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Beyond Life and Death

Investigating Cryopreservation Practices in Contemporary Societies

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In the past twenty years, science and technology studies (STS), anthropology and sociology have investigated how contemporary biosciences have shaped and transformed human and non-human life. This line of research has produced important insights into the »new biology« and the epistemological and structural reconfigurations it brought about in the study of life in the second half of the 20th century. So far, the work has focused on genetic and reproductive technologies, analyzing how they have enacted what historian of science Lily Kay once called a »molecular vision of life« (Kay 1993; see also de Chadarevian, Kamminga 1998). The study of the impact of molecular biology and biotechnologies such as organ transplantation, cloning, tissue engineering and artificial insemination has attracted substantial interest among scholars (Clarke, Fujimura 1992; Scheper-Hughes 2000; Franklin, Lock 2003; Thompson 2005; Sharp 2006; Waldby, Mitchell 2006; Franklin 2007). However, cryopreservation practices, which constitute the material basis for many of these technologies, have hardly been addressed (for notable exceptions see Parry 2004; Landecker 2007; Radin 2013; Kowal, Radin 2015; Radin 2017). As these practices are fundamental to contemporary life sciences and an essential element and infrastructural condition of processes of molecularization, further research is needed to fully explore their political, social and cultural dimensions.

This article presents some initial ideas and central theses of a research project recently funded by the European Research Council (ERC) within the Advanced Grant scheme.[1] Over the next five years the project »Suspended Life: Exploring Cryopreservation Practices in Contemporary Societies« (CRYOSOCIETIES) will investigate the collection, storage and usage of human and non-human organic material by technologies of cooling and freezing, what are known as cryotechnologies.[2] It is built on the premise that the study of the politics of life in the 21st century must go beyond the focus on molecular biology. While biotechnological interventions continue to target human and non-human life at the molecular level, cryotechnologies not only constitute an essential element of these practices but challenge our very understanding of life by arresting forms of vitality. Given the fundamental significance of cryobiology within the contemporary life sciences, CRYOSOCIETIES aims to empirically enrich and theoretically advance our understanding of cryopractices. It will entail ethnographic explorations of how the collection, storing and usage of human and non-human organic materials by technologies of freezing and thawing is entangled with political, social, cultural and moral issues. While cryotechnologies have so far remained at the margins of scholarly attention in STS, anthropology and sociology, CRYOSOCIETIES will provide important insights into how cryobiology has reconfigured concepts of life and death, health and illness, (in)fertility and biodiversity.

I will start by arguing that in contemporary societies, cryopreservation practices bring into existence a new form of life: »suspended life«. »Suspended life« enables vital processes to be kept in a liminal state in which biological substances are neither fully alive nor dead. The second part relates the analysis of contemporary cryopractices and cryobanks to the concept of biopolitics, while the third part investigates the question of how »suspended life« emerges in contemporary practices of cryopreservation. I will focus on three case studies. The first deals with cord blood banking with the promise to store vitality and ensure health; the second addresses oocyte freezing to extend fertility and rearrange reproductive futures, while in the third example the reproduction of whole species is at stake. Here I engage with the emer-

1 Grant Agreement number: 788196. The project team consists of the PI and three postdocs (Veit Braun, Sara Lafuente, Ruzana Liburkina) who are each responsible for one of the three subprojects described below (for further information see the project site http://cryosocieties.eu).

2 The word »cryos« derives from Ancient Greek (κρύος kríos) and means »ice« or »cold«.

gence of »frozen zoos«, that is to say cryobanks which seek to preserve organic material of endangered or extinct animal species. The conclusion will rehearse the central aspects of the proposed project and point to further directions of research.

1. Suspended Life

Cryopreservation has opened up the perspective of modifying and modulating temporal pathways and developmental cycles (Landecker 2007). The ability to arrest biological processes in order to reanimate them at some point in the future has profoundly transformed the terms of life. Cryobiology establishes a new regime of time that replaces linear by plastic temporalities, altering our understanding and experience of life (and death). Given the technological prospect of stopping and resetting cellular activities, it defines a liminal state in which a biological substance is neither fully alive nor dead (Radin 2013; Hoeyer 2017; on liminality see Squier 2004). Ultimately, cryopreservation practices bring into existence a new »form of life« (Helmreich, Roosth 2010; Helmreich 2011; see also Wittgenstein 1953) that is characterised by a permanent deferral of death: »suspended life« (Le Conte 1901). It enables vital processes to be kept in a state of »latency« for future revival (Radin 2013; Kowal, Radin 2015; Radin 2017), and generates »a sense of moral, social, and political suspense« (Hoeyer 2017: 211) that produces conceptual ambiguity and erodes existing categories of personhood, kinship and property.

»Cryogenic life« (Friedrich 2017) is not only defined by a liminal state between or beyond life and death but is also characterised by a double temporal suspension. Firstly, it refers to the prospect of interrupting and restarting biological processes, bringing the growth and death of cells and tissues to a temporary halt – a »pause« – in order to allow storage for an indefinite period of time (at least in principle). Cryopreservation puts bodies or rather bits of bodies »on hold«. The technological force at work does not operate on the »the plasticity of living matter« (Landecker 2007: 13) by transforming the cells and the body; rather, cryobiological plasticity paradoxically means that temporal change is blocked and put »on ice«, remaining inert and unmoving. Cryopreservation alters the meaning of biology by preventing »na-

tural cycles« from occurring, by interrupting the »normal« course of development and decay. Secondly, »suspended life« is an integral part of a more comprehensive »regime of anticipation« (Adams, Murphy, Clarke 2009: 250) that guides contemporary technoscientific and biomedical practices. This regime involves a temporal orientation that conceives of the future as open and contingent but at the same time as malleable and dependent on actions in the present. These modes of anticipation are informed by rationalities of prevention and preparedness, and are characterised by entanglements of fear and hope linking epistemic orientations to moral imperatives. Within this anticipatory logic the future is shaped and formed in the present by the cryopreservation of organic material credited with a huge potential for knowledge production and hitherto unknown technological applications (and commercial perspectives). Thus, »suspended life« represents a horizon of possibilities and a form of »promissory capital« (Thompson 2005; see also Fortun 2008) that materialises in the present to sustain, improve, foster or control processes of life (Adams, Murphy, Clarke 2009; Taussig, Hoeyer, Helmreich 2013).

As well as moulding temporal pathways and horizons, the emergence of »cryogenic life« engenders new spatial configurations. The technological option of successfully freezing and thawing human and non-human biospecimens has fostered the development of a new archival apparatus, cryobanks, to store vital matter at low temperatures for long or (possibly) indefinite periods of time. By reassembling »natural« specimens that differ in size and provenance, and by suspending vital functions and activities to prevent them from growing or perishing, these banks now resemble »a kind of immortal, artificial body« (Parry 2004: 403). Today, these »frozen archives« (Anderson 2017) occupy a central role within the cryogenic regime. The term »bank« in this context is more than a metaphor (see Swanson 2014); it indicates that historical documentation is not the primary aim. Cryobanks are simultaneously archives of collected and stored biomaterial and sites where it is processed for future use. They are controlled, long-term and secure depositories for vital resources for scientific research, commercial interests and technological practices, and represent an intimate entanglement of past, present and future temporalities. Practices of cryopreservation have become an important component of the transformation of bits of bodies into forms of biological capital that are at the same time epistemic reservoirs and economic resources. Thus, cryobanks embody biological value that may be transformed into an economic commodity (Sunder Rajan 2006; Waldby, Mitchell 2006; Cooper 2008; see also Lemke 2012).

2. Reassessing Biopolitics: Towards a New Regime of Cryopolitics?

The specimens assembled in cryobanks are designed to fulfil different objectives and represent all life cycles from the beginning to the end of life. They are not restricted to human bioprobes but extend to plants and animals to provide material necessary for agricultural production, biological conservation, medical research and pharmaceutical bioprospecting. The various enactments of »suspended life« problematize conventional understandings of life and politics, as they give rise to novel modes of controlling, enhancing and processing biological matter. Contemporary studies in STS, anthropology and sociology on the political and social impact of the life sciences and biomedical practices draw on the concept of biopolitics introduced by Foucault and widely discussed in the contemporary social sciences and humanities (Foucault 1978; 2003; for an overview see Lemke 2011; Campbell, Sitze 2013; Folkers, Lemke 2014). However, the analytic focus has been on what Nikolas Rose once called »molecular biopolitics« (Rose 2007: 11),[3] while cryobiological and cryopreservation practices have only occasionally been taken into account.

To capture the profound socio-material changes introduced by cryotechnological practices, Joanna Radin, Emma Kowal and other scholars have recently proposed the term »cryopolitics« as a way of correcting or complementing the analytic focus on processes of molecularization in contemporary studies in STS, anthropology and sociology. While the notion originates in debates on the geostrategic significance of the Arctic region in the light of global warming and the dwindling of natural resources in other climatic areas (Bravo, Rees 2006; Haverluk 2007; Bravo 2017), its current usage addresses the complex strategies of generating, regulating and processing »suspended life«. Kowal Radin (2015; Radin, Kowal 2017; see also Friedrich, Höhne 2014) have claimed that cryopolitics represents an important extension of the classical concept of biopolitics put forward by Foucault. While »biopower« is characterized by technologies that foster life or let die, and sovereignty by the power to take life or let live (Foucault 2003: 241), cryopolitics operates by the principle to »make live and not let die!« (Friedrich,

3 In his book »The Politics of Life Itself« Nikolas Rose famously argues that biopolitical interventions have shifted from the »molar level« of distinctive and visible bodily entities (organs, tissues, blood etc.) to the molecular level, addressing the functional and structural properties of nucleotide bases (see Rose 2007: 11 f.).

Höhne 2014; Kowal, Radin 2015; Friedrich 2017; Radin, Kowal 2017). Thus, cryopolitics is characterized by arresting processes of decay and dying, enabling the establishment of a form of life beyond life (as we know it) by exposing organisms (or rather bits of their bodies) to a new onto-political regime, being neither fully alive nor dead.

3. Empirical fields and case studies

CRYOSOCIETIES seeks to explore this theoretical proposition further by conceiving of cryopreserved organic material as »suspended life«. It conducts an ethnographic exploration of how technologies of freezing and thawing are entangled with political, social, cultural and moral issues at diverse sites and in different settings and is guided by the overarching question: How is »suspended life« enacted in contemporary practices of cryopreservation? CRYOSOCIETIES draws on and advances recent scholarship in STS and anthropology on »potentiality« and »anticipation«, in order to investigate the material-semiotic effects of future orientations that are operating in contemporary biosciences and biomedicine (Adams, Murphy, Clarke 2009; Svendsen 2011; Taussig, Hoeyer, Helmreich 2013). It also takes up insights developed by the sociology of expectations on how future-oriented imaginings and visions direct and shape scientific and technological activities by mobilising material and immaterial resources, coordinating heterogeneous groups of actors, and defining risks and opportunities (Brown 2003; Brown, Michael 2003; Borup et al. 2006; Tutton 2011; 2017).

The project will generate knowledge about the making of »suspended life« through several ethnographic studies. The ethnographies will examine how »cryogenic life« is assembled, negotiated, mobilized, and practiced by exploring distinctive fields of investigation and sites of cryobanking:

1. cord blood storage to prepare for possible regenerative therapies in the future,
2. oocyte freezing to extend fertility and rearrange reproductive futures,
3. the cryopreservation of endangered or extinct species with the prospect of »bringing them back to life« by employing reproductive and genetic technologies.

Thus, the case studies cover the fields of regenerative medicine, reproductive technologies, and conservation biology. They include human as well as non-human cryobanks and medical as well as non-medical applications, scientifically and medically sound but also speculative or utopian practices of cryopreservation. In the following, I will present the three case studies in more detail.

3.1 Storing Vitality, Ensuring Health: Cord Blood Storage

Umbilical cord blood (UCB) is a rich source of haematopoietic (i.e. blood-forming) stem and progenitor cells used in treating a variety of serious disorders. Collection takes place by immediate clamping of the umbilical cord after birth. The first experimental application was performed in the 1980s, but until the new millennium UCB transplantations were relatively small in number and restricted to a small group of rare disorders. In the early 2000s, regenerative medicine emerged as a promissory biomedical field; speculation about future treatments using stem cells fuelled the rapid rise of commercial cord blood banking. The private cryobanks provide services for autologous applications (i.e. using one's own UCB) for either specific disease indications (cancer or rare genetic diseases) or anticipated regenerative therapies that might be available in the future (to cure conditions ranging from tissue damage to neurodegenerative diseases to blood disorders). However, their clinical use is currently very limited; instead, private UCB banks build upon – and stress in their marketing – the future biomedical potential (Martin, Brown, Turner 2008; Samuel, Kerridge, O'Brien 2008; Ballen, Gluckman, Broxmeyer 2013). Partly due to the low (or even non-existent) clinical utility of private UCB banking, some EU countries have outlawed the practice, considering it an unacceptable commercialisation of body parts (Santoro 2009; Katz, Mills 2010).

As UCB storage is still a recent development, little in-depth research is currently being conducted in STS, anthropology or sociology in this area (Brown, Kraft 2006; Dickenson 2007; Waldby, Mitchell 2006; Martin, Brown, Turner 2008; Appleby-Arnold 2013; Brown 2013; Hauskeller, Beltrame 2016; Sleeboom-Faulkener, Chang 2016). Our ethnographic study will focus on the speculative value of cryopreserved UCB. As UCB banking is often presented as a form of biological insurance within families against fu-

ture diseases, the study seeks to elucidate how appeals to maternal responsibility that require women-as-mothers to do everything they can for their child are entangled with hopes about future medical treatments and progress in regenerative medicine (Haw 2016). By exploring the promissory dimensions of cryopreserved UCB in Germany, this case study will examine the regimes of prevention and preparedness informing UCB banking in a context that differs significantly from studies conducted so far. Interestingly, in Germany UCB is defined formally as a drug, which means it has to be produced and handled under the guidelines of the Medicinal Products Act. Focusing on a country with a long tradition in »social insurance« (while other European countries endorse »social citizenship« in healthcare services, see Appleby-Arnold 2013) and a comparatively conservative regulatory framework in using biological material, this case study is uniquely placed to explore how the »suspended life« of UCB intersects with moral, religious, political and commercial practices.

The fieldwork will be done in facilities of private and public UCB banks in Germany. It will include participant observation of the collection, testing, processing, freezing, storage and use of UCB as well as interviews with women who have banked in the cord blood banks under investigation, staff and lab scientists involved with the processing and cryopreservation of UCB, and healthcare providers who have assisted with UCB collection. Key research questions include: How is knowledge about a cryostored »biological reserve« or a »vital depot« enacted and mobilised? How is the matter and meaning of »health« and »prevention« shaped by the practice of UCB banking? How does the individual decision to cryopreserve UCB relate to more general rationalities of investment and insurance? How do medical prospects and moral imperatives materialise in UCB banking?

3.2 Postponing Pregnancy, Extending Fertility: »Social Freezing«

Cryobiology plays a fundamental role in many forms of assisted fertility treatment, as it allows the use of discretely stored elements (sperm, embryos, eggs) for reproductive purposes. Today, the preservation of individual reproductive capacity through time constitutes an essential segment of cryobanking. While the storage of sperm has been possible for decades (Moore 2007), the secure cryopreservation of human oocytes has only recently become a realistic option (Gook 2011). The freezing of oocytes was initially

offered to women facing cancer treatment or other fertility-impairing conditions. Today, it is increasingly being performed for non-medical reasons. Such »social« egg freezing targets healthy young women planning their reproductive futures (Martin 2010; Shkedi-Rafid, Hashiloni-Dolev 2011; Argyle, Harper, Davies 2016).

As the cryopreservation of oocytes became a technological option only recently, there are no more than a few empirical studies that base their research directly upon women's experiences and their motivation for freezing their eggs for future use. Most of these studies used online surveys or questionnaires (Hodes-Wertz et al. 2013; Lallemant et al. 2016; Pritchard et al. 2017), and there is a lack of qualitative accounts that engage in depth with the temporal dimensions that shape women's decisions to freeze their eggs (for notable exceptions see Martin 2010; Waldby 2015; Balwin 2017). The subproject shifts the analytical focus to the reasoning behind women's decisions to store their eggs, and investigates how the practices of egg freezing intersect with different temporalities and modes of anticipation that seek to govern reproductive processes and bodily futures. Here, the idea of a »biological clock« that needs to be synchronized and aligned with other life cycles (professional life, emotional life etc.) seems to be of central importance (van de Wiel 2015).

This case study seeks to generate insights into the anticipatory terms and narratives through which women's future age-related infertility is socially and morally valued in relation to the technological possibility of cryopreserving eggs. The ethnography will take place in two reproductive clinics in Spain. Spain is not only the most important country for fertility services (The ESHRE Working Group on Oocyte Cryopreservation in Europe 2017), but it seems to represent »a more ethical choice« (Kroløkke 2014: 68) for many international patients compared to service providers in Eastern Europe. Both reproductive clinics offer fertility services for international clients from many European and non-European countries by assisting them through bilingual doctors and tutors. Through participant observations in their facilities as well as interviews with women, gynaecologists and other medical staff members, the project team will examine the ways in which knowledge about the »suspended life« of frozen oocytes materializes in daily practices and reproductive decision-making. Research questions include: How is the practice of cryopreserving oocytes entangled with ontological issues and moral concerns? How is the matter and meaning of »(in-)fertility« and »pregnant bodies-to-be« shaped by the practice of egg freezing?

3.3 Protecting Biodiversity, Resisting Extinction: »Frozen Zoos«

The range of cryobanks is not limited to human material, but also encompasses archives that cryopreserve gametes, tissue or DNA of plants and animals. In recent decades, the accelerating extinction of species has led to an enormous effort to collect and store specimens, relying on cryotechnological procedures. The aim is to preserve biodiversity by deep-freezing organic material of endangered or extinct species. These cryobanks are more than sites of conservation and storage, since they also provide the material resources for the potential resurrection of extinct species. These strategies of reanimation – known as »resurrection biology« (O'Connor 2015) or »de-extinction science« (Shapiro 2015) – are intended to »bring back to life« species that are already extinct by the use of reproductive and genetic technologies[4] (Friese 2009; 2013; Chrulew 2011; Fletcher 2014; Saragusty et al. 2016).

Cryobanks that seek to preserve endangered animal species are commonly called »frozen zoos« (Corley-Smith, Brandhorst 1999; Lanza, Dresser, Damiani 2000). One of the most important initiatives in this field is the Frozen Ark project coordinated at the University of Nottingham in the UK (Clarke 2009). The Ark's consortium is a network of research and conservation bodies, including zoos, aquariums, natural history museums, universities and research laboratories around the world, including institutions in several European countries. The consortium has developed protocols for storing material, implemented a catalogued repository of animal specimens, and carried out scientific research. To date, Frozen Ark is the most important and innovative project in the field in Europe. So far, 48.000 samples of endangered animals have been collected, representing more than 5.000 species (www.frozenark.org; Comizzoli 2017).

The ethnography in this case study will focus on the Frozen Ark facilities in Nottingham, where the administrative, organizational and main research activities take place. It will observe the practices aimed at halting extinction by securing a frozen »backup« of animal specimens within the consortium, and will examine the ambivalent prospects of »conservation« and »resurrection« in the cryoprojects. The subproject will trace the human and non-human actors assembled in endeavours to protect and reanimate threatened species. Through participant observation in the Frozen Ark consortium as well as interviews with zoologists, conservation biologists, environmentalists

4 e.g. embryo transfer, intergenic surrogacy and cloning.

and researchers working in the field of de-extinction science, it will investigate the ways in which knowledge about the »suspended life« of frozen animal specimens shapes conservation concerns and practices.

Research questions include: What are the benefits and risks, the hopes and contestations associated with this form of »conservation as banking«? How do different notions of life, nature, and time – embodied, situated and finite organisms and disembodied, decontextualized and reprogrammable genetic information – materialize in frozen zoos?

4. Conclusion

CRYOSOCIETIES is based on the thesis that cryopreservation inaugurates a particular »form of life« – »suspended life« – that arrests vital functions in order to re-activate them in the future. It investigates how cryopractices transform temporal and spatial relations and reconfigure our understandings of life and death, health and illness, and our notions of (in)fertility and sustainability as well as family planning and conservational practices. While there are certainly continuities and resonances with other contemporary biomedical and biotechnological practices of »suspended animation« (Franklin, Lock 2003; Hayden 2003) and the hybridisation of life and death (Lock 2003; Landecker 2007), cryotechnologies have articulated them in novel ways that open up hitherto unidentified temporal and spatial constellations – not least by mobilising and exploring the »as yet unknown« (Radin 2017: 55).

As »suspended life« is fundamental to contemporary life sciences and an essential element and infrastructural condition of processes of molecularisation, further research is needed to fully explore the intersections and complementarities between »molecular biopolitics« and »cryogenic life«. By combining three case studies, CRYOSOCIETIES seeks to investigate empirically the dynamics and complexities of cryopreservation practices, the profound implications of which for the government of life in contemporary societies have hardly been recognised up to now.

In pursuing this project, it is important to address two central issues. First, we need to investigate the intersections of informational and biological knowledge in order to analyse how the idea of a »back up« guides and shapes cryobanking practices. Also, we will need to investigate how contemporary data infrastructures and archiving technologies support the cryobanks under

investigation. Cryobanks are not just neutral systems for storing, naming, and classifying data or a collection of things; they also allow for what Geoffrey Bowker once called »memory practices« (Bowker 2005) that constitute a force field in which some ways of knowing materialize while others are excluded (Stoler 2009).

Second, it is important to reassess and extend the concept of biopolitics in the wake of Foucault's work, which was exclusively focused on »phenomena peculiar to the life of the human species« (Foucault 1978: 141), in order to address »more-than-human« practices (Braun, Whatmore 2010: 20). This conceptual move will make it possible to investigate how the government of non-humans is articulated with the government of humans. We also need to shift the focus of analysis beyond the two biopolitical poles of the individual and the population that Foucault identified (Foucault 1978; 2003). While this interpretative frame has guided the debate on the politics of life up to the 21st century, we have to address the life of »body parts« (see Hacking 2002) and the trajectories of embodiment they follow, resulting in the reanimation, reproduction or regeneration of singular individuals and whole species.

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