Tiziana N. Beltrame
et Yaël Kreplak
Les réserves des musées
Écologies des collections
les presses du réel — Œuvres en sociétés
T03
T05
T09
T11
T13
T15
T17
A060
A050
A040
A030
A020

ENGLISH TRANSLATION "La vie en suspens: Risque et potentiel dans les collections génétiques duMuséum national d'histoire naturelle" Dans *Les réserves des musées*. Paris: Presses du Réel, pp: 287-302

Suspended Life
Risk and potential in the genetic collections of the *Muséum national d'histoire naturelle*

Adrian Van Allen

Introduction

Cryopreservation has given way to a new scientific ice age: The ability to freeze and bank biological material is today a pivotal technological practice in areas such as breeding animals for agriculture, rewilding projects, human medical applications, and the "planned hindsight" of making biological collections for future use.[1] However, it is also transforming museum collections in fundamental ways. New technologies, such as genomics, have begun to open museum specimen collections to new audiences, and in doing so an understanding of the use and function of natural history collections is changing. From being perceived as merely a record of life—drawers of dusty specimens relevant only to taxonomists and museum professionals—natural history collections are now being re-imagined as an untapped vault of bioinformation.[2] Within this context, ideas of risk and potential have been examined from various perspectives.[3] In this chapter I focus on practices of genetically sampling collections, specifically on the integration of biotechnology into the ever-expanding collections at the Muséum national d'histoire naturelle in Paris (MNHN). It is through studying the daily practices of museum scientists as they make and sample specimens that their regimes of value become apparent. Engaging with scientists as they make specimens and take genetic samples highlights how these objects become a form of *life on the edge*—existing between life and death, between the futures they threaten or alternately make possible.[4] In effect, the specimen itself becomes a field site for understanding how different concepts of risk and potential are woven into the process of creating and using museum collections.

[1] On cloning wildlife see (Holt, Pickard, et Prather 2004); on cloning animals for agriculture see (Franklin 2007); on museum collections as resources see (Van Allen 2019a).
[2] Bi et al. (2013); Kress (2014).
[3] Selections of this chapter has been published previously in Van Allen (2023), "Entangled Timelines: Crafting Types of Time Through Making Museum Specimens."
[4] Radin (2013); Van Allen (2019a).

As extinction rates increase, with an estimated 50% of all species potentially heading towards extinction by mid-century, the ethical imperative to preserve biodiversity before it vanishes has taken on multiple forms.[5] While nature conservation efforts have traditionally focused on stabilizing dwindling populations of endangered species and their habitats, citing the interdependence of ecosystems, projects have emerged in the last few decades that focus on preserving vanishing biodiversity through genetic collecting for an uncertain future. Natural history museums have also shifted to echo this perspective, moving from diorama-based exhibits as "windows on nature" to emphasizing biodiversity, networks of all living things, and the genome as a "library of life's code" that can be gathered and preserved in their collections.[6] As life is increasingly understood as a network of living things, systems, and processes—not just as biodiverse, but also as biocomplex—natural history collections have also been transformed into networks of increasing complexity, with vouchers (the reference specimen), tissue samples, and genomic data dispersed across museum departments as well as across the globe at different museums, research centers, zoos, botanical gardens and biorepositories. The larger cultural shift towards reducing life to the biological forms the condition of possibility for genomic collecting projects that concentrate the dwindling diversity of life into museum-based assemblages of voucher specimens, tissue samples and genetic data.

Remaking the Future with Biotechnology

Natural history museums—the Smithsonian National Museum of Natural History in Washington D.C., to the California Academy of Sciences in San Francisco, to the Muséum national d'histoire naturelle in Paris—have been the field sites for my ethnographic research for more than a decade. At these sites I have worked alongside scientists, curators, collection managers, and laboratory technicians to understand how specimens were, made, used, and circulated to different spaces within the museum—from the tables where they were crafted into specimens, to the rooms where tissue samples were stored in freezers, to the labs where those tissue samples were transformed into DNA and circulated to global genomic databanks of wildlife.

[5] IUCN Red List (2022).

[6] On museum dioramas as "windows on nature," see Wonders (1993); Étienne (2020). On life as a "library of code" see: Strasser (2012); Encyclopedia of Life (2014); Gall et al. (2017).

In these museums I have seen genetic collecting follow two paths–articulated by members of the museum community as either "*mining*" the historic collections for ancient DNA or "*extending*" the collections with new specimens and fresh tissue samples. I came to understand these different modes of perceiving collections, their potential, and use through my participation in the different activities behind the scenes at the museum. These included taking tissue samples and tracking their movements, in the interviews I conducted with museum staff, as well as in various reports about the continuing relevance of the museum's collections and the need for continued support for their maintenance. I witnessed how specimens preserved over a century ago are now being re-evaluated for use in projects such as mapping historical climate change, reorganizing branches of the tree of life, potentially resurrecting lost ecologies, tracking invasive species, and mapping the influx of disease vectors through birds and mammals in the name of national security. At the same time the collections are being extended into new kinds of museum objects—such as tissues samples, DNA extracts, and environmental samples to name but a few of the parts and pieces being extracted and preserved in freezers and liquid nitrogen tanks. As specimens are taken apart into these different kinds of objects—such as a stuffed bird skin, frozen tissue samples, extracted DNA in small plastic vials—they migrate to different spaces within the museum designed to contain them. At the MNHN, the bird skins are stored in wooden drawers, much as they have for centuries. The tissue samples are stored in rows of super cold freezers in the main workroom, along with the DNA extracts. However other genetic collections at the MNHN, such as the botany collections, are stored in entirely different ways. Flat pages of pressed plants are stacked in special metal cabinets, with genetic samples stored in separate spaces. Instead of a tissue sample frozen in a 2ml cryovial, as is collected for vertebrates, plant samples are stored in small plastic bags with silica beads to reduce moisture and then stored in super cold freezers or large stainless-steel vats of liquid nitrogen.

These specimens, and their various genetic samples, become embodiments of different types of risk. In the context of the museum, risk can be understood in several ways. There is the risk of exposure to pathogens carried by wild animals as scientists open carcasses and are exposed to blood and viscera, a risk mitigated by wearing latex gloves during the specimen preparation process. However, there is another form of risk that imbues these sessions between human and

non-human animals, between scientist and their specimen as they transform it into smaller parts and pieces such as a stuffed bird skin, a tissue sample frozen in a tube, or a box of cleaned bones. This other risk is one of a lost future, of increasing mass species extinction—potentially a full ecological collapse. As the scientists at MNHN held a dead bird in their hand, a stuffed skin of an extinct species, they held not only a piece of the past, as we shall see, but a bundle of *potentiality* in the form of a mass of feathers, bone, and beak. In other words, the perceived potential to *remake the future* is encapsulated in these collections of dead animal bodies and the genetic data they hold. Different futures are made possible through the tools and practices of genomics utilized in the museum context—for example, a slice of toepad from an extinct passenger pigeon in a museum drawer can be used to reconstruct its genome, and at least theoretically, then recreate this lost species and reintroduce it into future landscapes.[7]

The thread of *potentiality* can be seen in a closer examination of the uses of "nature" as both material and metaphor—a perception of living things as being inherently open to modification for as-yet-unknown uses, which in turn provides a driving moral force to preserve them before they go extinct. In considering the long history of potential as a concept and its instrumentalization in the power and politics of biomedicine, Karen-Sue Taussig, Klaus Hoeyer and Stefan Helmreich define three forms of potential: (1) a hidden force that will manifest itself with or without intervention, (2) an inherent plasticity in something that has the capacity to transform, and (3) also a latent possibility open to human manipulation and direction to propel an object or subject into becoming something else.[8]

The slippages possible between these forms speaks to both the power and ambiguity of the concept of *potential* itself. A bird skin, as we shall see, can exist across all three forms: manifesting its inherent potential as it emerges from its eggshell, transformed from an embryo into a fledgling bird, and then the plasticity of the bird body as it is transformed from living animal into a scientific specimen, and finally the potential of that specimen to be used in new ways driven by new technology, such as a site for extracting genomic data.

In the Museum Collections: An Archive of Loss and Potential

[7] Revive and Restore (2022); Van Allen (2019b).
[8] Taussig, Hoeyer, et Helmreich (2013).

Walking through the cold winter rain in the Jardin des Plantes in January 2019, I followed one of the museum's curators of birds down a series of staircases, through creaking steels doors. We enter a space full of metal cabinets stacked closely together, each housing rows upon rows of taxidermy animals and study skins laid out in drawers. Built between 1979-1986, the zoothèque is a three-story underground vault built under the esplanade in front of the museum. It now contains most of the zoological collections of the Museum, a mere part of the museum's collection of 67 million specimens which include anthropological, zoological, botanical collections, earth sciences, and living collections. We pass by large brown bears crowded together, the head of a giraffe tucked in at the end, rows of parrots with dusty glass eyes [Figure 1]. I am reminded of the stuffed parrot in *A Simple Heart* by Flaubert, where the heroine sees in her dying moment the Holy Ghost of the Trinity appear to her not as a dove, but as her beloved pet parrot.[9] Here too, in the museum collections, there are emblems of salvation and redemption close at hand. Salvation not for our eternal souls, but perhaps instead for something more tangible from a scientific perspective—the salvation of a collective ecological future.

The bird curator and I arrive at our destination: a plain steel door behind which the treasured remains of extinct species are kept. An archive of loss, but also one of potential. Opening the door, we are met with locked metal cabinets painted a bright blue, almost a royal blue reminiscent of the decor at Versailles. Indeed, the origins of this specific museum collection date back to the *Cabinet du roi*, the King's personal collection of rarities and natural wonders.[10] In front of me now are some of the same objects that once adorned the *Cabinet du roi,* such as the narwhal tusks hanging from hooks on the wall, rhinoceros horns lined up on a shelf, and rows of brightly colored birds on carved wooden perches. It is still a cabinet of curiosities, but one re-imagined as a vault of untapped genetic resources in an era of biotechnology.

This underground vault of specimens is accessible only to those with a verified need to view the collections, such as visiting scientists and researchers, or on this occasion an anthropologist studying the scientists and their collections. The perceived value of the contents within this concrete bunker have shifted over time as new technologies emerge for using museum specimens for genetic studies. The genetic resource collections at the MNHN include samples

[9] Flaubert (2018).
[10] Laissus (1995, pp.16-31).

from specimens such as bits of bone, snips of feather or fur, an insect leg or abdomen, fragments of horn, remnants of dried blood or muscle, or pieces of plants dried and stored in silica gel and kept in -20C freezers.[11] Each of these seemingly insignificant remains can be a source for extracting DNA, a new wonder in miniature. The strands of protein sequences obtained from these historical specimens are short and fragmented, degraded by heat, moisture, light, and time itself. To assemble them into « long reads » (i.e., long strands of DNA that can, for example, be used to identify a specific species) requires a great deal of computational capacity, which was once itself a rare commodity. As biotechnology and data analysis become cheaper, easier, and faster, the value of museum specimens collected for centuries and housed in museums around the world becomes correspondingly valuable to ever-widening audiences.[12] Once valuable only to taxonomists building the branches in their complex tree of life, the museum collections are now valuable as potential genomic data for measuring historical disease vectors, invasive species, ecological decline, or even ecological reconstruction, to name but a few of the ever-expanding uses.

The bird curator unlocks a cabinet and pulls out one of the birds, setting it on a table next to a scalpel, labels, and a small plastic tube. He pulls on latex gloves and verifies the catalog number and species identification before carefully looking at its feet. He holds the bird out for me to see, smiling as he explains that he is searching for the best place to remove a small sliver of toepad. Carefully holding the small black and white bird in one hand, he holds his breath to keep the blade steady as he cuts off a slice of toepad the size of a grain of rice and places it in a plastic tube [Figure 2]. After he sets the bird back down, he takes a breath and relaxes his shoulders. The stressful moment of cutting into the precious object has passed. This specimen of the Seychelles magpie-robin (*Copsychus sechellarum*) is one of only a few of this endangered bird in collections around the world. The piece he has just cut will be frozen, ground into powder, the proteins separated out by various acids, replicated by polymerase chain reaction (PCR), and the resulting drop of milky DNA sequenced to compare against other samples from other birds in other museum collections. All this effort is focused on answering questions about how related species function within an ecosystem, and why they went almost went extinct. The ability to answer those questions is based on the availability of samples from the

[11] Muséum national d'histoire naturelle (2022a; 2022b).
[12] Bi et al. (2013).

precious few specimens in museums, as well as the skill of the researcher doing the genetic work, and the current state of the technologies they employ.

These specimens are a finite resource, the bird curator reiterates, as he places the bird back in the cabinet. There are a limited number of samples that can be taken from any individual or there would be no feet left—nothing to use in the future if new questions need to be answered. There is also the potential of future technology being able to use much smaller samples to yield greater results. The technology for mining the collections continues to develop at a rapid pace, fueled by the human biomedical sciences that trickle down into the natural sciences. The best use of the specimen, he points out, may be yet to come. As the curator in charge of the care of the collection, he must evaluate requests for tissue samples, judging their chance for success and the value of their contribution to the scientific discourse against the dwindling footpads of his bird specimens. It is his moral obligation, he tells me, to protect the collections for the future and make sure they are used in the best ways possible.

Much of the current scientific understanding of several recently extinct species—such as the Tasmanian tiger or Thylacine (*Thylacinus cynocephalus*), the Caribbean monk seal (*Neomonachus tropicalis*) and the passenger pigeon (*Ectopistes migratorius*), to name but a few—have directly resulted from genomic information extracted from museum collections.[13] From this perspective, museums are being recast as unparalleled—and largely untapped—resources for creating genetic collections of extinct species, part of large-scale genomic studies of animals and plants. However, it is vital to understand who is creating this sense of untapped potential, and the kinds of imagined futures that are part of those visions.

Yet the existing collecting are not the only genetic resource being mined in the museum. New specimens that are collected are also subject to genetic sampling as they are prepared. Indeed, earlier that month the bird curator and I had sampled liver from birds that were donated to the museum after they died by flying into windows. Though common, the hawk from which I took my sample was particularly useful [Figure 3]. As an apex predator who consumed other birds, it could provide clues into the heavy metal environmental contaminants. These tissue samples extended the collections into assemblages of specimens, tissue tubes, extracted DNA, and

[13] Miller et al. (2008); Bertrand (2017).

genetic data all taken from one animal or plant.

Frozen in freezers or stored in liquid nitrogen tanks, these tiny samples of once living things represent new kinds of both risk and potential. On the one hand they signify the risk of losing biodiversity, and the steps taken by scientists to understand and preserve the array of life before it disappears. On the other hand, the potential that was *imagined to exist* within these samples is articulated differently by different audiences. For example, conservation biologists may look to the collections for a proxy species to repopulate an ecological niche, while policy makers may want a number count of species to see if a geographic area qualifies for preservation status, while a genomicist may simply want as many samples as possible from a unique species to test a new genomic sequencing technology. Each audience brings their own hopes, fears, and expectations to bear on the collections.

On our way out of the zoothèque, the bird curator and I pause among the shelves of parrot specimens, pulling out large wood drawers to reveal their bright feathers. As he takes notes on specimens that were about to go out on loan to other museums around the world, I carefully explore the parrots for myself. I am curious about their origins and find many with tags indicating they were originally part of the menagerie in the Jardin Des Plantes, some dating back to the early 1800s. Once exotic animals living in captivity, they then migrated into the museum's scientific collections to begin their afterlife as a specimen. With the capacity of genetic sampling, their DNA could be extracted and replicated, kept frozen for future use, suspended in a state of « latent life ».[14] These dead birds, and particularly their data, may fly further in their afterlives than they did when alive. As Foucault has noted, power moves in multiple directions, disciplining life into forms that are allowed to live and those, in this age of cryopolitics, made to live and let die.[15] In the contemporary museum now equipped with the tools of biotechnology, it seems life and death now have increasingly circular, non-linear paths.

Balancing Between Future Potential and Future Risk

Thinking through natural history collections, both morphological (a stuffed bird skin in a cabinet) and molecular (a tissue tube in liquid nitrogen), as transformed *life* raises many questions as well as offering up opportunities for thinking through how, why, and by whom

[14] Radin (2013).
[15] Radin et Kowal (2017).

life is being archived and for what *kinds* of imagined futures.-Each specimen's "life history" can be seen as a collection of moments, important events as it is collected, prepared, accessioned, and sampled. These moments are markers not just in the "afterlife" of the specimen that begins after death, but form a constellation of specimens, clustered points in a timeline that define the specimen and the scientist. Formerly living things are made into different assemblages that combine biological materials (feathers and bones), concepts of nature (species, evolution, trees of life), skilled labor (forceps, pins, cotton thread), and regimes of value ("banking" precious biodiversity, global collecting networks). These assembled specimens circulate within the museum and beyond to other museums, institutions, and research sites, accumulating and negotiating these concepts of nature, value, time, and care as they move between domains and different modes of coming into being.

A bird skin is no longer just a bird skin, it is an archive of lost ecologies and the potential for resurrection and redemption. In the work rooms of the MNHN I witnessed staff preparing specimens with meticulous attention to detail, carefully crafting specimens as objects that would last for centuries. On the other hand, they also carefully sliced off a toepad, a small piece of heart, or some liver tissue to sample for DNA. Preservation and destruction both enacted in the name of future potential—the specimen preserved for future taxonomic work and partially destroyed for immediate genomic work. Layer upon layer these circular paths fold onto themselves in spirals of perceived future utility, always just beyond the horizon.

Reconsidering a specimen as an assemblage of people, places, materials and different concepts of time and potential brings a different museum into focus. From this perspective the collections spaces of the museum can be understood as assemblages themselves, hybrid spaces that fold together physical and digital spaces—with the bird skins in drawers, the tissue samples in freezers, and the genomic data in a global database. Potential in this context can be conceived as a revisiting of the past, tracing a path back to an object and re-envisioning how it may be revisited in the future. This can be seen as a historic specimen becomes relevant as its closet genetic kin go extinct, or a new technology suddenly rendering a whole category of specimens as new, untapped resources—for mining genomic data, for reconstructing viral paths, or even resurrecting lost ecologies.[16]

[16] Keck (2020); Van Allen (2022).

It is important to understand that this potential within the specimen as intimately defined by the visions and goals of the person who crafts it. The scientist or technician who prepares the specimen has specific individual, institutional, and cultural understandings of potential that in turn shape the imagined future uses of the specimen—defining what parts of a specimen are saved or discarded, deemed to be precious, or to be biowaste. Each of these pieces of the specimen then carry their own timeline, and their own set of possibilities or endings. In sum, a specimen it not simply a part of nature removed and stored within a museum collection. It is an on-going assemblage of the biomaterials of the living thing combined with the museum spaces, practices, and people—and it is these assemblages that compose the collections and determine their future potential.

References

Bertrand, Pauline. 2017. « Le Thylacine du Muséum-Aquarium de Nancy: Deux interventions pour la re-présentation de la taxidermie erronée d'un animal disparu. Un outil de sensibilisation à la conservation du vivant. » Dss., Avignon : Ecole Supérieure d'Art d'Avignon.

Bi, Ke, Tyler Linderoth, Dan Vanderpool, Jeffrey M. Good, Rasmus Nielsen, et Craig Moritz. 2013. « Unlocking the vault: Next-generation museum population genomics ». *Molecular Ecology* 22 (24) : 6018-32.

Encyclopedia of Life. 2014. « Encyclopedia of Life (EOL) ». 2014. http://eol.org/.

Étienne, Noémie. 2020. *Les dioramas de Franz Boas et d'Arthur C. Parker à New York en 1900*. Dijon : Les Presses du réel/Œuvres en société.

Flaubert, Gustave. 2018. *Un coeur simple*. Sanary-sur-Mer : Livio Editions.

Franklin, Sarah. 2007. *Dolly Mixtures: The Remaking of Genealogy*. Duke University Press.

Gall, Line, Frédéric Delsuc, Stéphane Hourdez, Guillaume Lecointre, et Jean-Yves Rasplus. 2017. « Toward the DNA library of life ». *European Journal of Taxonomy* 2017 (janvier).

Holt, William V., Amanda R. Pickard, et Randall S. Prather. 2004. « Wildlife conservation and reproductive cloning ». *Reproduction* 127 (3) : 317-24.

IUCN Red List. 2022. « IUCN Red List of Threatened Species ». Prepared by the IUCN Species Survival Commission. IUCN, The World Conservation Union. Consulté le 12 janvier 2022. https://www.iucnredlist.org/.

Keck, Frédéric. 2020. *Avian Reservoirs: Virus Hunters and Birdwatchers in Chinese Sentinel Posts*. Experimental Futures. Durham, NC : Duke University Press.

Kress, John. 2014. « Valuing collections ». *Science* 346 (6215) : 1310-1310.

Laissus, Yves. 1995. *Le Muséum national d'histoire naturelle*. Paris : Éditions Gallimard.

Miller, Webb, Daniela I Drautz, Jan E Janecka, Arthur M Lesk, Aakrosh Ratan, Lynn P Tomsho, Mike Packard, et al. 2008. « The mitochondrial genome sequence of the Tasmanian tiger (Thylacinus cynocephalus) ». *Genome Research* 19 (2) : 213-20.

Muséum national d'Histoire naturelle. 2022a. « Frozen vertebrates tissues & cells - Collections ». 2022. https://science.mnhn.fr/institution/mnhn/collection/tccv/item/search/form.

———. 2022b. « Plant tissues preserved for genetic studies ». Muséum national d'Histoire naturelle. 2022. https://www.mnhn.fr/en/plant-tissues-preserved-for-genetic-studies.

Radin, Joanna. 2013. « Latent life: Concepts and practices of human tissue preservation in the International Biological Program ». *Social Studies of Science* 43 (4) : 484-508.

Radin, Joanna, et Emma Kowal. 2017. *Cryopolitics: Frozen Life in a Melting World*. Cambridge, MA : MIT University Press.

Revive and Restore. 2022. « The Great Passenger Pigeon Comeback ». 2022. https://reviverestore.org/about-the-passenger-pigeon/.

Strasser, Bruno. 2012. « Data-driven sciences: From wonder cabinets to electronic databases ». *Studies in History and Philosophy of Science Part C: Studies in History and Philosophy of Biological and Biomedical Sciences* 43 (1) : 85-87.

Taussig, Karen-Sue, Klaus Hoeyer, et Stefan Helmreich. 2013. « The Anthropology of Potentiality in Biomedicine: An Introduction to Supplement 7 ». *Current Anthropology* 54 (S7) : S3-14.

Van Allen, Adrian. 2019a. « Folding Time: Practices of Preservation, Endangerment and Care in Making Bird Specimens ». In *Deterritorializing the Future: Heritage in, of and after the Anthropocene*. Sous la direction de Rodney Harrison et Colin Sterling, 129-54. Critical Climate Change. London : Open Humanities Press.

———. 2019b. « Resurrecting Ferrets and Remaking Ecosystems ». *Anthropology News*, Special Issue: *Animalia*, 60 (3) : 20-23.

———. 2022. « Entangled Timelines: Crafting Types of Time Through Making Museum Specimens ». *Centaurus: Journal of the European Society for the History of Science*, nº Special Issue: Collections, Knowledge and Time, edited by Karin Tyjberg and Martin Grünfeld.

Wonders, Karen. 1993. *Habitat Dioramas: Illusions of Wilderness in Museums of Natural History*. Uppsala : Almqvist and Wiksell International.