Raworth, "Must the Anthropocene Be a Manthropocene," *The Guardian*, October 20, 2014, accessed September 15, 2022, http://www.theguardian.com/commentisfree/2014/oct/20/anthropocene-working-group-science-gender-bias.

10 Jason W. Moore, "The Capitalocene Part I: On the Nature & Origins of Our Ecological Crisis," accessed September 1, 2022, http://www.jasonwmoore.com/uploads/The_Capitalocene__Part_I_June_2014.pdf.

11 Donna Haraway, *Staying with the Trouble: Making Kin in the Chthulucene* (Durham: Duke University Press Books, 2016).

will first look at how the concept of rhythm is situated in a certain scientific discourse, and then examine in each case how these layers bring together disparate elements to produce a unique sound composition. Accordingly, the first case study, the *Interspecific Collective*'s work, focuses on the sound production through the electrical and chemical properties of microbes; then, the *dark side of the cell* presents a science-art interface through sonoctology as a tool of scientific investigation; and finally, Victoria Shennan's *Anthropocene* project transforms the deep layers of the microbial level into a sound experience that can be perceived by the human ear with the help of algorithmic tools. In the conclusion, I will discuss what these three case studies mean for the Anthropocene debate through the conceptualization of "microbe-sound."

HEARING MICROBE-SOUNDS, BUT HOW?

What do we hear when we hear microbe-sounds? This is not the same question as Thomas Nagel's famous "what is it like to be a bat?"[12] Nagel explains in detail that we cannot know the answer to this question. We cannot know it because to claim that we are able to know it is to claim that we have access to the mode of experience of the bat as a distinct life form, and this is in fact to fall into an anthropomorphic illusion. In the first place, the mode of existence of the "battiness" is immediately defined by sonar qualities that lie beyond the human perceptual equipment, which makes a bat an "alien" to human beings.[13] On the other hand, another vein of thought, which also shares the similar concerns of anthropomorphism, and which heavily relies on the recent discoveries and theories in life sciences, especially with symbiosis accepted as the very origin of multicellular life,[14] focuses on the emerging forms of inter- or multispecies alliance toward new adventures in "symbiogenesis."[15] Yet, this is not the end of the question pertaining to the relationship between nonhuman life forms and human beings, but rather in Donna Haraway's words, a way of staying with the trouble,[16] and insisting on the "wonderful, messy tales" of multispecies history.[17] Staying with the trouble means that there is no pre-established multispecies relationship and that each one of them problematically emerges as a result of the

12 Thomas Nagel, "What Is It Like to Be a Bat?," *The Philosophical Review* 83, no. 4 (1974): 435, https://doi.org/10.2307/2183914.

13 Nagel, 438.

14 Lynn Margulis, *Symbiotic Planet* (New York: Basic Books, 1999); Martin Nowak and Roger Highfield, *Super Cooperators: Evolution, Altruism and Human Behaviour Or Why We Need Each Other to Succeed* (New York: Free Press, 2011).

15 Donna Haraway, *When Species Meet* (Minneapolis: University Of Minnesota Press, 2008); Donna Haraway, *Staying with the Trouble: Making Kin in the Chthulucene* (Durham: Duke University Press Books, 2016); Vinciane Despret and Jocelyne Porcher, *Être Bête* (Paris: Actes Sud, 2007); Anna Lowenhaupt Tsing, *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins* (New Jersey: Princeton University Press, 2015).

16 Haraway, *Staying with the Trouble*, 2016.

17 Donna Haraway, "Staying with the Trouble: Anthropocene, Capitalocene, Chthulucene," in *Anthropocene or Capitalocene?: Nature, History, and the Crisis of Capitalism*, ed. Jason W. Moore (Oakland: PM Press, 2016), 44.

entanglement of the material-semiotic systems.[18] The material-semiotic systems cut across the axis that defines a certain type of liveliness, and the related horizon of meanings through a nature-culture continuum.

Therefore, when it comes to microbes and, in relation to them, the production of sound compositions, "staying with the trouble" involves the creation of a problematic field that can hold the complexity of material-semiotic systems with all the different dimensions together without reducing them to each other: defining a research field in such a way as to continue the research without having the last word. Such a field is populated with nonhuman beings and thus shifts the focus away from an internal analysis of social conventions and institutions towards an analysis of the interactions among humans, digital interfaces and their ways of construction, biological entities, technological procedures, physical processes, artifacts, images, and other forms of documentation within a "multispecies ethnograph[ical]" sensibility.[19] It accommodates the zones of encounter between human beings and other beings in mutual ecologies.[20] The term "multispecies" already travels in biological and ecological research environments, referring to patterns of multispecies interactions, co-construction of niches, and ecological life,[21] inviting to follow genes, cells, and organisms across landscapes and laboratories.[22] To this we can add that the formation of scientific theories and practices does not operate according to a presupposed transparent regime of truth, and that the laboratories, the experimental setting, the methodologies employed, and the various aspects of an entire culture in ever widening circles come together in problematic ways. As the research program of science and technology studies (STS) has shown more and more since the 1990s, it is the presence of the performative acts in scientific activity that relate it to a wider field of activities.[23]

We know that the world of animals from time to time operates as a catalyst for thought. Deers, bees, and ants in Jean de La Fontaine's fables, Jakob von Uexküll's tick, Franz Kafka's vermin, mice, moles, and dogs, Herman Melville's whale, Deleuze and

18 Haraway, *When Species Meet*, 2008.

19 Philippe Descola, Geneviève Godbout, and Benjamin P. Luley, *The Ecology of Others* (Amsterdam: Amsterdam University Press, 2013); Eduardo Kohn, *How Forests Think: Toward an Anthropology Beyond the Human* (Oakland: University of California Press, 2013); Eben Kirksey, *The Multispecies Salon* (Amsterdam: Amsterdam University Press, 2014); S. Eben Kirksey and Stefan Helmreich, "The Emergence of Multispecies Ethnography," *Cultural Anthropology* 25, no. 4 (2010): 545–76, https://doi.org/10.1111/j.1548-1360.2010.01069.x.

20 Kirksey, *The Multispecies Salon*, 2014.

21 Peter Cornelis de Ruiter et al., *Dynamic Food Webs: Multispecies Assemblages, Ecosystem Development, and Environmental Change* (Amsterdam: Amsterdam University Press, 2005).

22 Lindsay Kelley and Eva Hayward, "Carnal Light," *Parallax* 19, no. 1 (2013): 114–27, https://doi.org/10.1080/13534645.2013.743297.

23 Knorr Karin Cetina, *Epistemic Cultures: How the Sciences Make Knowledge* (Cambridge: Harvard University Press, 1999); Bruno Latour, "Une Sociologie sans Objet? Note théorique sur l'interobjectivité," *Sociologie Du Travail* 36, no. 4 (1994): 587–607, https://doi.org/10.3406/sotra.1994.2196; Bruno Latour, *Reassembling the Social: An Introduction to Actor-Network-Theory* (Oxford: Oxford University Press, 2005); John Law, "Actor Network Theory and Material Semiotics," in *The New Blackwell Companion to Social Theory*, ed. Bryan S. Turner (Oxford: Blackwell, 2008), 141–58.

Guattari's orchid and wasp, even Heidegger's animals that do not deserve to die properly.[24] Contemporary art theory also presents many different animals.[25] The situation, however, is different for microbes. Since the fate of the microbe in the cultural field is dependent on scientific discourses, it assumes in advance an exclusionary logic, one associated with the pathological. It is not easy to conceive of microbes outside the disease context. Nevertheless, this preliminary logic of exclusion based on the pathological conception of microbes has been traversed by other kinds of logic.[26] With ecological approaches, we begin to explore the different dimensions to the relationship between the environment and microbes and especially between microbes and the human world through different symbiotic modes.[27]

In this article, I use the term "microbe" instead of microorganism, which seems more neutral, to emphasize this semantic reversal from a pathological to a symbiotic conception of microbe. The Human Microbiome Project's discovery that 90 percent of the cells in the human body come from the genes associated with microbes is a critical cornerstone in this reversal.[28] Microorganisms living in the human body form complex ecosystems that are unique to the body's habitat and subtly adapt themselves to this habitat and environmental factors.[29] The microbiome studies are an expanding field and have an effect on shifting our perspectives on how we think about health,

24 History of philosophy offers a rich repertoire to think with and through animals. In the first place, Aristotle's amazing work presents a lot of entry points for thinking about animals that could be (re)problematized under the recent scientific findings. See James Lennox, *Aristotle: On the Parts of Animals I-IV* (Oxford: Clarendon Press, 2002). For an interesting work on Aristotle's analysis of animals, see Pierre Pellegrin, *La classification des animaux chez Aristote: statut de la biologie et unité de l'aristotélisme* (Paris: Société d'édition "Les Belles lettres," 1982). For a quick revisiting of the conception of animality in the history of philosophy, see Gilbert Simondon and Jean-Pierre Zarader, *Deux Leçons Sur l'animal et l'homme* (Paris: Ellipses, 2020).

25 For a detailed cartography and analysis of the Anthropocene related art, see Susan Ballard, *Art and Nature in the Anthropocene: Planetary Aesthetics* (New York: Routledge, 2021).

26 Georges Canguilhem, *La connaissance de la vie* (Paris: Vrin, 2000).

27 See Frank MacFarlane Burnet, *Biological Aspects of Infectious Diseases* (Cambridge: Cambridge University Press, 1940); Lynn Margulis and Dorion Sagan, *Microcosmos: Four Billion Years of Evolution from Our Microbial Ancestors* (London: Allen & Unwin, 1987); Lynn Margulis, Dorion Sagan, and Thomas, *Microcosmos: Four Billion Years of Microbial Evolution* (Amsterdam: Amsterdam University Press, 1997); Alfred Tauber I., *The Immune Self: Theory or Metaphor?* (Cambridge: Cambridge University Press, 1994).

28 Brigitte Nerlich and Iina Hellsten, "Beyond the Human Genome: Microbes, Metaphors and What It Means to Be Human in an Interconnected Post-Genomic World," *New Genetics and Society* 28, no. 1 (2009): 19–36, https://doi.org/10.1080/14636770802670233.

29 Rachel A. Ankeny and Sabina Leonelli, "What's so Special about Model Organisms?," *Studies in History and Philosophy of Science Part A* 42, no. 2 (2011): 313–23, https://doi.org/10.1016/j.shpsa.2010.11.039; Angela Creager, *The Life of a Virus: Tobacco Mosaic Virus as an Experimental Model, 1930-1965* (Chicago: University of Chicago Press, 2001); Christopher M Kelty, "This Is Not an Article: Model Organism Newsletters and the Question of 'Open Science,'" *BioSocieties* 7, no. 2 (2012): 140–68, https://doi.org/10.1057/biosoc.2012.8; Robert Kohler, *Lords of the Fly: Drosophila Genetics and the Experimental Life* (Chicago: University of Chicago Press, 1994); Karen Rader, *Making Mice: Standardizing Animals for American Biomedical Research, 1900-1955* (Princeton: Princeton University Press, 2004); Edmund Ramsden, "Model Organisms and Model Environments: A Rodent Laboratory in Science, Medicine and Society," *Medical History* 55, no. 3 (2011): 365–68, https://doi.org/10.1017/s002572730000541x.

disease, human-environment relations and, moreover, philosophical questions pertaining to self and other, death and life.[30] This has stimulated the interest of artists in this field, and artists and even scientists have experimented in order to produce various microbial forms that traverse scientific activity, but are not reducible to its regime of truth. Here, the relationship with microbes goes beyond the concern of specialists and becomes an occasion to think and act differently in the world and search for different modes of relationality with microbes. This relationship is often described in terms of non-humans in the human and vice versa. This reciprocity is even more pertinent for sound phenomena since they traverse the entire nature-culture continuum as a kind of natural phenomena from a minimum point of meaningfulness that can be called noise to the production of culturally meaningful harmonious rhythmic blocks that can be called music.

The production of microbial sound, rendered possible by techno-scientific means, cuts across the entire microbe-human continuum and reveals a field of experience in which layers of cultural meaning, microbial world, and technical tools are crystallized in the appropriation of sound phenomena by the human ear. The concept of rhythm constitutes the specific entry angle that traverses this entire field.

NAVIGATING THE RHYTHMS AND MILIEUS

Sound has relative priority over image. Lightning comes before thunder but to hear it we don't need to look to the sky. What do we hear when with the naked ear we listen to what we cannot see with the naked eye? Microbes' invisibility also means their inaudibility. When they are rendered audible as part of a scientific research setting, how should we interpret this? Is it thanks to sciences' capacity to decode the heard microbial sound with respect to explanatory scientific schemes? Or more generally, should we attribute this readability of a microbial sound to a privileged element of the human culture on which the institutions are founded? Is it technological or cultural mediation that instrumentalizes sound for specific ends? To answer these questions, I will first trace the genealogy of a particular scientific discourse that conceives of life and living forms in terms of the rhythmic relationships that underlie sound phenomena.

Many organisms possess an internal rhythm that dictates different behaviors at different times of day. These behaviors range from "the cyclical change in metabolic enzyme activities of a bacterium to the sleep–wake cycles of human.[31] Having a circadian clock enables an organism to anticipate regular daily changes in its environment and to take appropriate action in advance. Periodic changes in physiological properties, such as physical activity, body temperature, reproduction,

30 Joshua Lederberg, "Of Men and Microbes," *New Perspectives Quarterly* 21, no. 4 (2004): 92–96, https://doi.org/10.1111/j.1540-5842.2004.00705.x.

31 Bruce Alberts et al., *Molecular Biology of the Cell* (New York: Garland Science, 2014), 876–77.

etc., are "entrained" to the 24-hour cycle of light and darkness. External signals indicating the time of day cause small adjustments in the running of the clock so as to keep the organism in synchrony with its environment. Thus, it is both a certain rhythmicity inherent in the organism and its adaptation according to environmental conditions that enable life to function and maintain it in a certain stable state. But the internal functioning does not solely consist of a linear regularity, nor does adaptation exclude the introduction of new rhythms, hence the possibility of metamorphosis. Philosophically speaking, this means that the concept of rhythm cannot be equated with a dogmatic measure, which would produce rhythmic forms according to a fixed point of reference each time.

Deleuze and Guattari show in *A Thousand Plateaus* that a rhythm is not a movement based on a regular or irregular measure.[32] A measure might only be the outcome of rhythmic patterns. It is set up according to a codified form and assumes a homogeneity between the supposedly encompassed elements. However, what determines a rhythm is the critical moments; how the measures pass into and articulate with each other, how they inform each other as to be altered altogether, at which moments they lose their cadence as to relate to each other. It is true that rhythm assumes an iterative cycle and its periodicity is defined by a certain routine. Yet, it is the non-routine elements at the heart of the system that ensure continuity of the cycle. What this means is that, at some point, the functioning of the elements that set up the system through forms of interconnection, which is assumed by periodicity, is interrupted. The system becomes inactive due to its smooth and regular operation. On the other hand, it is at this very moment of inoperativity when the system goes beyond the patterns of activity predesigned as possibilities, that the system is recharged by new possibilities in order to sustain itself. In this respect, it is not the harmonized functional units that define a biological cycle but areal tensions and their resolutions with respect to some disparate elements. Rhythm concerns the passage. While one event is ending, another is about to start. What is transferred between these two events is not predetermined forms but rhythmic blocks, the patterns of interrelations that cross them. In scientific discourse, such a non-linear transition will be expressed precisely by oscillatory events and feedback processes taking place at the cellular level.

For the regulation of the cellular processes, oscillations become inevitable in a highly complex, multicomponent biochemical pathway, due to the large number of feedback loops. The key principle here is that circadian clocks generally depend on negative feedback loop.[33] These loops in-between the rhythmic oscillations in a circadian clock felt in the entirety of organism cause spontaneous oscillations which

32 Gilles Deleuze, Félix Guattari, *A Thousand Plateaus: Capitalism and Schizophrenia* (Minneapolis: University of Minnesota Press, 1987), 313.

33 John J. Tyson, "Biochemical Oscillations," in *Computational Cell Biology*, ed. Christopher P. Fall, Eric S. Marland, John M. Wagner, John J. Tyson (New York: Springer 2004), 232, https://doi.org/10.1007/978-0-387-22459-6_9.

"only exist in nonlinear dynamic systems and persist with finite amplitude."[34] As Ilya Prigogine points out in his introduction to Albert Goldbeter's book *Biochemical Oscillations and Cellular Rhythms*, spontaneous oscillations are highly complex and constrained by non-equilibrium systems.[35] Spontaneous oscillations reveal at the same time "limit cycles, steady states, chaotic behavior . . . without any emerging universal scheme."[36] A negative feedback loop contains delay mechanism that slows down the feedback signal through the loop: "rather than generating a new stable state as in a rapid negative feedback loop, a delayed loop generates pulses, or spontaneous oscillations, in the levels of its components."[37] A vital activity then cannot be encapsulated in either the overall organization of the circadian rhythm occurring dependently on the internal and external conditions of related cells in contact with the environment nor through regulation of certain lively activities in the negative feedback process. Vital activity finds the condition of its operativity in its inactivity, in other words, in the delay. It is in these spontaneous oscillations that the delay can be felt by cells. It is the network of molecular relations, controlled by positive or negative feedback loops and driven by a flow of matter that contingently gives rise to periodic or chaotic behavior. From this perspective, explaining biological processes solely through function, utility, or in the range of the already known structures of meaning, and even the strictly material conditions of the event's occurrence would be inadequate. Biological processes implicate an aspect that does not comply with the external relations of cause and effect. They incorporate a margin of unexpectedness lying at the heart of the system's characteristic paths of action and reaction as the possibility of capacitation by the access to new potentials.

This immanent margin of unexpectedness brings the necessity of understanding the rhythm not with respect to structures that presuppose a unitary form but through the concept of milieu that assumes the interrelationality of elements and their complication within each act of relating. A milieu is not a meta-structure in which organic structures resolve. In other words, it is not a unitary concept. The regular meter of a milieu is a vital pulse not a reproduction of the same, whose regularity and variability are inseparable from the inter-milieu rhythms of difference. In this sense, periodic repetition of the biological milieu produces a rhythm but not by reproducing an identical measure and not in isolation from other milieus. Rhythm takes place between at least two milieus. This is one of the most important points of Deleuze and Guattari's philosophical elaboration of the concept of rhythm.[38] Measure may be regular but rhythm "is the Unequal or Incommensurable, always in a process of transcoding," operating "not in a homogeneous space-time, but with

34 Karsten Kruse and Frank Jülicher, "Oscillations in Cell Biology," *Current Opinion in Cell Biology* 17, no. 1 (2005): 21, https://doi.org/10.1016/j.ceb.2004.12.007.

35 Albert Goldbeter and M. J. Berridge, *Biochemical Oscillations and Cellular Rhythms: The Molecular Bases of Periodic and Chaotic Behaviour* (Cambridge: Cambridge University Press, 1997).

36 Goldbeter and Berridge, 1997, XXI.

37 Bruce Alberts et al., *Molecular Biology*, 516.

38 Deleuze and Guattari, *A Thousand Plateaus*.

heterogeneous blocks."[39] Rhythm is difference or the relationality of in-betweenness whereby milieus communicate with one another through transcoding or transduction. Each milieu is an array of relations linked to other milieus and the transduction amounts to the non-linear, transversal transmission of rhythmic patterns. From cellular events to extracellular milieu, each milieu is constituted by the interlocking of smaller and larger pulses and patterns. A correlated population of intervals and intervals of intervals is stretched out according to their interweaving from the relatively simpler levels to higher levels, constantly going and coming in-between. The complex interplay of genetic sequences, genes, proteins, macromolecular complexes, signaling networks, adaptive and regulatory functions, species, communities, in brief, a whole ecology consists of complex interrelations. Now, life turns into a kind of music, a symphonic interplay between genes, cells, organs, body, and environment.[40]

When it comes to microbiology or microbiome studies on this matter, they deal with huge diversity of facts or pieces, constantly offering new complex patterns to describe evolutionary processes.[41] Depending on the circumstances and food supply, an organism is able to play a whole repertoire of action-reactions in different tunes. For example, according to one of the forerunners of microbiome research—Rob Knight, the gut microbiome works like a large-scale ecosystem in which different groupings of microbial species can carry out different functions in an orchestrated way.[42] The orchestration of units does not necessarily mean that they are articulated with each other in a harmonious or pre-established way. Rather, this orchestration implies that even the dissonances are always a part of the biological process that define their eventfulness as seen with spontaneous oscillations in circadian rhythm, tune into each other in the interpenetration of different speeds (rate of rhythmicity). A group of microbes competes with others in order to gain territory and resources as much as they cooperate with each other. Microbes don't have a nervous system, yet "have varieties of perception, memory, communication, and social governance."[43] Their functional operations are basically shaped by chemical and electrical networks that give rise to leveling and layering among different biological processes. The continuous execution of vital activities induces changes of pace, rhythm, and key. Each species participates in this never-ending background music of life through their own modes of feeling.[44]

39 Deleuze and Guattari, *A Thousand Plateaus*, 385.

40 Denis Noble, *The Music of Life: Biology Beyond Genes* (Oxford: Oxford University Press, 2008).

41 Fernando Baquero and César Nombela, "The Microbiome as a Human Organ," *Clinical Microbiology and Infection* 18 (2012): 2–4, https://doi.org/10.1111/j.1469-0691.2012.03916.x.

42 Emeran Mayer, *The Mind-Gut Connection: How the Hidden Conversation Within Our Bodies Impacts Our Mood, Our Choices, and Our Overall Health* (New York: Harper Wave, 2018).

43 Antonio Damasio, *The Strange Order of Things: Life, Feeling, and the Making of Cultures* (New York: Pantheon Books, 2018).

44 Assal Habibi and Antonio Damasio, "Music, Feelings, and the Human Brain," *Psychomusicology: Music, Mind, and Brain* 24, no. 1 (2014): 92–102, https://doi.org/10.1037/pmu0000033; Matthew E. Sachs, Antonio Damasio, and Assal

The production of microbe-sounds with different interests and ends, how we listen and engage with them in various ways belongs to this expanded field of feelings. Microbial rhythms are captured according to whatever techniques and operations are put into use, and accordingly, are transformed into a sound that can be heard by the human ear. In this way, the rhythms of the microbial field, technical tools, and the human ear come together to produce a complex interplay of rhythms.

INTERSPECIFICS

Interspecifics, a bioart collective based in Mexico, explores communication dynamics between different species through sound phenomena. "Interspecifics" means "arising between species" and what arises between species here is the different vibratory regimes produced by electrical-chemical activities converted into sound compositions by specifically designed interfaces. Members of the group produce different tools depending on the requirements of the project at hand. *Energy Bending Lab* is comprised of a set of custom-built modular synthesizers and tools that help to convert accumulated electric properties found in bacteria into real-time sonification. *Interspecifics* appeals to a series of transduction in the literal sense of the term: the conversion of a signal from one medium to another in which sound travels through different material environments. But this technical meaning of transduction also converges with its philosophical meaning in the sense that sound phenomena are not simply quantifiable raw matter passively transferred from one medium to another in a linear way. Rather, they are rhythmic patterns that undergo qualitative transformation within each transductive operation. The main emphasis of the collective is to discover these emerging rhythmic patterns through multimodal formats. The relationship between waveforms, matter, and frequencies' physical form finds its expression in the patterning of data values through critical turns of oscillations.

For example, in *Micro-Rhythms*, the collective aims to capture small voltage variations inside microbial cells. The cells are sampled from the soil, where harmless bacteria are isolated and grown in a laboratory environment. The micro signals produced by the bacteria is then amplified so that the micro voltages can be converted into electronic signals. These signals are introduced as data into a pattern recognition algorithm that matches the oscillation sequences to be turned into sound. Finally, a Python algorithm and three Raspberry Pi cameras with Open Computer Vision are used to track light changes and create a real-time octophonic audio system score played using a SuperCollider. In this way, the installation creates an audiovisual system, which converts the bacteria's metabolic oscillations into integrated rhythmic blocs perceivable by the human ear with an organic quality to the music. As Antonio Damasio explains, a metabolism is the name of the rhythmic cycling of cells' chemical

Habibi, "The Pleasures of Sad Music: A Systematic Review," *Frontiers in Human Neuroscience* 9 (2015), https://doi.org/10.3389/fnhum.2015.0040.

pathways as they extract the necessary energy from their environment, use it as efficiently as possible, and then throw away the waste products.[45] Each of these operations requires a number of integration and differentiation processes in which the concept of transduction finds its meaning. According to Simondon's elaboration of the concept, the affectivity of a living being, at some moment, holds the information acquired from its environment in a reserve according to the given circumstances in order to integrate that information into its system as to ensure a continuity or a relative stability.[46] In another moment, the acquired energies are gradually distributed in a differential way according to the capacity of accumulation of different parts. Finally, this means that at each of these moments and at each level, the transducers are triggered in accordance with the intensity of affectivity leading to a cascade of events affecting the coordination of the whole system. In *Micro-Rhythms*, what is perceived by the human ear as changing rhythms giving quality to sound is this process of integration-differentiation actualized by multiple transducers, each time individuated according to specific circumstances in the soil, petri dish, bacterial groupings and conditions of growth and the designs of the algorithms, cameras, and audio-visual system. These disparate elements are then brought together in the form of audiovisual installation.

In *Interspecifics Collective*'s work, aural effects implicate their potentials beyond instrumental purposes toward the creation of interactions designed to attune human perception to non-human elements. Each installation's interface design plays an important role in actively contributing to the work's eventfulness as a nexus for the generation of rhythmic time. In the process, it crystallizes potentials beyond spatialized connotations.[47] Meanwhile, in *Nonhuman Rhythms*, an unnoticed aspect of urban life, yet somehow experienced in the spatiotemporal coordinates of daily life, is brought to the fore. The collective gathers water and sediment from the nearest shore to the exhibition site in order to build a microbial fuel cell and signal amplifier that will transduce the microbial vibrations captured through the collected samples into sound. To process the bioelectric signals, *Interspecifics* uses the Processing and Pure Data programming tools, and Open Computer Vision to analyse the movements under the microscope. The bacteria, when deprived of oxygen, reduce metals from their environment and in the process grow nano antennas used as an electron transfer respiratory tube. A conversion of frequencies emerges from this relationship between bacteria, oxygen, and metals captured by the various tools sensitive enough for their capture.

In *Nonhuman Rhythms*, elements pertaining to soil, water, weather, plants, bacteria, fungi, electronics, and humans are co-composed as traversing the dynamics of each element but translated as transducers of energies and flows, changing

45 Damasio, *The Strange Order*, 34.

46 Gilbert Simondon, *L'individu et sa genese physico-biologique: L'individuation a la lumiere des notions de forme et d'information* (Paris: Presses universitaires de France, 1964), 142.

47 Eleni Ikoniadou, "A Rhythmic Time for the Digital," *The Senses and Society* 7, no. 3 (2012): 261–75, https://doi.org/10.2752/174589312x13276628771721; Eleni Ikoniadou, *The Rhythmic Event: Art, Media, and the Sonic* (Amsterdam: Amsterdam University Press, 2014).

character with each operation. The gently shuffling rhythms and persistent electronic rattles, beeps, and interruptions of the work intertwine in a complex ecology of speed in what Eleni Ikoniadou calls "rhythmic time." This rhythmic time passes through diverse elements or transducers, pointing toward a capacity beyond the already established and settled temporalities couched in a specific field of activity through its functionalities and affordances.[48] The growing feeling of uncertainty in the work indicates the existence of complex rhythmic patterning which vibrates "beneath solid structures, organized structures, organized spaces, specific spatiotemporal dimensions, peoples and events."[49] This patterning is mainly achieved through electrical energy, which is derived from the physical-chemical activities of the microbes. The environmental conditions that determine the acquisition of electrical energy are effective in the emergence of frequencies and oscillations. While all of these factors are distinguishable in extension as separate entities, they are involved in the formation of the singular quality of sound as disparate elements. Which soil, what kind of bacteria and algorithms come together and what kind of discursive intervention ensures the involvement of the participants?

the dark side of the cell: CELLULAR NOISE OR CELLULAR MUSIC?

The second microbe-sound example, *the dark side of the cell*, an audio-visual installation realized as a collaboration between Anne Niemetz and Andrew Pelling, involves microbial sound produced directly within the scientific framework that can be posited within a specific research program or lead the way for asking new scientific questions. According to a technique called sonocytology, vibrational movements of cell walls can be recorded by the aid of a scanning probe microscope and amplified in order to render them audible to the human ear.[50] In this technique, the cellular vibrations are then converted into cellular sounds that can be interpreted as conveying meaningful information from the mobilized scientific point of view. James Gimzewski, the (bio)chemist who discovered this technique, calls the sounds captured as a result of sonocytological procedures "music" since they are not just random noise but help to produce scientifically meaningful results and are articulated in a harmonious way. As well as being part of scientific research, these sounds were exhibited as an art-science performance under the title *the dark side of the cell*. Is it enough, however, to qualify a sound as music or art, to associate it with meaning or produce distinguishable rhythmic patterns recognized by the human ear?

In order to understand the production of a microbe-sound through sonocytology, we can once again appeal to the concept of transduction. The most important aspect distinguishing Simondon's concept of transduction from its

48 Ikoniadou, "A Rhythmic Time for the Digital," 263.
49 Ikoniadou, "A Rhythmic Time for the Digital," 272.
50 Sophia Roosth, "Crafting Life: A Sensory Ethnography of Fabricated Biologies" (Doctoral dissertation, Cambridge: Massachusetts Institute of Technology, 2009).

technical meaning as the translation of signals across various media is the emphasis on the amplificatory processes. What makes this concept crucial in Simondon's philosophy through amplificatory processes is that it criss-crosses both the organic and inorganic world, the living processes and the invention of technical forms. Livingness is not defined in relation to a substance, but as the becoming-together of three dimensions: action, milieu and being part of an individuation.[51] The process of individuation, which consists of a series of operations, determines how these three dimensions come together and how the relationships between them are to be interweaved. Milieu and individual are a couple, which indicates that neither of them is given and that they emerge together as a result of a process of individuation. This means that the individual is an end product and that its emergence involves an eventual dimension. A tension arises between the elements, which is brought up by the anterior resolutions that partially sustain themselves in the successive resolutions according to the ways in which the milieus restructure themselves. This tension consolidates itself as an adaptative act, but also always as more than that, as something that cannot be resolved by remaining within the confines of previous solutions. At some point, a solution needs to be improvised and all milieus are to be re-coordinated accordingly.

Being is re-coordinated by leaps and amplifications, according to the partiality or totality of dissolutions depending on the degrees into which they correspond and their rhythmicity as the destructuring and restructuring of the system.[52] This explains why each process of transduction necessarily involves amplification.[53] The disparity between the elements coexisting within a field of interaction creates a certain tension according to the distribution of polarities. Transduction basically amounts to the resolution of this tension. This process culminates in the emergence of an extra-effect that cannot be either reduced to a single privileged element or forecasted as having a definitive form. This means that translation across series, that is—the transition of a signal from one medium to another or the effects of elemental forces distributed in the same field, cannot be explained according to a linear unfolding. The participating elements, despite being disparate, operate in solidarity. Their coming-together itself is a taking-form, which means that it is a process of invention *(ontogenesis)*.

The sonocytological operations that render possible *the dark side of the cell* consist of a series of biological and technical transductions. The recorded sound is not only the capture of cellular responses to some extracellular circumstances (cytoplasmic events) but also a produced effect which demonstrates cell wall porosity, blurring the boundary between intracellular and extracellular milieus. The sound betokens that each response or resolution enters into a process of capacitation projected into specific regimes of vibration. The specificity of this regime depends on

51 Gilbert Simondon, *L'individuation à la lumière des notions de forme et d'information* (Grenoble: Editions Jérôme Millon, 2005), 213.

52 Simondon, *L'individuation*, 315.

53 Simondon, 31–33, 107–10 and *passim*.

the constitution of the porous structure as a site of resonance emerging from the disparate elements, kept in suspense and moved towards their resolution. All this to say that the technical tools that enable the translation of biological information into electrical impulse, in a sense, represent a field of sensibility which collects the rhythms of the field of elemental interactions. Each use of this technique is a process of form-taking and brings an amplification in its functioning site as the capacitation of the system. Conversion of the input energy into output energy by an atomic force microscope, rather than being a gradual development of an already predesigned all-encompassing structure as a staging of pre-established trajectories, instead translates a series of vibrations through different transductions. In this regard, this process of translation explains why we hear a musicality (harmony) in the produced sound, even from the scientific perspective. The recorded sound provides access to the workings of the cellular interior by indexically mapping the cellular metabolism, and in this way, appearing as a technical tool for the advancement of scientific research. But also, through the dispersion of sonic height, depth, and directionality, it also opens an auditory space. The vibrations are conditioned by intra-, inter-, infra-cellular processes unfolding in cytoplasmic milieus; they are "the busy hum of actin and myosin filaments assembling cellular scaffolding, the whoosh of molecular transport through cytosol, the glub glub of endocytosis and exocytosis."[54]

The process is overloaded with potentials and capacities in such a way that the actual forms cannot be delegated to involvement of different factors and their interactions with each other. Simondon calls this margin of uninvested potential the preindividual and constructs it as the absolute openness of the future, as the presence of inactuality in actuality.[55] The two meanings of the -trans prefix in the trans-duction come together at this point: being traversed and moving beyond. This means that neither does objectivity—assumed by scientificity, leave the world in a rigid state, nor are the rhythmic movements captured through its temporary, not-yet-consistent personal or individual investments. Sonocytological procedures could be used as a diagnostic tool in order to detect cancer at an early stage. Perhaps this is the most important point distinguishing *the dark side of the cell* from a musical piece. However, in the scientific context in which sonocytology was installed, we find typical germination of microbe-sounds through the scientific knowledge: the translation of biological processes' dynamics into possible medical applications. The structure of recorded sound might provide access to cell functioning by signifying cellular metabolism and movement. As such, the frequency difference between vibrations at higher or lesser degrees might index the difference in the ATP metabolization speed, therefore helping to distinguish between cancerous cells and noncancerous cells.[56] Sonocytology, in this regard, brings into view the interface of this echoic transitivity established in a specific scientific formation, and therefore makes us feel a certain

54 Roosth, "Crafting Life," 347.

55 Simondon, 247–55; Muriel Combes, *Simondon, individu et collectivité: Pour une philosophie du transindividuel* (Paris: University Press of France, 2013), 35.

56 Roosth, 340–41.

musicality that roams the whole nature-culture continuum.

VICTORIA SHENNAN'S *ANTHROPOCENE*

Victoria Shennan's *Anthropocene* goes beyond scientific microbe conception through the intersection of the biological and computational. The convergence between these two indicates "the increasing integration of biology and informatics, molecular biology and computer science, DNA and data."[57] Contemporary techno-scientific apparatuses have a capacity for proliferating innumerable molecular activities in which a certain lively potential is enveloped by an algorithmic functioning. For instance, metagenomic methods include a series of computational approaches that allow sampling the environment without assembling the genome of a species but by collecting a lot of small fragments of DNA from different species. This might lead to the cataloging of many previously unknown microbial species, as well as lists of millions of microbial genes collectively known as human microbiome. These processes show that microorganisms perceive environmental conditions and react in ways advantageous to the continuation of their lives. They can communicate among themselves and with the environment through complex molecular processes. The functional operations rely on chemical and electrical networks or in the higher levels on the ecosystemic factors. For this reason, computational approaches come into prominence in terms of explaining these processes as well as the behaviors of microorganisms.[58]

Different types of microbes in the human body interact with each other and with the different mechanisms of the human organism. These interactions vary depending on which area of the body is concerned, environmental factors, or factors related to lifestyle such as diet or physical activity. DNA sequences can be isolated through samples taken from a body part, and then the samples can be translated into an identification of the species of bacteria by the aid of computer software-algorithm. Then, the genetic code of microbes can be translated into protein structures, encoded by the same DNA or RNA letters. Shennan's *Anthropocene* turns these complex processes of encodings into melodies and melodies into a symphony with which they are anchored. Therefore, the field of electrical-chemical interactions, which at one level defines a certain layer of the microbial interaction field and is traversed by oscillators, which are already components of a non-linear process (see the *Interspecific Collective* example) is doubled by a more profound field of algorithmic functioning.

In order to penetrate into this multi-layered level, Shennan firstly translates DNA sequences into musical notes. Each DNA letter represents one note. The

57 Eugene Thacker, "Biophilosophy for the 21st Century," in *Resisting Biopolitics: Philosophical, Political, and Performative Strategies*, ed. S.E. Wilmer, Audronė Žukauskaitė, 123–35 (New York: Routledge, 2015).

58 For a brilliant analysis of the aparalel evolution of biological sciences and informatics, see John Johnston, *The Allure of Machinic Life: Cybernetics, Artificial Life, and the New AI* (Amsterdam: Amsterdam University Press, 2010).

collected microbe samples are turned into DNA information and then reassembled as the three-dimensional (3D) digital reconstructions of the proteins. Using data from X-ray crystallography—a technique that determines the spatial disposition of the amino acids that compose the protein—the computer assigns note sequences to specific 3D features of the protein. As a result, the notes and melodies are constructed with the letters this time corresponding to RNA codes, and these are overlapped with the DNA-linked melodies placed in the background as a separate layer. In this way, recognizable musical note patterns emerge from the 3D structural data and DNA coding. The characteristic patterns of protein structures such as helixes are heard as arpeggios and beta-sheets as a succession of similar notes in order to produce repetitive patterns, changing in rhythm, melody, and intensity throughout the piece. The ways in which the genetic code of nucleotides or the shapes of protein are translated into sound patches are incidental but not metaphorical, organized but not preordained. The use of different algorithms for different ends transposes the engineering nature of the project into the whole continuum of life as the modes of interrelations, from molecules to microbes, microbes to human organisms, and from human organisms to cultures, as the qualitative nature of the human ear's implication in the very experience of listening to the *Anthropocene's* microbe-sound composition.

The resulting melodies are obtained by the extraction of DNA and RNA sequences, by their conversion into data, and their attribution to the musical notes in a contingent way. On the other hand, this echoes a deeper contingency, which traverses vital processes and their rhythms, and, consequently, their consolidated phases beyond contingencies. Each molecular event is populated by heterogeneous elements and shaped by selections according to the capacity of each element participating as a factor. Additionally, they resonate in the mutual web of relations between different bodies and milieus, in relation to the ecosystem of bodies.[59] The production is everywhere. Not only the affair of human subjects or groups, it also takes place at the molecular level of cells, enzymes, DNA, and genes.[60] Each time, the algorithmic structuring gets complicated by systemic relationality and generates new modes with each complication, which opens a field of "unexplored potentials" (surplus-value of algorithmic effect).

In Shennan's *Anthropocene*, it is this problematic structure of interacting with microbes and the potentializing effects of a microbe-sound composition that cuts across different vital, technical, and social layers, and exhibits a different sound quality than the other projects discussed. This is precisely where the hyphen in the term "microbe-sound" finds its meaning. It is the index of a problematic field that combines two meanings of *milieu*: Both the singular crystallization of multiple factors that traverse an entire ecosystem (milieu as environment), and the unique logic of relationality, of "in-betweenness," based on the premise that the relation cannot be

59 Luciana Parisi, *Abstract Sex: Philosophy, Biotechnology and the Mutations of Desire* (London: Bloomsbury Academic, 2004), 31.

60 Eugene Thacker, *The Global Genome: Biotechnology, Politics, and Culture* (Amsterdam: Amsterdam University Press, 2006).

reduced to its terms (milieu as middle). This is precisely the main point of this paper's proposal for Anthropocene debates through the analysis of microbe-sound compositions: the determination of different modes of becoming, which traverse the entire nature-culture continuum, modes of mutual inclusion that span a whole plane of horizontal interdependencies. Rather than reassuming the human mastery of nature under a form of stewardship, or simply determining the various forms of presumed non-human subjectivities, which do not undermine the dichotomous thinking that is transposed into different life forms, I propose experimenting with the problematic character of an in-between in search for an incumbent liveliness in scientific, technological, social, political, and philosophical expressions. This also brings the task of developing process-oriented approaches based on the study of the field of reciprocal presuppositions and multiple interactions between different life forms.

CONCLUSION

Even in critical circles, the Anthropocene debate continues to be a focal point for issues such as ecological crisis, environmental governance, human-nonhuman relationships, or sustainable futures. The call for immediate action on issues such as carbon emission, climate change, wildlife habitat, and endangered species especially fosters science-based policies, and the mobilization of technologies for this end. These technoscientific-oriented approaches emphasize an approach in which human being is at the center of the universe, and its master status, which reserves the necessary "goodwill," imposing on him to care for other beings. Another line of thinking calls into question the dominant position of the human being and the related anthropocentric assumptions. According to this view, humans are part of a horizontal web of interdependencies with other living beings and non-living beings. Especially in "post-humanist" approaches, whereas the human-non-human interactions are reshaped by new technologies that function as amplificatory prosthetic apparatus, the main emphasis is on human's capacity of overcoming themselves entirely, on the possibility of the becoming-other of the human in symbiosis with nonhuman in the emerging forms of inter-or multispecies alliance.[61] This, in a way, leads the way to the "new materialist" approaches according to which living beings' potential of producing a quality of liveliness amplifies each other's relational potential for sensing and acting.[62] Here, what I attempt to conceptualize in this article under the term

61 Rosi Braidotti, *The Posthuman* (Cambridge: Polity, 2013); Katherine Hayles, *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics* (Chicago: University of Chicago Press, 1999); Donna Haraway, *The Companion Species Manifesto: Dogs, People, and Significant Otherness* (Chicago: Prickly Paradigm Press, 2003).

62 See especially Jane Bennett, *Vibrant Matter: A Political Ecology of Things* (Durham: Duke University Press Books, 2010); Diana Coole and Samantha Frost, *New Materialisms: Ontology, Agency, and Politics* (Durham: Duke University Press Books, 2010); Rick Dolphijn and Van Iris der Tuin, *New Materialism: Interviews & Cartographies* (London: Open Humanities Press, 2012).

"microbe-sounds" follows this line of thinking and researching, but also aims at distilling the modes of sound phenomena that traverse a human-microbe continuum.

According to the perspective mobilized in this article through Simondonian and Deleuzo-Guattarian conceptual toolbox, artistic engagement with microbes through the sound compositions brings to the fore an in-betweenness of human and microbe, which situationally sweeps them together towards a becoming-other within the stirring of tensional forces traversing both. It performs the "in-between" (*milieu*) by its distancing with respect to the existential parameters of these two terms and according to its capacity of exceeding them. In this respect, microbe-sounds crystallize the artfulness that expresses a relational field's complexity couched in scientific formations in multiple ways. The fact that our relationship with microbes is basically conditioned by sciences does not change the fact that their priority was established only retrospectively. In contrast, retrospectivity is the index of a pre-discursive field's existence. This means that only a pre-vital field potentializes the vital processes as examined in life sciences.[63] Whereas these potentials are dispersed in various fields of activity, they are consumed in certain ways to be reborn in transversal ways.

In an artwork, microbe-sounds relate to a particular rhythmic interlinking of accelerations and decelerations, increases and decreases, starts and stops, which form vital processes. They produce a certain quality of movement captured by scientific and technical tools, then transduced to musical notes that are the minimum unit of nature's musicality in the human world. They are then recomposed according to the various forms of transducers in this sphere. Disparate elements come together in a microbe-sound composition where they become sensitive to each other and grow within rhythmic articulations. A similar process takes place in research, thinking, and writing, each with their own processual resources, with the construction of a problematic field that holds together the heterogenous elements, in a performative manner, in resonance and interference. What we hear with microbe-sounds is the birth of such a problematic field that infinitely proliferates itself. ⊡

63 Simondon, *L'individuation*.

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