<<halftitle page>>

[we, other utopians]

[recombinant DNA, genome editing, and artificial life]

[Blurb]

[Eva Šlesingerová is an anthropologist and sociologist. She has focused on different areas of research and academic interest: body, genomics, AI technologies, robots and biotechnological art and experiments. She teaches courses like Anthropology and Technology, Kinship or Research in Art. Her publications include texts in journals like *Social Science Information, Body & Society* or *Medicine, Health Care and Philosophy*.]

Acknowledgements

Here I would like to recall my positive memories of all the great people, animals, environments, and institutions, and to express my gratitude for the support I received during my research, through the months as I was writing this book, and now as I release it and see it off on its own life.

The following text would not be possible without the research I carried out under my MCSA Marie-Curie Skłodowska Fellowship (no 750088), and the project ARTENGINE (*Artificial Life/Anthropological and Sociological Analysis of Life Engineering*) that I worked on at the Goethe University in the "*Biotechnologies, Nature and Society*" research group of Thomas Lemke. It would also not have been possible to complete without the support of the Department of Sociology, Faculty of Social Studies, Masaryk University, specifically the department head, my colleague Tomáš Katrňák.

My biggest thanks go to my partners in the research field, the members of the lab where I was involved, and all the people who were willing to spend some time with me during our interviews, including MPs and members of ethics boards. The hours I spent with them changed many of my narrow-minded stereotypes about science, inspired me to expand my own utopian (and admittedly sometimes dystopian) imagination, and simultaneously brought me memories from my childhood, deeply hidden and seemingly forgotten.

I also thank all my students for our long discussions, my colleagues who were involved in the track about genome editing (*Editing future life and biotechnological utopias/Bio-political*

materialization and potentialities of CRISPRcas9) EASST/4S in Prague 2020, and to Thomas Lemke for helping me with the book proposal.

I give my warmest thanks to my friends for their support: Jana, Adéla, Renate, Šárka, Robin, Alan, Petzi and Klaus.

Sincere thanks go to Anne Johnson – my editing superhero and first reader, always encouraging, for her continuous, irreplaceable, and warm support; to Diana Ciabotea for her very kind, thoughtfulness and professional help guiding me through the long path from the first ideas of the book across the "COVID slowing-everything-down" bridge to the final manuscript; and to Michael Morrison for his ever positive, consistently kind and witty vibes.

My most glamorous thanks go to Sofia the cat, who lay on my keyboard enough to actually become my co-author and who always reminded me there is some other universe and of course that cats do not need any enhancement! Thanks also to the squirrels in the garden at my apartment in Frankfurt, for all the fun and the nuts all around.

And thanks beyond words to all my supportive and loving networks and kin, to my Frankfurt family and to my Brno family.

Brno 17th May 2021

Chapter 01

Introduction

Abstract

The introduction establishes the main themes and analytical lines of the book. These concern explorations of genome editing and recombinant DNA technologies, their genealogy and social and cultural contexts as well as their current developments. In particular, the narratives and discussions on CRISPR-Cas9 techniques are addressed. All these topics open the possible reconsideration of the consequences of engineering perspectives of the human body as malleable, programmable, and repairable. The opening words of the book also focus on utopian biotechnological bodies, their specific temporalities, apolitical biopolitics, and technocracy. Together with time-tricking practices in the lab where the research took place, the strength of imaginative thinking and tinkering in miscellaneous futures, visions, hopes, fears, and concerns connected with contemporary genome editing technologies are raised for the subsequent analysis.

Eva Slesingerova
ORCID ID: 0000-0002-8944-5422,
http://orcid.org/0000-0002-8944-5422

From an engineering perspective, living systems can be perceived as overly complex, inefficient, and unpredictable.

Csete and Doyle

The coming utopia has already arrived.

Boris Groys

We have always been traveling. ... we are the Dasein in the sky.

Michel Serres

In the course of my life, I have experienced many revolutions.

My whole childhood was flooded by revolutionary rhetoric. The images of permanent revolution were essential for the power rituals performed under state socialism in Czechoslovakia. Notably, science and technology were considered as the main revolutionary and emancipatory elements. The perspectives of *scientific socialism* and *scientific and technological revolution* colonised the social space. Continual scientific progress heading beyond the infinite horizons of better tomorrows – this was the official version of reality at that time. However, hoping every day for the achievement of the ultimate utopian dream is a somewhat tiring experience, as is life under authoritarian governance, a failed state, and the

lack of actual socialism under state socialism. After the Velvet Revolution of 1989, alliances between science, technology, and society continued to expand under neoliberal techno-capitalism. Later, the only revolution that seemed to persist was the scientific and technological one. Having blended science, technocracy, the market, and other social institutions, the technoscientific era goes on in new frames and parameters – apparently without any convincing or vital political alternatives in post-political, end-of-history, post-democratic, and hyper-normalised societies (Mouffe, 2005; Yurchak, 2006; Swyngedouw, 2014; Meyer, 2019).

For years, life engineering and genomics have been significant inspirations for stories about the constant science-technological revolution, with its multiple cascades of breakthroughs and discoveries. As Nathaniel Comfort wrote in *MIT Technology Review* (2018): 'There have been many "DNA revolutions" since the discovery of the double helix, and now we're in the midst of another.' And Petr Dvořák, the former head of the Czech Bioethical Commission, stated: 'We are facing a new revolution in life sciences, which provides medicine and science with enormous potential and power. This includes above all genome sequencing, induced pluripotent stem cells, tissue engineering, and genome editing technologies' (Koubová 2016). This book explores one of the current DNA revolutions – advances in DNA recombination and genome editing technologies. It investigates the imagined biotechnological utopias, visions, and practices of repaired future, perfect, flawless bodies, and scientists' thoughts, emotions, and dreams. The text discusses apolitical biopolitics when analysing the social and cultural contexts of genome editing technologies. Specifically, the book address the roles of politics and the poetics of utopian thinking surrounding recombinant DNA technologies. In the text I ask what kinds of subjectivities, networks, and reconfigurations are made by the *dispositif de securité* within genome editing and recombining DNA technologies. What kinds of biotechnological utopias, spaces of hope and hype, visions, fears, and concerns do we face today in the context

of human genome editing technologies? Which social and political issues are mirrored and created by these technologies? What modes of de/politicisation are involved in this area? What kinds of new social control, hierarchies, exclusion, and domination, as well as care and social inclusion can genome editing technologies help accomplish? And further, as Montenegro de Wit asked (2020:2): 'Who owns this technology, who has access and who is making decisions about its development and use?'

The dreams of worlds that have never been achieved, but could be, are combined with real socio-technological changes simultaneously existing in our memories and in our hopes for the future. They live concurrently in the past and in the future, in some heterotopic or rather heterochronic spaces. Nikolai Ssorin-Chaikov explored such overlapping temporalities and wrote that they 'are "others" to each other, and, as a non-Euclidean social time frame, they constitute a complex yet internally fragmented social fabric' (Ssorin-Chaikov, 2006:371). Specifically, entanglements of scientists, DNA recombination technologies, and their translations to public spaces or to popular culture create such space and time spirals, as does work with slowed and frozen time in cryonic boxes for biomaterial (Lemke, 2019), envisioning future bodies, plans for regulations, immortalised cell lines, and memories. Despite the recall of the past in scientists' motivations and their work with DNA samples from cells that are decades old, the main time arrow of DNA recombination is pointed towards the future. The theme of DNA recombination and genome editing echoes the general situation of studies of science and technology, which have become imbued with analyses of visions of the future, 'those creatures of the future tense,' when exploring the expectations, speculations, visions, hopes, prophecies, promises, and potentials as well as the hype, pessimism, fear, and concern in connection with recombinant DNA technologies (Selin in Tutton, 2011:412; Tutton, 2011).

Writing about the sociology of the future, Cynthia Selin suggested that we should consider the mutual co-dependence of technological and societal change followed by the production of new cultural meanings (Selin, 2008). Selin claimed that:

> What is taking form is a sociology of the future comprised of scholars who are particularly interested in the future tense and how the future – as temporal abstraction, as story, as discursive strategy – is a component of social reality … The expectations, hopes, fears, and promises of new technologies are not set apart from nor layered on top of scientific and technological practices, but are, rather, formative elements of innovation and of the constitution of a new field (Selin, 2008:1891).

Likewise, Kaethe Selkirk, Cynthia Selin, and Ulrike Felt suggested looking at the 'festival of futures' (2018), excavating multiple temporalities, nonlinear futures packaged in narratives, expectations, and actions, and engaging memories, imagination, and promises. They asserted that there are multiple 'temporalities and knowledges that come to bear in shaping the future and our ideas of it.' They construct both ideational and concrete spaces designed to explore potential futures and responsible decision-making strategies (Selkirk et al., 2018). However, 'in parallel with positive visions and hopes of future advancements, fears and tenebrous imaginings of future risk are often associated with scientific and technological change. Such dark imaginaries have provided the material of science fiction for more than a century. Futures are contested, whether conjured as visions of utopia or dystopia' (Tutton, 2011:412). Analysing such contesting variability of the future, Roxana Moroşanu and Felix Ringel proposed 'the concept of "time-tricking" – the different ways in which people individually and collectively attempt to modify, mangle, bend, distort, speed up or slow down or structure the times they are

living in.' The future 'can be tricked, manipulated, and moulded into, among other things, self-fulfilling prophecy' (Moroşanu and Ringel in Bryant & Knight, 2019:14). Against this backdrop, I analyse the social and cultural phenomenon of genome editing technologies as also working with time, as a kind of 'time-tricking'. I interpret technologies for recombining DNA and editing genomes as existing in a specific biopolitical space-time continuum between evolution and revolution, immortality and ageing, or as Paul Martin and others have delineated: between continuity and discontinuity (Martin et al., 2020). For already developed diseases, bodily deterioration, and the search for new drugs, I present the DNA recombination technologies as an array of specific races against time, or in more structural time matters within the contest among global biotech laboratories for patenting and being the first and foremost (Kirksey, 2020).

The book examines the technology that imitates natural immune mechanisms to speed up and control human evolution or to enhance genome repair ability in the future. In the perspective of accelerated evolution, its future orientation creates and is created by the situation of social drama – a transgression to the next stage of evolution (Turner, 1980). Currently, the most popularised social drama within genome editing is the case of biophysicist He Jiankui and his experiments with editing germlines, raising issues of trespassing across borderlines. In November 2018, the CRISPR-Cas genome editing technology was used by the Chinese biophysicist to alter the DNA of twin children in China. 'It marked the first time in history that humans edited the genetic code of a future generation.'[i]

During one lecture about CRISPR-Cas9 technology, a genomic plant engineer named Jakub[ii] introduced himself as a dreamer and visionary:

> People have always wanted to modify genomes. CRISPR-Cas9 is one of the most revolutionary or rather the most groundbreaking discoveries ever made in genetics. Is it evolution or revolution? It is accelerated evolution, I guess. Natural evolution occurring via mutations in DNA is too slow. In biotechnology, everything is about money; the more money, the faster it will be developed. Sorry, but social science and bioethicists could not keep up; they are too slow to appraise what life sciences really do. We are already getting away from them. They have just started to consider it, and we are in fact doing it. We do not ask if it will happen; we ask how.

Although Jakub, other scientists and journalists consider the scientific and technological breakthroughs as something that tremendously influences society, the speed, intensity, and real impact are much more complicated. Hub Zwart showed the complexity of the process when analysing the memories of Jennifer Doudna, one of the leading and most visible scientists in the contemporary field of genome editing. She and Emmanuelle Charpentier were awarded the Nobel Prize in chemistry for CRISPR-Cas technology in 2020, also referred to as 'genetic scissors'. In investigating Doudna's autobiography (Doudna, 2017), Zwart voiced the problem of translation from the lab to the society. He explained the process by which the technological breakthroughs travel a complicated path from the laboratory to application in the real world, an environment that is not as controlled. 'Techniques and insights produced in the drastically simplified environments known as laboratories are not that easily transferrable into messy reality, where countless intruding factors come into play. In short, the gap between the lab and the real world seems obfuscated in Doudna's announcement of the technological reproducibility of life' (Zwart, 2018:73).

Repair, edit, enhance

This book delves into the technologies of recombining DNA and editing genomes, their social and cultural background and impact, the questions they provoke, their temporalities, spaces, and non-sites, the desires and dreams surrounding them. The text is primarily about the scientists who use these technologies, presenting their motivations, visions, hopes, and concerns. The analysis is based on my research in the biochemical lab of a university research centre in Czech Republic, from 2017 to 2019. The lab specialises in recombining DNA, experimenting with mutations, and with possibly healing future bodies and diseases. While establishing and entering the field, my research interest was caught by the issues around DNA recombining and genome editing, particularly its 'hope and hype' atmosphere and the revolutionary proclamations and claims regarding radically fixed and controlled human bodies.

DNA recombination technologies have developed since the 1960s with an enormous impact on society and on contemporary forms of biopolitics. In laboratory settings, recombination means producing reconfigured DNA using mechanisms of the cell's or organism's immune or repair system. It is a site-specific genetic recombination that helps to adapt and recognise new pathogens. The artificial recombination process in genetic engineering refers to the deliberate recombination of varied pieces of DNA from heterogenous organisms. It is a process of proteins interacting with DNA to trigger and target desired mutations, making molecules with altered base sequences. An essential example of recombinant DNA is gene targeting, which is used to add, delete, duplicate, or otherwise change a new allelic variation in an organism's genes (Sharan et al., 2009; Buerstedde, 2005). In general, DNA recombination is 'the exchange of DNA strands to produce new nucleotide sequence arrangements'[iii] and it is based on 'breaking and rejoining DNA segments'. It is essential for genetic evolution. DNA mutations, breaks, and repairs are the basis of natural evolution, genetic diversity, and maintaining genome integrity. In recent years, new genome editing technologies have emerged that enable effective and

economically efficient work with sequence-specific modifications in the genomes of a broad variety of cells and organisms. The core technologies that are now most commonly used to facilitate genome editing are: clustered regularly interspaced short palindromic repeats (CRISPR-Cas9), transcription activator-like effector nucleases (TALENS), zinc-finger nucleases (ZFNs), and homing endonucleases or meganucleases (Gaj et al., 2016).

> The ease with which CRISPR-Cas9 and TALENs can be configured to recognize new genomic sequences has driven a revolution in genome editing that has accelerated scientific breakthroughs and discoveries in disciplines as diverse as synthetic biology, human gene therapy, disease modeling, drug discovery, neuroscience, and the agricultural sciences (Gaj et al., 2016).

The view of DNA and genomes as fixed and static entities of heritage is a myth. They ceaselessly undergo continual mutations and alterations as a consequence of natural evolution and reaction to outer stimuli. In light of this, to what extent are human-made genome alterations legitimate and desirable (Botbol-Baum, 2018)? Where is the border for experimental praxis within human germline research (Baltimore et al., 2015; Lanphier et al., 2015)? These questions are embodied in the example of He Jiankui, who used genome editing technology (CRISPR-Cas9) to modify the CCR5 gene of viable human embryos. This experiment was criticised around the world (Scott & Selin, 2019).[iv] This case was not unique and isolated – on the contrary, it was a step in the broader advancements in the technology. As Christopher Thomas Scott and Cynthia Selin wrote: 'He's CRISPR babies hardly came as a surprise. Tell tales were apparent as early as 2013 when a Chinese team reported generating rats using the technology (Li et al., 2013). In January 2014, a different group in China reported twin cynomolgus monkeys born with mutations made with CRISPR-Cas9 (Niu et al., 2014). These experiments

foreordained the eventual application of the technology in human embryos … and the future had rushed ever closer'(Scott & Selin, 2019).[v]

The cases and experiments echo developments in recombinant DNA technology. Chiefly, the experimental designs were based on fragmentation, mutation, and replacement of hybrid genetic material among various species, viruses, or bacteria. In February 1975, the conference in Asilomar organised by Peter Berg aimed to discuss and reflect the main potential risks when calling for regulations in recombinant DNA technology. The conference was a reaction to the advancements in biology, biochemistry, genetics, and information science during the 1950s and 1960s after the discovery of DNA structure and the progress in technologies of genome manipulation. The biosafety consequences of the technologies and new biotypes were discussed. Asilomar and the visions of scientists presented new breakthroughs in life engineering and DNA recombination as a kind of rite of passage (Turner, 1980). The genealogy of the recombinant DNA field shows how the problematisation of the technology used on human cells and germlines is continually accompanied by rhetoric on the essence of genomes, humanness, and eugenics. The continual process of problematising biosafety, including considering threats to the authentic human genomic pool, the natural character of life, and the prospective new inequalities and social injustices, raises the question of 'how and why certain things became a *problem*' (Foucault, 2001:171). To what extent is the problem the altered 'essence' of a genome that is constantly mutating and hybridising itself? And who defines which mutations are wanted, normal, or problematic, and which ones are not?

The problematisation of today's genome editing technologies is also interpreted as cultural work with anomalies or transgressive practices. The networks of genetics and genomics, culture and techno-nature are analysed extensively as crossing the borderlines between society and

technology (Latour, 1990; Law, 2004). Nature-cultures and biosocialities have been studied by many authors (Rabinow, 1992, 2005; Haraway, 1997; Latimer & Miele, 2013; Ingold & Pálsson, 2013; Callon, 1995). The character of edited and recombined mutations transgressing the established categories of nature and society, with technology as a kind of work with temporal anomalies threatening the social symbolic order, as presented by Mary Douglas, was analysed by Michael Morrison and Stevienna de Saille:

> Hybrid biotechnologies appear to pose a threat to the shared meanings, values and rules of conduct that make communal social living and organisation possible. Part of what constitutes the yuck or fear response to these technologies, we argue, is a shared (though often tacit) sense that matter has somehow been shifted out of its 'correct' or natural place (Morrison & de Saille, 2019).

The mechanisms and networks of the technologies of genome editing of human DNA, the visions of healthy bodies, the interventions into human genetic design, and their problematisation are also based on post-Darwinian interpretations of the theory of evolution as an unending linear progression, a fight for survival, and competitive sociality. However, the legitimacy or credibility of this big narrative have been, during its existence, accompanied or confronted by alternative stories. The alternative or 'utopian' non-conventional narratives portray evolution as a co-evolution of organisms, as 'mutual aid' or symbiogenesis, or as possible techno post-evolution. Examples of this include inspirations from anarchism and post-anarchism, such as from anarchist and biologist Peter Kropotkin (1882), Hannah Arendt's critique of social Darwinism (Arendt, 1951), Henri Bergson's theory of creative evolution and the role of time (Bergson, 1911), and the theories of symbiogenesis, sympoiesis, making-with, relationality, and networks of life (Kozo-Polyansky, 1924; Margulis, 1993; Haraway, 2016;

Strathern, 2020, 1991; Fet, 2021). Among many others in their text *Dreamers, Visionaries, and Revolutionaries in the Life Sciences* (2018), Oren Harman and Michael R. Dietrich describe the work of Peter Kropotkin and his conception of mutual aid and Lynn Margulis's theory of evolution, both of which influenced contemporary visions of biology and life.

When speaking about Margulis, her crucial influence in current ideas about evolution, and the theory of Gaia,[vi] Victor Fet wrote: 'she went further to claim that the main mechanism of evolution and speciation is not a slow accumulation of small mutations but genome exchange, *horizontal transfer*'; according to Fet, Margulis did not support 'evolutionary biology' since she believed that the theory of evolution was a far broader science (Fet, 2021). Donna Haraway, in her contemplations of biotechnologised living networks, was fundamentally inspired by Margulis's research. She describes kin, having pointed out the role of symbiogenesis and the importance of studying the 'webbed inter- and intra-actions of symbiosis and sympoiesis, in heterogeneous temporalities and spatialities' (Haraway, 2016:64). Haraway characterised Margulis as 'a radical evolutionary theorist' adding:

> The core of Margulis's view of life was that new kinds of cells, tissues, organs, and species evolve primarily through the long-lasting intimacy of strangers. The fusion of genomes in symbioses, followed by natural selection—with a very modest role for mutation as a motor of system level change—leads to increasingly complex levels of good enough quasi-individuality to get through the day, or the aeon. Margulis called this basic and mortal life-making process symbiogenesis. (Haraway, 2016:60).

Biotechnological embodiments: imagination of utopian bodies

‘Welcome to the world of your programmable body’ – the documentary *Hack Your DNA with CRISPR* (2018) introduces the field of genome editing with the concept of the body as a kind of sophisticated machine. The documentary and many other films, talks, and texts commenting on genomics and genome editing still picture the body as a programmable, repairable, and controllable entity or object, a network of do-it-better strategies. ‘Scientists tend to think of men as machines, genes as their broken parts and variations in life as problems to be solved—aberrations outside the normal curve’ (Kozubek, 2017). In writing about the plasticity of living tissues and biological time, Rosine Kelz mentioned Philip Pauly’s text on developmental biology in which he described the ‘engineering ethos’ of modern biology. ‘In the late 19th century, he argues, the development of experimental, laboratory-based biology started to re-define the fundamental purpose of this science as the control of organisms. In this narrative, biologists moved away from ontological and epistemological concerns in favor of an emphasis on technique,’ in which, according to Pauly, nature became the ‘raw material’ that is ‘transformed by the power of the biologist’ (Pauly 1987:4 in Kelz, 2021).[vii]

Beyond this engineering perspective, the social life of the body and the networks of miscellaneous biotechnological embodiments in the lab are far from being such machines or computers. Between fractality and fragmentation, simulation and embodied emotions, the mortal and worn bodies of scientists and immortalised cell lines, and simulated future DNA mutations – the body and biotechnological embodiments become essential issues in the lab. They are living things, bodies as technology, organisms understood as machines or computers, and machines considered as organisms or part of embodied networks. In the context of DNA recombination, Eugene Thacker wrote about bio-media, where the biological incorporates the digital and the digital is living within the biological (Thacker, 2003). Considering the body as an interface between the biological, material, and immaterial, as a material-semiotic knot, Brian

Massumi builds on a term briefly employed by Michel Foucault – *incorporeal materialism*, where 'the body', he remarks, 'is as immediately abstract as it is concrete; its activity and expressivity extend, as on their underside, into an incorporeal, yet perfectly real, dimension of pressing potential' (2002:31), or 'real incorporeality of the concrete' (Massumi, 2002:5).[viii]

The specific continuum or assemblage of immaterial and materialised bodies, embodiments, and bio-objects have been embodied by editing genome technologies in the lab. This refers to forms of life within *bio-tekhné,* alive through technology, where clear lines between materiality, immateriality, and things and persons are blurred (Pottage, 2004). The dream about living matter and technologised embodiment has a long and intriguing history. The modern unity of technology, embodiment, and 'building of the future' has emerged as not only a physical site but with a claim for the radical reconceptualisation of the individual body, inner life, and society. The human body has become an essential element in networks or processes in which technology become biology and biology becomes technology (Landecker, 2007).

In this framework, the body is also a specific non-site or a heterotopic mirroring of utopian projects, a future object anticipating socio-material networks (Foucault, 2006; Jameson, 2005; Esguerra, 2019). In his text *Utopian Bodies*, Michel Foucault noted that:

> Utopia is a place outside all places, but it is a place where I will have a body without body, a body that will be beautiful, limpid, transparent, luminous, speedy, colossal in its power, infinite in its duration. Untethered, invisible, protected – always transfigured. It may very well be that the first utopia, the one most deeply rooted in the hearts of men, is precisely the utopia of an incorporeal body (Foucault, 2006:229).

In this text, Foucault also expressed the essential paradoxical and complementary character of embodied utopias: ‘my body, it’s the opposite of a utopia: that which is never under different skies. It is the absolute place, the little fragment of space where I am, literally, embodied’ and simultaneously ‘in any case, one thing is certain: that the human body is the principal actor in all utopias. After all, isn’t it one of the oldest utopias’ (Foucault, 2006:229, 231).

The book *We, other utopians* explores embodied utopias, heterotopias, and biotechnological embodiments as well as bodies as non-sites of experiments and experimentations (Foucault, 2006; Thacker, 2004; Rheinberger, 1997; Marcus, 2010, 2014). Experimentations (Lüthy, 2017) eventually stabilise the new realities that articulate themselves. Experimentation is essential in the context of the laboratory corporeality of genome editing and DNA recombination technologies as well as prevailing perspective for reconfiguring bodies. The experimental system always involves the potential for surprise, unexpected objects or ideas, and delving into unknown areas. It contains two components: epistemic things and technical objects. Epistemic things ‘are material entities or processes … that constitute the objects of inquiry’. They ‘represent themselves in a characteristic, irreducible vagueness. This vagueness is inevitable because, paradoxically, epistemic things embody what one does not yet know,’ they have ‘the precarious status of being absent in their experimental presence’ (Rheinberger, 1997:28).

> Experimentation is a risky enterprise: experiments do not promise ease and assurance; they are unpredictable, uncharted ‘labyrinths’ (Rheinberger 1997:74). For Hans Jörg Rheinberger, experimentation is a tacit, embodied practice of ‘groping’ through dark spaces of not knowing. Experimenters must be agile as they

> navigate between extended periods of disorientation and moments of insight. In this process, new objects, new questions, and new modes of experimentation come into view. Nothing is stable, including the end products of experiments: scientific images, models, and animations are themselves open reading frames … (Lynch and Woolgar, 1990 in Myers & Dumit, 2011:244).

Genome editing and utopias

In her text *Taking social and anthropological consequences of genome editing seriously*, Mylène Botbol-Baum (2018) claimed that 'it compels us to readdress the metaphor of "genome editing" and its utopian, thus often deceiving, power.' Many texts discuss this aspect of the newest genome editing technology. When speaking about the CRISPR 'cowboy' efforts of genetic self-experimentation to try to cure diseases or to overcome ageing, Courtney Addison announced 'a bold future, a new species, our concept of health reinvented. This rhetoric is familiar in the context of the life sciences, of what we used to call the new genetics, and certainly, still, of the genomic era. It is genre of hype that we are accustomed to hearing from biotech executives, market analysts, and science journalists' (Addison, 2020:150). In the context of DNA recombining since the 1970s, the cultures of science, technologies, and political order have co-produced possible new social realities and techno-imaginaries creating the future (Jasanoff, 2005). Sheila Jasanoff portrays the techno-phantasies as crucial for the modern world, including visions about how it should look. According to Stephen Tutton, with the normative in relation to visions of desirable futures, Jasanoff's techno-imaginaries take a utopian turn (Tutton, 2018:521-522). But how are the utopian traits of such technologies to be imagined and analysed between hype, hope, utopias, and dystopias?

According to Fredric Jameson (2005), utopias have an ambiguous reputation after affairs with the authoritarian version of state socialism under Stalinism and others. In his *Archaeologies of the Future*, Jameson argued that utopias do more than envision alternate systems; the utopian form is itself a representational meditation on radical otherness (Jameson, 2005). Blanes et al. (2016) even stated that utopia moved beyond the realm of political philosophy to inform practices of artistic creation, creative imagination, and epistemologies. And Franco Berardi argued that the 'future'—as it was understood in the 20th century, based on the notion of progress toward improvement, enrichment, even perfection—was over. According to Berardi, in the Western cultural imagination, dystopia replaced utopia in envisioning possible futures (Berardi, 2011). Jameson also mentioned the dystopic side of the techno-imaginaries:

> Meanwhile, liberal politics incorporates portions of this particular impulse in political platforms offering enhanced medical research and universal health coverage, although the appeal to eternal youth for a more appropriate place on the secret agenda of the Right and the wealthy and privileged, in fantasies about the traffic in organs and the technological possibilities of rejuvenation therapy (Jameson, 2005:9).

This declination of the utopian cultural imagination as better worlds 'is also evident in the writings of many social thinkers, scientists, and engineers as well, who imagine and anticipate imminent futures of disaster, collapse, and decline' (Urry in Tutton, 2018).

Despite this, Jasanoff and others have suggested thinking differently and turned their attention to the sociology of expectations. 'Although images of decline and collapse are indeed prevalent, they propose that for many actors, technoscience is the means to work toward and achieve

desirable futures' – echoing the older theories of Robert Merton's self-fulfilling prophecies (Tutton 2018:522). As Ruth Levitas argued, the popular understanding of utopia is often as an impracticable fantasy or 'idle dream' or worse, the road to totalitarianism. However, this is not what Levitas had in mind when she was discussing utopia: at its most simple, she defined utopia as the 'expression of a desire for a better way of living and being' (Levitas in Tutton, 2018:521). Some authors have concentrated on social and cultural expectations, where 'expectations can therefore be understood as "wishful enactments" of, rather than "wishful thinking" about, desired futures, which have a vital relational quality, brokering relationships between actors so that expectations can become mutually shared guides for action' (Tutton, 2011:413). The contemporary biotechnological utopias of genome editing also mirror and create the imagination of power and inequalities topology and simultaneously a map for hope.

In the chapters that follow, I hope to address the issues presented above in different ways.

Chapter 1, *The Lab*, introduces the biochemical lab where I carried out the research. It portrays its inhabitants and my introduction to the field and to the people who became my partners in the laboratory. In Chapter 2, *Genome Editing and Recombinant DNA Today: Cheap Enough, Easy Enough, Accurate Enough*, the text describes the map of DNA recombining and genome editing technologies. I analyse the poetics and politics of genome editing technologies. In Chapter 3, *Biotechnological Corporeality: Heterotopias and Utopias in the Lab*, I connect these two lines with the idea of the futurity of human embodiment as an example of a specific utopian project of the human body. In exploring this and using concepts of utopia and heterotopia, I hope to contribute to the contemporary debate and texts on biotechnological embodiments, utopias, and biopolitics (Siebers, 1994; Stapleton & Beyers, 2015) and on the dynamics of corporeality in the context of recombinant DNA and genome editing technologies (Thacker, 2003, 2004; Haraway, 1997). Chapter 4, *Dreaming about Living Matter: A Matter of Art* is

about the role of imagination, dreams, and visions in the field of genome editing. I focus particularly on the various forms of entanglement among art, imagination, and the technologies editing life. Regarding concrete art works, I analyse potential dreamscapes or spheres of techno-imagination in the context of genome editing technologies. In Chapter 5, *We, Other Utopians: Biopolitics Recombinant …* I explore apolitical biopolitics and the role of technocracy and types of eugenics. I connect genealogy, paths of continuity, and connections to post-socialist memories. The research data analysis shows that genealogy and the specificity of the genome editing *dispositif* in the Czech Republic is, in addition to the international and global character of life science, affected by post-communistic memories and echoes of socialistic ideas related to 'scientific revolution' and 'scientific communism'. This specific rhetoric surrounds genome editing technologies today; therefore, it is also useful to follow some genealogical paths in this specific background, including population enhancement and leftist eugenic echoes. The closing part of the chapter is analytically focused on the idea and practice of experimentation transgressing the technocratic character of science both as research methods and as theoretic-ethical positions and variable strategies.

Some parts of the book are based on the text 'Recombinant DNA and Genome-Editing Technologies: Embodied Utopias and Heterotopias' published in the journal *Body & Society* in 2021.

In Brno, May 2021

Near Mendel Square

References

Addison C (2020) CRISPR Cowboys? Genetic Self-Experimentation and the Limits of the Person. In: de Leeuw M and Van Wichelen S (eds) *Personhood in the Age of Biolegality, Brave New Law Personhood in the Age of Biolegality, Brave New Law*. London: Palgrave McMillan.

Arendt H (1973) [1951] *The Origins of Totalitarianism*. New York: Harcourt Brace Jovanovich.

Baltimore D, Berg P, Botchan M, Carroll D, Charo RA, Church G, Corn JE, Daley GQ, Doudna JA, Fenner M, Greely HT, Jinek M, Martin GS, Penhoet E, Puck J, Sternberg SH, Weissman JS, Yamamoto KR (2015) A prudent forward for genomic engineering and germline gene modification. *Science* 348 (6230): 36–38.

Berardi F (2011) *After the Future.* AK Press.

Bergson H (1911) *Creative Evolution* (translated by Arthur Mitchell). New York: Henry Holt and Company.

Blanes R, Flynn A, Maskens M, and Tinius J (2016) Micro-utopias: anthropological perspectives on art, relationality, and creativity. *Cadernos de arte e antropologia* 5: 5–20.

Botbol-Baum M (2018) *Taking social and anthropological consequences of genome editing seriously.* ARRIGE Kick-off Meeting (Inserm) (Paris, du 22/03/2018 au 23/03/2018). http:// hdl.handle.net/2078.1/230365.

Bryant R and Knight D (2019) *The Anthropology of the Future*. Cambridge: Cambridge University Press.

Buerstedde J (2005) DNA Recombination. In: Ganten D and Ruckpaul K (eds) *Encyclopedic Reference of Genomics and Proteomics in Molecular Medicine,* Berlin, Heidelberg: Springer.

Callon M (1995) Four models for the dynamics of science. In S. Jasanoff, GE, Markle JC Petersen and Pinch T (eds) *Handbook of science and technology studies* (pp. 29–63). Thousand Oaks, CA: SAGE.

Comfort N (2018) Sociogenomics is opening a new door to eugenics. MIT Technology Review, available at https://www.technologyreview.com/2018/10/23/139420/sociogenomics-is-opening-a-new-door-to-eugenics/, (accessed 3 October 2020).

Csete ME and Doyle JC (2002) Reverse engineering of biological complexity. *Science*. 295(5560):1664–9.

Doudna J (2017) *A Crack in creation: Gene editing and the unthinkable power to control evolution*. Boston, New York: Mariner Books.

Esguerra A (2019) Future objects: tracing the socio-material politics or anticipation. *Sustain Sci* 14: 963-971.

Fet V (2021) Lynn Margulis and Boris Kozo-Polyansky: How the Symbiogenesis was translated from Russian. *Biosystems* 199 (2021): 104316.

Foucault M (2001) *Fearless Speech*. Pearson J. (ed) Cambridge: The MIT Press.

Foucault M [1966] (2006) *Le corps Utopique,* radio broadcast, translated and published. In: Jones Caroline (ed) *Sensorium, Embodied Experience, Technology and Contemporary Art*. Cambridge, MA: MIT Press.

Gaj T, Sirk SJ, Shui SI and Liu J (2016) Genome-editing technologies: Principles and Applications. *Cold Spring Harbor Perspectives in Biology* 8 (12): a023754.

Groys B (2002) "Kunst im Zeitalter der Biopolitik. Vom Kunstwerk zur Kunstdokumentation", in *Documenta 11, Platform 5: Ausstelung*, Ostfildern-Ruit: Hatje Cantz, 107–113.

Haraway D (1997) *Modest-Witness@Second-Millenium. Femaleman-Meets-Oncomouse: Feminism and Technoscience.* London: Routledge.

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

Harman O and Dietrich MR (eds) (2018) *Dreamers, Visionaries, and Revolutionaries in the Life Sciences*. Chicago: The University of Chicago Press.

Ingold T and Pálsson G (eds) (2013) *Biosocial Becomings: Integrating biological and social anthropology*. Cambridge: Cambridge University Press.

Jameson F (2005) *Archaeologies of the Future. A Desire Called Utopia and Other Science Fictions.* London: Verso.

Jasanoff S (2005) *Designs on Nature: Science and Democracy in Europe and the United States.* Princeton: Princeton University Press.

Kelz R (2021) Tissue culture and biological time: Alexis Carrel, Henri Bergson and the plasticity of living matter. *BioSocieties*, doi: https://doi.org/10.1057/s41292-020-00224-2.

Kirksey E (2020) *The Mutant Project_ Inside the Global Race to Genetically Modify Humans*. New York: St. Martin´s Press.

Koubová M (2016) *Nové etické problémy lékařského výzkumu: mezidruhové chiméry i editace genomu* [*New ethical problems of medical research: multispecies chimeras and editing genome*]. Zdravotnický deník, 12 July 2016.

Kozo-Polyansky BM [1924] (2010) *Symbiogenesis: A New Principle of Evolution* (ed. By V. Fet and L. Margulis, translated by V.Fet). Cambridge, Mass: Harvard University Press.

Kozubek J (2017) Opinion: How Gene Editing Could Ruin Human Evolution. Available at: https://scipol.duke.edu/news/opinion-how-gene-editing-could-ruin-human-evolution (accessed 16 October 2019).

Kropotkin P (1882) '*Charles Darwin*', Le Revolté, 29 April.

Landecker H (2007) *Culturing Life: How Cells Became Technologies.* Cambridge, MA: Harvard University Press.

Lanphier E, Urnov F, Haecker SE, Werner M and Smolenski J (2015) Don´t edit the human germ line. *Nature* 519:410–411.

Latimer J and Miele M (2013) Naturecultures? Science, Affect and the Non-human. *Theory, Culture & Society* 30 (7-8): 5–31.

Latour B (1990) Technology is Society Made Durable. *The Sociological Review 38*(1_suppl): 103–131.

Law J (2004) *After method: mess in social science research*. London New York: Routledge.

Lemke T (2019) Beyond Life and Death. Investigating Cryopreservation Practices in Contemporary Societies. *Soziologie* 48 (4): 450–466.

Lüthy C (2017) *The triple space of the experimental: A conceptual contribution along and beyond H.-J. Rheinberger*, conference 33rd EGOS Colloquium, Copenhagen, July.

Marcus GE (2014) Prototyping and Contemporary Anthropological Experiments with Ethnographic Method. *Journal of Cultural Economy* 7 (4): 399–410.

Marcus GE (2010) Contemporary Fieldwork Aesthetics in Art and Anthropology: Experiments in Collaboration and Intervention. *Visual Anthropology* 23 (4): 263–277.

Margulis L (1993) Origins of species: acquired genomes and individuality. *Biosystems* 31 (2-3): 121–125.

Martin P, Morrison M, Turkmendag I, Nerlich B, McMahon A, de Saille S, and Bartlett, A (2020) Genome editing: the dynamics of continuity, convergence, and change in the engineering of life. *New Genetics and Society* 39 (2): 219–242.

Massumi B (2002) *Parables for the Virtual. Movement, Affect, Sensation*. Durham, NC: Duke University Press.

Meyer JM (2020) The politics of the "post-political" contesting the diagnosis. *Democratization* 2l,7 (3): 408-425.

Montenegro de Wit M (2020) Democratizing CRISPR? Stories, practices, and politics of science and governance on the agricultural gene editing frontier. *Elementa: Science of the Anthropocene* 8 (9): 1–34.

Morrison M and de Saille S (2019) CRISPR in context: towards a socially responsible debate on embryo editing. *Palgrave Communications* 5, 110.

Mouffe C (2005) *On the Political*. London: Routledge.

Myers N and Dumit J (2011) Haptic Creativity and the Mid-Embodiments of Experimental Life. In: Mascia-Lees, Fran (ed) *Wiley-Blackwell Companion to the Anthropology of the Body and Embodiment*. New Jersey: Wiley-Blackwell, p:239–261.

Pottage A (2004) Introduction: the fabrication of persons and things. In: Pottage, A and Mundy, M. (eds) *Law, Anthropology, and the Constitution of the Social: Making Persons and Things*. Cambridge: Cambridge University Press.

Rabinow P (1992) Studies in the Anthropology of Reason. *Anthropology Today* 8(5): 7–10.

Rabinow P (2005) Emergent Forms of Life and the Anthropological Voice. *American Anthropologist* 107 (1): 148–149.

Rheinberger HJ (1997) *Towards a history of Epistemic Things. Synthetizing Proteins in the Test Tube.* Stanford University Press.

Scott CT and Selin C (2019) What to Expect When Expecting CRISPR Baby Number Four. *The American Journal of Bioethics* 19 (3) :7–9.

Selin C (2008) The Sociology of the Future: Tracing Stories of Technology and Time. *Sociology Compass* 2 (6): 1878–1895.

Selkirk K, Selin C and Felt U (2018) A Festival of Futures: Recognizing and Reckoning Temporal Complexity in Foresight. In: Poli, R (ed) *Handbook of Anticipation/Theoretical and Applied Aspects of the Use of Future in Decision Making*. Cham: Springer.

Serres M (1995) *Angels: A Modern Myth*. Paris: Flammarion.

Sharan S, Thomason L, Kuznetsov S and Court, D (2009) Recombineering a homologous recombination-based method of genetic engineering. *Nature Protocols* 4: 206–223.

Siebers T (1994) *Heterotopia: Postmodern Utopia and the Body Politics*, Ann Arbor: University of Michigan Press.

Šlesingerová E (2021) Recombinant DNA and Genome-editing Technologies: Embodied Utopias and Heterotopias. *Body & Society*, doi: 10.1177/1357034X21998449.

Ssorin-Chaikov N (2006) On heterochrony: birthday gifts to Stalin, 1949. *Journal of the Royal Anthropological Institute* 12 (2): 355–375.

Stapleton P and Beyers A (eds) (2015) *Biopolitics and Utopia: An Interdisciplinary Reader.* London: Palgrave Macmillan.

Strathern M (1991) *Partial Connections*. Savage, MD: Rowman and Littlefield Publishers.

Strathern M (2020) *Relations: An Anthropological Account*. Durham: Duke University Press.

Swyngedouw E (2014) Where is the political? Insurgent mobilisations and the incipient "return of the political". *Space and Polity* 18 (2): 122–136.

Thacker E (2003) What is Biomedia? *Configurations* 11(1): 47–79.

Thacker E (2004) *Biomedia*. Minneapolis, MN: University of Minnesota Press.

the documentary *Hack Your DNA with CRISPR* (2018)

Turner V (1980) Social Dramas and Stories about Them. *Critical Inquiry* 7(1): 141–168.

Tutton R (2011) Promising pessimism: reading the futures to be avoided in biotech. *Social Studies of Science* 41(3): 411–429.

Tutton R (2018) Multiplanetary Imaginaries and Utopia: The Case of Mars One. *Science, Technology & Human Values* 43 (3): 518–539.

Yurchak A (2006) *Everything was forever, until it was no more: The last Soviet Generation.* Princeton: Princeton University Press.