Collections, Knowledge, and Time

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\textbf{\textsection SPECIAL ISSUE ARTICLE} in \textit{Collections, Knowledge, and Time}, ed. by Karin Tybjerg & Martin Grünfeld

\textbf{\textsection ABSTRACT} In recent decades, an increasing interest in the dynamics of collections has brought to view how objects circulate as parts of networks of knowledge and how collections can acquire new meanings. Introducing this special issue on \textit{Collections, Knowledge, and Time}, we want to shift focus from geographical circulation towards the temporal dynamics of collections: the layering and interweaving of asynchronous temporalities as collections are preserved, frozen, reinterpreted, sampled, and destroyed over time, and how these temporalities constitute knowledge potentials. We treat collections broadly across museums of history of medicine, history of science, and ethnography, and scientific institutions including biobanks, seed banks, and fly centres, to investigate the considerable overlap in collection practices, as well as how objects can move between cultural historical and scientific uses. We limit ourselves, however, to epistemic collections, mainly scientific ones, assembled with research as a main purpose. This introduction first explores apparently mundane collection practices such as preservation and care, as well as technologies such as freezers and boxes, to unravel them as temporal practices that make stored items transcend time. We then discuss historical practices across cultural and scientific collections to show how historical thinking plays a central part in scientific collection work and how new scientific methods shape investigations of the past. Finally, we outline the potentialities for future knowledge in collections. In conclusion, we sketch out a
pluralist epistemology of collections focusing specifically on how the dynamics of time create multiple epistemic potentials for historical scholarship and scientific research in the present and future.

**Keywords** Collections, Epistemology, History and Philosophy of Science, Knowledge, Museum Collections, Biomedical Collections, Endings, Historiography, Preservation, Time

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1. Introduction

The Medical Museon in Copenhagen keeps in their collections a sealed glass bottle with a whitish liquid. At first glance, it appears rather insignificant—slight and unassuming in its exterior—but in recent years it has attracted much attention because of its contents. It contains, as its label tersely notes, intestinal excretion from a patient with advanced cholera from October 1853. This bottle thus constitutes a historical object viscerally close to patient experiences and the medical handling of 19th-century cholera epidemics, as well as a possibly unique sample of an extinct strain of the cholera bacteria. When first collected, presumably during the cholera outbreaks in Copenhagen or Stockholm, the bottle was a medical sample. It is unclear how exactly it was intended to be used—to demonstrate the diagnostic signs of cholera, as a specimen for a pathological collection, or as a sample for the microscope—but it was collected to understand infectious disease. However, as time passed, the bottle fell out of medical use. When it reached the collections of the museum, it had become a historical object, materializing the attempts of the 19th-century medical profession to encapsulate epidemic disease. Most recently, the bottle has received renewed scientific attention as a group of researchers have inquired about the possibility of drilling into the bottle to obtain a sample for analysis with new technologies. Their hope is that the bottle contains DNA of the *Vibrio cholerae* and remnants of proteins that might fill out an empty space in the phylogenetic tree tracking the genetic development of the cholera bacterium, which might provide clues to its virulence and the puzzle of how cholera was transmitted.¹

This brief history of the cholera bottle unpacks the nexus between collections, knowledge, and time that we thematize on a larger scale in this special issue. The bottle with its dusty white liquid may be seen as a microcosm—like the small snow-globes containing tiny white worlds surrounded by swirling flecks—that consists not just of microbes and human matter, but also of complicated relations between collections, histories, and science. Transgressing temporal spans between past, present, and future and crossing the disciplinary boundaries of medicine, history, and biology, Matthew Phelps et al. (2018) combine historical studies of the epidemic in Copenhagen with hypotheses about fighting cholera in Bangladesh. In the view of one of the researchers, analysis of the contents of the bottle may—together with careful historical analysis of the water supply and hygiene practices of 19th-century citizens—lead to insights useful for curbing future outbreaks of cholera. See also Brichet (2022).

¹ Matthew Phelps et al. (2018) combine historical studies of the epidemic in Copenhagen with hypotheses about fighting cholera in Bangladesh. In the view of one of the researchers, analysis of the contents of the bottle may—together with careful historical analysis of the water supply and hygiene practices of 19th-century citizens—lead to insights useful for curbing future outbreaks of cholera. See also Brichet (2022).
it offers cultural, scientific, and evolutionary knowledge as well as hopes for future knowledge and epidemic control. It thus provides a starting point for unfolding the central themes and background of the issue Collections, Knowledge, and Time.

When we focus on collections in this issue, we offer comparisons across dissimilar types of collections: we investigate collections held in museums of history of medicine, science and ethnography, but include also collections kept by scientific institutions, such as biobanks, seedbanks, and even fly stock centres. We thus stretch the definition of collections, as “collection” is not always an actor’s term in the case of modern collections of biomedicine and bioscience. Attention has, however, been drawn to the continued roles of collections in these fields. Moreover, commonalities between biomedical and museum collections are never far away, as the director of the Danish National Biobank expressed after a conversation about biobank and museum practices: “I normally describe myself as a technician,” he stated, acutely aware of the work in preservation, registration, and infrastructure involved, “but now I realize that I am a curator.” As we see it, collections across natural science and museums share a set of collection practices: registration, preservation, maintenance, mapping of particular fields of objects, and categorizing. Practices of collection care and knowledge production that we find important to study in our comparisons across disciplinary boundaries. Thus, this issue will show how thinking across the categories of cultural and scientific collections can bring further insights. In particular, it allows the historical practices of scientific collections to stand out clearly, and it draws lines between parallel developments in scientific and cultural historical collections.

Our take on collections specifically thematizes how we gain knowledge from collections. While we might be stretching the notion of collections by including cultural, scientific, and medical collections, we also narrow it by limiting ourselves to collections that are gathered with the aim of knowledge production—what we might call epistemic collections. Collections may be created and maintained for multiple purposes—such as status, pleasure, identity, nation building, cultural capital, or knowledge—but in this special issue we focus on the epistemic potentialities. We deal in particular with collections whose explicit purpose is generating knowledge, whether for teaching or research. We span scientific and cultural historical collections, but pragmatically limit ourselves to those related to science, medicine, natural history, and ethnography. Such collections, when considered as dynamic over time, may be viewed as epistemic things in Hans-Jörg Rheinberger’s sense of entities that are not known in their totality, but about which new aspects may be discovered when

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2 On the importance of collection practices in modern biology and in medicine, see, respectively, Strasser (2012; 2019); Tybjerg (2015; 2022).
3 Kristian Hvem (2013), personal communication to the authors.
4 Knowledge and collecting might even be seen as being intrinsically connected, especially if we also consider collection of data, but the connection is neither one-way nor simple. See, for instance, te Heesen & Spary (2001); te Heesen (2015).
5 Other accounts that go across cultural history and science are Jardine, Kowal, & Bangham (2019); Pearce (1992).
they are manipulated in different technological and conceptual contexts. Historically, our focus on epistemic collections follows in the steps of studies identifying museums as central “sites of knowledge” and places “shaping knowledge,” both at their inception with cabinets of wonder in the Renaissance and in large national museums from the 16th to 19th century. It also resonates with a renewed emphasis on the ongoing importance of collecting as an epistemic activity in medicine and science. We thus extend beyond the traditional period of the early museum and natural history, where, for example, John Pickstone identified collecting as an important “way of knowing,” and we extend the range of collection disciplines listed by Robert E. Kohler by adding medicine to natural history, anthropology, and archaeology. In recent years, collections and collection practices have been shown to be central to modern biosciences and biomedicine, and, in these fields, collections—plant seeds and human and animal specimens—have gained new roles in tracking genetic or disease developments or saving endangered material. Today, natural historical specimens have also gained importance in contemporary science for studies of ecological and biological changes over long timespans. Such interests, paired with improved techniques for analysing genomes and proteonomes from historic samples, have led to a veritable scrum for material in a race to analyse (and consequently often destroy) the most exciting specimens.

We focus in this special issue particularly on how time and temporal dynamics generate knowledge in collections and, in doing so, we shift attention from geographical circulation towards the layering and interweaving of asynchronous temporalities in collections. In recent studies in history of science, anthropology, and museology, the lives of collections have been restyled as dynamic and changeable in an attempt to challenge the image of stale and passive institutions. Objects are gathered from afar and circulate as parts of networks of trade, knowledge, or colonialism, and collections and objects acquire new meanings through history and through tracing the relations among people surrounding them. At the same time, the attention to dynamism in collections has also led to studying processes of forgetting, dispersal, or decaying of collections, as well as the ongoing care and quotidian practices undertaken to keep collections—feeding, maintenance, taxidermy, re-registering. And modern re-examinations of historical objects have led to tensions between scientific and...

6 Rheinberger (2010).
8 Pickstone (1994; 2010); Kohler (2007).
9 Strasser (2012; 2019); Tybjerg (2015; 2022); Radin (2017); Radin & Kowal (2017); Curry (2019).
10 Meineke, Barnabas, Daru, Davies, & Davis (2019).
12 Early classical texts on the circulation of knowledge are Latour (1988); Secord (2007); more recent anthologies treating collections on the move are Driver, Nesbitt, & Cornish (2021); Wils, de Bont, & Au (2017). As for relations of people understood through collections, Gosden & Larson (2007) explicitly write of the Ashmolean as a collection of people; and Hallam (2016) emphasizes the relations between the dead patients whose body parts are in the anatomical collections and the living students and teachers using the collections.
13 On collections ending, see Jardine, Kowal, & Bangham (2019); on being forgotten, see Lubar (2017); on decaying, see DeSilvey (2006; 2017); Grünfeld (2022); and on being cared for, see Bangham (2019); Van Allen (2020).
historical studies when the same object—such as the cholera bottle—is both a source and a sample.\(^{14}\) It is such shifts and connections over time—past, present, and future—that we investigate further, as well as drawing together notions of ordering, caring, freezing, and rediscovering of collections to understand, theoretically and practically, different ways that stabilized historical material may be used to generate knowledge.\(^{15}\)

In the following, we particularly wish to develop a better understanding of how different temporalities are interwoven in collections and how they constitute potentials and possibilities for knowledge production. In Section 2, we begin by exploring apparently mundane collection practices, such as preservation and care, freezing, and boxing, to unravel them as temporal practices allowing stored items to transcend time. In Section 3, we discuss historical practices across cultural and scientific collections, and how new scientific methods shape investigations of the past. And finally, in Section 4, we outline the potentiality for future knowledge in collections. In other words, what interests us here is to sketch out an epistemology of collections focusing specifically on how the dynamics of time create multiple epistemic potentialities.

This special issue is itself a collection—a collection of articles crossing disciplines and connecting to a past and future. They were first put forward at an international workshop held at the Medical Museion, University of Copenhagen, in 2019, spanning the disciplines of medicine, natural history, biomedicine, cultural history, anthropology, and history of science. We send it into the world with thanks to all the authors and participants and look forward to following unexpected future uses of the issue.

2. Collections Transcending Time: Preservation and Storage Practices Stretching the Lifetimes of Objects

Why begin by focusing on preservation and storage in a paper about time and knowledge in collections? Because the epistemic potentials of collections depend on collection care making reappearances of collected objects possible and transforming the knowledge they generate. In this section, we focus specifically on collection care and technologies that affect the temporalities of collected items. We borrow from Barbara Adam the notion of acts of time transcendence as a “collective means to overcome the threat of non-existence, finitude or transience.”\(^{16}\) Such acts highlight one of the defining features of collections: the ability not only to transcend the lifetimes of their collectors but, potentially, to be transported into a future that cannot be reduced to a future present but remains unknown.\(^{17}\) To characterize the capabilities of collections to transcend time, we highlight two crucial components: practices of maintenance and care, and apparently mundane technologies, such as freezers and boxes. Focusing

14 A locus classicus for the tension between timeless science and history is Latour’s (2000) discussion of whether Ramses II could have died from tuberculosis, when the bacterium was yet to be discovered. See also Keuck (2018); Tybjerg (2023).
15 As done for archives in Daston (2012; 2017).
on mundane practices, such as preservation and storage, provides a practical access point for a reading across natural and cultural collections that allow their similarities and differences to emerge and that show how crucial temporal acts of care and storage are for collection work. It also provides a basis for developing our argument that such acts of time transcendence constitute a dynamic tension between temporal gaps and material continuities, allowing collected items to travel simultaneously in and out of time.

Let us begin our cross-reading of science and culture to explore the acts of time transcendence by posing the seductively simple question: What do museum preservation practices have in common with the maintenance of scientific collections? An immediate answer to this question would be that museum and scientific collections are marked by a striving for stability across temporal spans that often exceeds the natural rate of decay of the collected objects and the lifetimes of the collectors. This simple answer, however, also finds grounding in the shared use of the term “immortality” in descriptions of how collections in general decontextualize their materials from the original context of circulation to become parts of a collection. For example, as Susan Pearce describes, museum objects are “wrenched out of their own true contexts and become dead to their living time and space in order that they may be given an immortality within the collection,” further stating that collectors seek immortality through their collections as a form of “extended self.”\textsuperscript{18} Such descriptions resonate with the inter-generational obligation of museums as cultural guardians responsible for the long-term preservation and presentation of culture and community.\textsuperscript{19} Similarly, scientific collections also withdraw objects from the cycle of life to become immortal. For example, in the context of tissue culture, Hannah Landecker describes how the term “immortality” entered biological discourse when cells were freed from bodies and thus freed from the limits of the organism’s life span. In tissue culture, the life span of the cell is drastically changed outside the limitations of the body and put under human temporal control and management. Both artefacts and tissue samples are removed from their natural circulation to become parts of a temporal reorganization of objects in collections formed by techniques that make processes happen faster or slower or establish continuity.\textsuperscript{20}

In the quest for “immortality” a simple yet effective technology—the freezer—plays a central role, allowing conservators and researchers to manage and manipulate the temporal life spans of collected samples and specimens.

Cryopreservation entails a temporal reorganization that—for example, in the case of influenza viruses, as described by Frédéric Keck in this issue—allows virologists to study pandemics within an artificial temporality that differs from the naturally occurring cyclical and seasonal appearance of viruses around the globe.\textsuperscript{21} In his study of how viral strains and bird specimens have been used as collections to

\begin{footnotesize}
\begin{enumerate}
\item Knell (1994, p. 2).
\item Landecker (2009, pp. 11–12).
\item See Keck (2023).
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\end{footnotesize}
anticipate influenza pandemics, Keck not only shows how collecting practices and the techniques of hunting viruses changed when Chinese specimens were integrated into collections, but also suggests that such reservoirs or “museums” of samples and specimens transform into signs and images of future catastrophic events such as the COVID-19 pandemic. Interestingly, however, when viruses are removed from their naturally occurring seasonal cycle, they enter an artificial cycle of global research rendered possible by freezing. Likewise, Joana Radin describes how freezing meant that blood no longer circulated only in human bodies but became part of a global infrastructure circulating across temporal scales. These temporal disruptions of continuity across generations, as Landecker remarks in the context of tissue culture, “depend to some degree on the rather banal presence of a working deep freeze.” According to Radin, the freezer was adopted as a time capsule: “a means of making a biological freeze-frame for the future.” In this freeze-frame, blood, tissue, and flesh were turned into future assets for research to realize later.

The freezer is also a central method—in current preservation practices in biological and medical collections. Meanwhile, in cultural collections of, for example, ethnographic and historical artefacts, freezers are not usually used to store materials, but are rather utilized for pest control and disaster management. After the 1997 amendment to the United Nations’ Montreal Protocol, museums turned their attention to thermal methods for pest eradication. As a replacement for the use of toxic treatments, such as methyl bromide, freezing was standardized as the means for eradicating pests. Furthermore, freezing has also been suggested as a way to “buy time” in the case of water damage, where mould can develop in as little as 48–72 hours depending on temperature. Even an ordinary freezer may keep mould and bacteria dormant and decrease the speed of deterioration, enabling conservators to make the right long-term decisions.

While freezing in cultural collections is a means for pest control and disaster management, the imagery of freezing as stopping time plays out on a metaphorical plane that can describe collections care as well. As Susan Crane suggests, “objects are frozen in the moment of their most emblematic value, … and denied their natural, or intended, decadent life span.” To metaphorically “freeze” collections in (almost) permanent states of emblematic value at an ethnographic museum requires the everyday maintenance practices of monitoring and cleaning. For example, as Tiziana Nicoletta Beltrame shows in her contribution to this issue, conservators at the ethnographic museum Musée du quai Branly in Paris meticulously manage the unstable nature of heritage objects by monitoring dust and insects, to get a sense of their temporal impact on collections and to make decisions on how to best preserve

23 Landecker (2010).
24 Radin (2017, p. 3).
26 American Museum of Natural History (n.d.).
collections. As Beltrame argues, the exhibition space can be seen as a place of flows, where multiple entities, such as insects and powdery fragments, circulate and cohabit. At a general level, collections care resembles a definition of care as “everything we do to maintain, continue and repair our world.” However, the current paradigm of preventative conservation, especially in Western culture, emphasizes maintenance and continuity, but not repair, except in extraordinary circumstances. Rather, as Beltrame documents in her fieldwork, the maintenance of anthropological heritage collections depends on mundane, everyday practices of vacuuming, cleaning, and trapping insects to ensure stability across timelines—indeed, constructing temporality in the museum. As Martin Grünfeld, Adam Bencard, and Louise Whiteley also discuss in their contribution to this issue, the museum is constantly manipulating the life course and temporalities of objects through the proliferation of metabolic processes, limits, and potentials. Preventative conservation involves monitoring a collection as a whole, focusing specifically on macro-environmental conditions, such as humidity, light, storage, and pests, to maintain an inhospitable environment. Furthermore, seemingly simple storage solutions such as acid-free cardboard boxes also act as “time capsules”—an image not only used to describe cryopreservation in science but also preservation in museums—that maintain collections in stable states isolated from dust, light, and fiddling fingers. As Susanne Bauer highlights, boxes not only open and close, but also fold and unfold, hold still, and speed up. In other words, boxes and freezers do more than store objects; they perform a temporal function of transporting objects into the future where they may be unfolded.

From the literal freezing of body parts in biobanks to the metaphorical “freezing” of artefacts, collections care across science and culture involves acts of time transcendence. These acts of time transcendence, in instances such as frozen collections in biobanks and natural history museums, most clearly show a dynamic tension between constituting gaps in the timeline and material continuities across the timeline—essentially allowing collected objects to transcend time while hibernating in time. However, not all stabilized collections may fit quite as neatly within the dynamics between material continuity and temporal gaps in the timeline. For example, as Xan Chacko and Jenny Bangham discuss in their contribution to this issue, certain living collections, such as tropical fruit plants and Drosophila fruit flies, cannot be frozen, and in the case of seeds in seed banks, need to be able to germinate after freezing. Chacko and Bangham describe how such living collections have very different needs and life cycles, from the fast life cycles of reproducing fruit flies within controlled stocks to the slow and meticulous maintenance of plant strains’ life cycles of thawing, growing, seeding and freezing (again). Consequently, as Chacko and Bangham also discuss, the continuous material identity of living collections of Drosophila fruit

28 See Beltrame (2023).
29 Puig de la Bellacasa (2017, p. 3).
30 See Grünfeld, Bencard, & Whiteley (2023).
31 For more on this, see, for example, Van Allen (2020); Grünfeld (2022).
32 Bauer (2020).
33 See Chacko & Bangham (2023).
flies and seeds depend on them actually living and reproducing through time to maintain strains, lines, or stocks rather than individual objects or samples. The living collections thus persist as permanent, yet dynamic, entities through time.

In contrast to cryopreservation, which most effectively constitutes temporal gaps—essentially, bringing collections out of time—allowing samples to transcend time, living collections need to live through time and reproduce in controllable settings that allow them to remain stable strains or stocks. This dynamicity yields radically different affordances in contrast to a collection of unique artefacts. As suggested by Boris Jardine, Emma Kowal, and Jenny Bangham, we can distinguish between collections understood as archives, in which objects are valued for their unique historical, geographical, or genetic characteristics, and as libraries with replaceable objects.34 This distinction marks a radical difference between unique frozen samples and replaceable fruit flies. However, while living collections provide an interesting challenge to our description of collections as dynamic entities of material stability and time transcendence, living collections in a sense also transcend time as collection managers maintain permanent stocks or strains with recognizable genetic and phenotypic features. However, this occurs through radically different acts of time transcendence, because freezing is not always an option. Meanwhile, collections of artefacts sit in an odd middle position. Similar to fly stocks, freezing is not a permanent storage solution. Rather, fly stocks and museum artefacts are kept as stable as possible on shelves, in vials and cardboard boxes. Perhaps surprisingly, despite the differences between a dynamic collection of fruit flies, a living but dormant seed bank, and a (somewhat) stable collection of artefacts, these sites share strategies for collections care, such as a focus on macro-environmental factors and a common striving for time transcendence, in order to keep the genetic make-up or material constitution of their collections permanent.

Through temporal control measures (preparation, freezers, boxes, environmental monitoring, and care), we impose a cultural will on time and arrest (or control, we might add) change through technological means, as Adam also notes.35 Such acts of time transcendence constitute gaps in the timeline and disrupt the natural and/or intended time span of things, whether living or dead, creating a dynamic between temporal gaps that allows objects to hibernate out of time and maintain material continuity in time.

3. Collections and Their Pasts: History in Science and Science in History

Now let us move from the acts of time transcendence to a discussion of what such acts render possible—how knowledge arises from removing objects from their historical contexts, preserving them, and then allowing them to relate to their pasts

35 See also Adam (2010, p. 96).
later in time. We may start with the almost trivial idea that history and collections are deeply connected. The moment an object is selected and inserted into a collection it becomes historical relative to its original context. This is the case both for objects traditionally belonging to cultural history and for natural historical or medical specimens. But while generating historical knowledge is par for the course when working with cultural historical collections, the historical component is much less overt in work with collections in natural history, bioscience, or biomedicine. Scientific collections are not viewed primarily as historical even when they trace histories of the Earth, evolutionary pasts, or the development of diseases over time. The historical character of much knowledge deriving from such collections comes to the light, however, when we adopt a broad notion of collection-based history as establishing developments over time through comparisons of collected material, and when we compare scientific and medical collections to cultural historical ones. Cryobiology makes it possible, as Landecker points out, for two points of a lineage to cross for a side-by-side comparison. But as we shall see, these are not just timeless scientific comparisons, but also historical comparisons that actively use the passage of time between the collection and analysis.

The relation of collected objects to their pasts changes over the course of the history of collections, and we can start with a brief overview of three historical periods: the early modern era, the 19th century, and the late-20th and 21st centuries. In early modern museums of natural history, collections gathered materials from a natural world that had expanded with the discoveries in the New World. The Italian Renaissance collections of natural history did not, however, just collect many new objects. They blurred—as Paula Findlen showed in her Possessing Nature—the boundary between ancient textual knowledge and the novel discoveries. Novel objects were thus placed in the context of classical texts that defined learning, and by relating words and things these collections merged present and past. Moving on to the second period in the 19th century, ancient learning lost its centrality and museums became essential infrastructures of knowledge. Their collections defined disciplines and they materially mapped and categorized the cultural and natural worlds. As the century drew to a close, many collections did not just map disciplines, they also displayed historical developments as a way of understanding the world. The focus of the collections was, however, to point to the present rather than the past. Many museum collections presented history as a purposeful path leading to the pinnacle of the then-current state of knowledge. A powerful example is the Pitt Rivers Museum, where technological developments in cultures around the world were presented as steps leading towards Victorian civilization. In this way, collections were enlisted to provide teleological histories evidencing the superiority of the present state of knowledge and culture. In the most recent period starting in the second half of the 20th century,

36 Landecker (2010).
37 Findlen (1994).
38 Pearce (1992); Gosden & Larsson (2007).
century, museums gradually lost their privileged position in research. Disciplines originally based on physical collections, such as anthropology and archaeology, moved to university departments and developed separately from collections. And researchers began to criticize the monolithic histories of progress told by museums in the 19th and early 20th centuries emphasizing instead the multiplicity of histories surrounding collections. Eilean Hooper-Greenhill, for instance, imagines the “same” object being part of collections in museums of different ages (from the Medici Palace to the disciplinary museum) and argues that its meaning would be radically different within these diverse settings. Collections were thus seen as relating to multiple pasts—as well as multiple futures. Summing up, the ways that collection practices related to their pasts changed over history, from correspondence to ancient knowledge, to viewing history as directed towards a present, and to multiplying histories in both the past and the future.

Having very cursorily traced relations to the past in the history of collecting, we now dig further into the complex historical relations of particular objects in cultural and scientific collections. We take as our point of departure Susan Pearce’s seminal book, Museums, Objects and Collections, in which she conceptualizes the relation between collected objects and their pasts to “try to understand how it is that objects can operate both in the past and in the present” and “what the nature of that relationship is.” Drawing on the anthropologist Edmund Leach, Pearce distinguishes two types of relationships between an object and its historical context: It can work as a sign when it stands for the historical context of which it has been an integral part, and as a symbol when it is brought into association with something of which it is not an intrinsic part. This analysis she exemplifies with the changing roles of a sword from the Jacobite revolt in Scotland in 1745. The sword was an integral part of the battle in which it took part, and then gained multiple additional meanings in the aftermath as a symbol of the barbarity of the Scots, the romanticized highlanders, and Scotland’s national history. Moving to natural historical objects, we may, Pearce suggests, think of these in a parallel way. A stuffed magpie, for instance, is a sign relative to its natural habitat, while later, as a taxidermied specimen, it becomes a symbol relative to a taxonomic system or to the cultural connotation of the thieving magpie. The essence of the power of the objects is thus that, in terms of their material survival power, they can hold both an intrinsic or “real” relation to the past for which they are a sign (or primary source or sample), and also carry reinterpretations as history is told and/or classified. As we dig more into the roles played by objects in collections, the distinction between the “real” material relation and narrative “symbolic” relations blurs, however, as does the distinction between historical and scientific objects.

The natural history collections at the Smithsonian investigated by Adrian Van Allen in this volume present, for instance, a throng of complex relations. The

39 Tybjerg (2019); Alberti (2009).
42 Van Allen (2023).
butterfly specimens are, as per Pearce’s example, related in a real material way to their original natural habitat, and symbolically to the scientific taxonomies they embody. But they are also directly related to the stage in their life cycle when they were killed and symbolically to the generalized life cycle that is constructed in the museum by a series of individual insects—each arrested at a different stage—to show the development from larva through pupa to butterfly. The plot thickens, however, when we consider how specimens made by conservators, such as the butterfly specimens, are as much an intrinsic part of this context as of its natural habitat. This real relation is then followed by new relations to the life history of the conservator who produced the specimen, shaping it with their body as they used their thumb’s width to measure its placement, and, more broadly, by new relations to disciplinary histories. Last, the introduction of genetic methods of analysis unfolds yet more temporal relations. When DNA is extracted, amplified, mapped, and circulated to databases around the globe, it acts not just as a symbol, but as a “proxy” for the individual insect and species, and as an indicator for the state of the entire ecosystem of which it was part.43

New methods thus constitute additional ways of relating a history to the material object, and thereby add complexity to the division posed by Pearce, as they both analyse the real object as created in its original context and construct new knowledge and histories. Our closer analysis of scientific collections and the way objects are materially manipulated in the collections thus adds to the original contexts as well as to later symbolic histories. Historical relations include the state of the discipline, collection history, and the life histories of conservators, as well as phylogenetic trees, insect life cycles, and environmental history. The butterfly specimen connects points in time in different ways: as a sample, a specimen, and a source—as well as a sign or symbol.

We claim that it is often such combinations of historical and scientific approaches that promise new knowledge. An example is Boris Jardine and Joshua Nall’s article in this issue, which combines scientific and historical studies of scientific instruments. They describe how laboratory methods have been used to assess the performance of historical instruments, that is, to compare in an ostensibly timeless manner how well the past matches up to the present. Such studies were, however, often ignored by historians, who preferred contextual history and were concerned with the social networks that the instruments could be used to map rather than with their material constituents and precision.44 These are the disparate traditions that Jardine and Nall productively bridge by bringing together scientific, material measurements with contextual historical questions when they draw on laboratory analyses of the metal of instruments (their intrinsic properties) to establish networks of knowledge and craft, and to track how centres of instrument production changed over time.45

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43 Van Allen (2020).
44 For uses of collections as proxies for social networks, see Gosden & Larson (2007); Hallam (2017); Alberti (2005).
45 Jardine & Nall (2023).
From early science to present-day biology, objects from collections were related to their past to generate knowledge. They did so in a plurality of ways that do not lend themselves to neat divisions, but show that historical relations play a central part in the work with scientific collections. In fact, our comparative readings reveal a constant and complex interchange between historical and scientific uses of collections from the past: History and science, sources and samples, evidence and specimens, past and timeless scientific present are continuously combined as collections produce knowledge over time and about temporal developments.

4. Collections and Their Futures: Potentials of Intergenerational Lifetimes

So far, we have been discussing how acts of time transcendence extend the lifetimes of collected objects and bestow them with powers to speak from the past and to offer further epistemic potentials as new technologies and methods develop. We now want to consider how knowledge from collections may be projected into the future, as well as how futures require us to dig deeper into the past, and how collections travelling through time hold an uncertain potential for knowledge.

Scientific collections are often presented as being directed towards the future, as the “bank” metaphor also indicates with its promise of future interest on investments. Biobanks with human tissue samples focus, for instance, on novel discovery and benefits for “tomorrow’s health” in their self-presentations.46 Similarly, seedbanks freeze seeds with the intention of them growing in the future, and genetic sequences of plants and animals are gathered not just with the intention to preserve, but also to rewild.47 Likewise, cultural historical collections attempt to escape the mausoleum associated with museums and have, since the turn of the millennium, been looking increasingly towards the future with, for example, the Museum Association publishing a report in 2005 entitled Collections for the Future.48 In the report, the authors celebrate the multiple potentials of collections to give pleasure and evoke wonder; to enable a sense of place, identity, and belonging anchored to an understanding of the past; to give status to ideas, people, and communities; and to provide evidence and opportunities for research and learning; but their celebration is also accompanied by a challenge for museums to realize more of the potential of their collections. So the life of a museum object is not only defined by its history, but also emphatically so by its possible relations to the future; conservators work specifically to enable objects to live long enough to be available for future generations to enjoy, explore, and learn from them.49 With resting time, the multiple (some hitherto unknown) potentials of collections emerge as new methods develop and alternative endings arise.

46 Biobank UK (n.d.).
47 Chacko & Bangham (2023); Van Allen (2023).
49 As documented through conversations with conservators by Grünfeld (2022).
Older collections allow for comparisons across stretches of time, but what we have not yet emphasized so strongly is that the temporal span between the time of collecting and time of use creates not just epistemic potentials for the past, but also for the future. As argued in Karin Tybjerg’s contribution to this volume, memory and the past are essential to medical diagnosis and prognosis. As a doctor predicts how a disease in a particular patient will develop on the basis of taking an anamnesis—literally an opening of the memory—so do medical researchers draw on collections of specimens, samples, and cases from patients of the past to understand how diseases develop in general. The collections form an institutional memory for the profession and are necessary for extending medical knowledge into the future. Also, as medical science seeks to start treatment earlier and earlier or even prevent disease altogether, researchers need to investigate the early signs or risk indicators. For this purpose, old samples in biobanks become increasingly important, because only with old samples is it possible to correlate characteristics in the tissue to the further destiny—health or disease—of the person from whom the sample was taken. Old samples—some often collected for reasons that are now of more historical interest—thus enable doctors and researchers to prognosticate into the future. For that reason, the Danish PKU-biobank, with blood samples taken as part of a standard diagnostic test for a number of rare diseases covering more than 99.9% of newborns, is a highly valuable collection. The new national biobanks that emerged across the world early in the millennium were attempts to create future pasts. As is also noted by Tybjerg, moving into the future requires historical material—even when it is freshly collected history—but this reliance on the past is rarely noted within the biomedical sciences.

When we link temporal gaps between the time of storage and use with the epistemic potentials of collections, we suggest that the temporal gap itself changes the potential uses that such collections make possible in the future, introducing uncertainties and opportunities. Moving from short-term storage and preparation of lab animals, for example, to longer temporal spans entails a move from projected use into potentially unknown terrain. Think of how intergenerational long-term storage of blood samples, for example, led to new findings. As Radin describes: “a blood sample collected in 1959 was thawed a quarter century after it had been collected, to study a virus that no scientist knew existed when it was first frozen.” Yet over time, old samples can also turn into contentious residues of political inequalities and colonization. For example, as Margaret Lock shows in her discussion of the global circulation of “exotic” DNA obtained from blood samples from indigenous people, the meanings of these samples differ radically between those from whom the samples were procured and the scientists creating the cell lines. Thus, while the “immortalization” of collections of things such as blood samples holds a promise for future knowledge, at the same time it potentially reveals the political inequalities of

50 Tybjerg (2023).
51 Tybjerg (2015; 2022); Nordfalk & Ekstrøm (2019). PKU stands for Phenylketonuria, a metabolic disease with severe consequences, which is nonetheless manageable if it is discovered early.
crafting, using, and owning collections. In that way, the future of collections always holds a promise for more than the present can project.

Both the passage of time and the process of preservation not only change the status of collections, but also alter their futures. Even if collections lose their original utility in a scientific context, they may hold the potential for a broader exploration of the epistemic culture of science—the material and historical conditions within which the object was investigated. As Van Allen argues in her contribution to this issue, time is folded in the preparation of samples, entangling timelines of disciplinary histories with projected or imagined futures.54 Folded time here entails that new practices and technologies are integrated into historical techniques and preservation practices, so that these new modes of practice and analysis not only replace old ones, but instead are layered and encapsulated into specimens or objects pointing towards uncertain futures of not just our perceptions of the objects under scrutiny but their very materiality.55 In that sense, folding is also a reduction—a selective process of preservation that distinguishes between value and waste. Or as Caitlin DeSilvey argues: “Strategies to arrest decay always destroy some cultural traces, even as they preserve others.56 This is well known in the history of scientific instruments where repair and polish easily erase possible traces of historical use. Likewise, in the tracing of literal fold lines in an 18th-century court dress at the Victoria & Albert Museum, Titika Malkogeorgou also shows how embroidered fabric had been folded over in a way that did not represent the original makeup of the dress.57 Such errors can help us trace previous practices of conservation and historical perceptions of artefacts. However, errors can also entail loss, as Keck describes in his genealogy of collecting bird specimens: “While the boat became the main tool for the collection and transportation of bird specimens, it was also the first site of observation of their decay, and many specimens had to be replaced on the way because they had become unusable.”58 Collecting and ending often travel together.59 Not only do collections transcend time to create possibilities for the future, but they are made in time and tell stories of techniques, materials, and epistemic frameworks.

Although museum curators or biobanking managers might plan for a projected future of usage for our preserved objects, be they blood samples, an 18th-century dress or a butterfly, the potentiality of collected objects has a certain darkness to it. As Giorgio Agamben poetically notes, the colour of potentiality may be darkness marked by an uncertain gap between the possible and the actual.60 The multiple actualization of object potentialities can begin as the seemingly simple practice of picking objects up and moving them around and between hands a bit more in order to prompt new thinking—to engage their own abilities to speak to us, as Ken Arnold suggests.

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54 Van Allen (2023).
55 Van Allen (2020).
57 Malkogeorgou (2011).
58 See Keck (2023).
in his epilogue to this issue.\textsuperscript{61} When collections are reawakened and used, they do not always reach their purposed end, but might end their lives in radically different ways than anticipated at the time of collecting. As collections unfold there exists an element of surprise (and a risk of surmise).\textsuperscript{62} However, the material unfolding of objects over time also constitutes alternate possibilities such as DeSilvey describes in her discussion of how decay not only shows itself as erasure, but can also be seen as a generative process leading to the recovery of memory.\textsuperscript{63} As she notes, “Memory, in this sense, is based on chance and imagination as much as evidence and explanation; the forgetting brought on by decay allows for a different form of recollection.”\textsuperscript{64}

Bringing us beyond acts of remembrance and right to the borders of the epistemic potentialities of collections, Grünfeld, Bencard, and Whiteley in this issue rework the potential endings of collections through transdisciplinary collaborations with artists, conservators, and researchers to experiment with alternate afterlives of museum objects in a way that does not lead to loss but proliferation.\textsuperscript{65} Their experimentation is perhaps reminiscent of Kate Bowell’s suggestion for an artistic rebirth of museum objects by engaging artists to reimagine and reinvent them as something other than the usual museum gestures of categorizing and labelling.\textsuperscript{66} Yet Grünfeld, Bencard, and Whiteley’s experiments also become a coda to collections—seeking the end of collections not as purpose or pinnacle as in the 19th-century museums, but as literal endings. These endings multiply the potential of unloved, marginalized, or even deaccessioned objects at the fringes of collections through a creative reimagining and multiplication of their ends, thus addressing the post-industrial problems of proliferation and disposal present in museums all over the world today.\textsuperscript{67}

When collections travel through time, it is through attempts to keep them in stable states or acts of time transcendence that it is made possible for them to reappear at a later point in time. However, as collections travel through time, their potentials and possible futures are radically transformed. Consequently, the potentialities of collections are not stable assets that we can realize as we please. While collections are stabilized through careful preservation practices, their potentialities are dynamic and changeable. We can try to realize their potentialities, yet there is always more—an open-ended promise of a future that may never come.

\textsuperscript{61} Arnold (2023).
\textsuperscript{62} As Gilles Deleuze (1993, p. 6), for example, argues in his discussion of “the fold” in Leibniz’s work, unfolding is not the opposite of folding, because unfolding entails dissemination, growth, and multiplication.
\textsuperscript{63} DeSilvey (2006, p. 323).
\textsuperscript{64} DeSilvey (2006, p. 328). See also DeSilvey (2017), for more on this.
\textsuperscript{65} See Grünfeld, Bencard, & Whiteley (2023).
\textsuperscript{66} Bowell (2018, p. 157).
\textsuperscript{67} For more on the fringes of collections and their objects, see Grünfeld & DeSilvey (2022). For more on the issues of proliferation and disposal at museums, see Morgan & Macdonald (2018).
5. Conclusion: Towards a Pluralist Epistemology of Collections

As the temporal asynchrony between the time of collecting and time of use increases, unknown knowledge potentials multiply. Acts of time transcendence, such as the preservation and storage that we have explored in this paper, can overcome the threat of non-existence through a temporal reorganization that stretches the life span of collected objects. This temporal reorganization provides a unique avenue into the past, constituting the possibility of gaining historical knowledge of many different kinds. But collections might also be riddled with past power structures, conservation practices, and errors. And when collections are reawakened, there is always the risk of loss. Destructive sampling or artistic tampering, however, also create new openings and potentials for knowledge—practices that create new objects (data sets or works of art) worth storing, while their material origin dissolves leading to the dilemmas that particularly face museum collections today: when is the right time to allow destructive sampling of unique specimens?

This question brings us full circle back to the cholera bottle mentioned in the beginning and the as-yet-unknown potentials for knowledge it holds. It will be in danger of breaking if a hole is drilled in the glass of the bottle to extricate a sample, but the contents might unfold the timelines of an extinct type of cholera and yield insights into the spread of modern strains and thus interfere with their history if it can suggest new ways of curbing epidemics. We want, however, to emphasize that new scientific techniques should not be what makes museum collections relevant. While the application of new scientific methods may draw attention to collections and lead to front-page articles in prestigious journals, they also may prove a double-edged sword if they devalue existing ways of generating knowledge from collections. They might not just lead to the potential destruction of unique collected objects, such as the cholera bottle, but also sideline traditional historical approaches to museum collections.68 The multiple tracks of cultural and scientific histories offer the deepest knowledge.

By paying attention to the nexus between collections, knowledge, and time, we show how the knowledge potentials of collections are multifaceted and dynamic. Objects of collections may be the objects of knowledge themselves, or may be investigated as source material for their original contexts, be they bodies, craft cultures, natural habitats, the ecosystem, or the museum itself. This means that the objects in collections may be used in an array of epistemic roles that can also shift, so that a sample can become a historical source and vice versa—as in the case of the cholera bottle. The objects may be samples (such as blood samples), where a part stands for the whole in a scientific analysis; they may be specimens (such as a butterfly in a natural history collection); they may be used as sources of knowledge about the past or a remote culture (such as historic instruments or masks); or they may be instruments of scientific research (such as flies in a fly stock centre). There are overlaps between

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68 Endersby (2018) likewise explains that the structural techniques of biological taxonomy practice have often been sidelined by genetic methods in natural historical collections.
the investigation of an object and its contexts, and there are overlaps between investigating a sample, which is often seen as unconnected to temporal change, and a source, which indicates a historical dimension—samples may after all be investigated with a view to mapping temporal developments. In a similar way, whole collections can be seen as sources, as well as methods or instruments for categorizing, mapping, or tracing development. Such multiple modes of knowing call for a pluralist epistemology of collections. A pluralist epistemology that, contrary to recent scientism, appreciates and acknowledges how different ways of knowing—biological, medical, historical, anthropological, and even artistic research—can together actualize the amazing epistemic potentials of collections. As long as we cherish and care for collections, there is always a promise for new renderings of the past and an open-ended future.

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