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Lei Niho Palaoa and Digital Tools to Safeguard Against the Illicit Use of Ancient DNA

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Introduction

The circumstances surrounding the acquisition, storage, and repatriation of potent relics by Western European nations through interactions with Polynesian royalty are both complex and controversial. For example, the acquisition of multiple artifacts following both King Kamehameha II (Liholiho) and Queen Kamāmalu's deaths resulting from contracting measles while visiting London in 1824 remain in question. Currently, Liholiho's cape remains on display in the Cambridge Museum of Archaeology and Anthropology (MAA). Whether the cape was associated with the body of the King (in life or death) or whether it was indeed brought to London as a diplomatic gift to coronate a meeting with George IV remains a mystery (Thomas 2016).

However, one of the lesser-known artifacts associated with this encounter, a lei niho palaoa (whale ivory necklace), is far more intriguing in 2020, not because it includes endangered whale ivory, but because the thick corded lei supporting the whale ivory pendant is composed of braided human hair collected from Hawaiian Kings. The lei on display at the Cambridge MAA is not just an artifact, but an ancestor.

These artifacts of encounter represent the colonial accumulation of not only valuable pieces of Polynesian history but the physical remains of our ancestors— our hair, genealogy, and DNA—and they are on display the world over (See Figure 1). Travel to the New York Metropolitan Museum of Arts' Oceanic Hall and you will find a lei niho palaoa on prominent display. Continue south from Manhattan on the 4 Train and you will find another lei niho palaloa on display in the Brooklyn Museum. Interested in owning one for your mantle? Want to spice up your bathroom with a little Indigenous radical design? Multiple lei niho palaoa have been auctioned off online for as low as $44,000 USD (Christies 2018).

Kānaka Maoli are not the only Polynesian culture that has chosen to adorn braided hair into lei's; there are countless pieces of our ancestors from Rarotonga and Tahiti that are being housed in museum collections around the world (Thomas 2016). However, in 2020, deriving DNA from ancient hair shafts is now a standard technique in the emergent field of paleogenomics, which is why as a Kanaka Maoli genome scientist I find myself in a particularly complicated conundrum (Wright *et al.* 2018).

The bone rush and the value of digital sequencing information

Paleogenomics, the extraction and investigation of DNA from ancient remains, both human and non-human, has emerged as a nascent field using a suite of methods to complement traditional archaeological methods, which upend previously held hypotheses and intensifies conversations around the evolving ethics of the Native American Graves Protection and Repatriation Act (NAGPRA) (Bardill *et al.* 2018). The field of paleogenomics is exploding with more ancient genomes sequenced in 2019 than in all of history (Fox and Hawks 2019). This has led to the exponential destruction of ancient human remains, many of whom are Indigenous ancestors (Claw *et al.* 2018). However, there is a finite amount of human remains on Planet Earth and with a sharp increase in the number of ancient DNA laboratories engineered to process and sequence ancient remains, a "bone rush" culture, motivated by the anxiety to publish in marquee journals, has emerged (Fox and Hawks 2019). But what happens when there are no more bones to mine for data?

We have transitioned from an economy in 2018 where oil was the number one global commodity to 2020 where data, including digital sequence

information (DSI), have emerged as the number one global commodity (Fox 2020). This shift is so new that experts are still evaluating what such information is worth in a global market. As investigators begin to aggregate and harmonize large-scale ancient genomics datasets in an effort to compare them to both archaic and modern human populations, questions around data access, privacy, and control arise. From the point of view of the Kānaka Maoli community, whose ancestors are being mined for DSI, several additional questions arise: Who does this benefit (Fox 2020; Hudson *et al.* 2020)? As well as, how did our ancestors end up in ice layered freezers and dust-filled steel drawers in the first place (Redman 2016)?

This unsustainable culture of science has gone on far too long and I am uncomfortable standing idly by and watching colonial enterprises and academics vandalize our ancestors in the name of making a publication in a marquee journal (Lewis-Kraus 2019). As careers are made, empires and academic legacies are built, and future generations of scientists are trained to prioritize a culture of science built from an anxiety of discovery, we need to reflect on the consequences of the current unsustainable trajectory of human ancient DNA research that is making its way to Hawai‘i (Fox and Hawks 2019; Kolodny 2012). Specifically, extracting and deriving digital sequence information from lei niho palaoa has high stakes and unintended consequences that could further disenfranchise the Kānaka Maoli community, our relationship to our kupuna, our connection to the deep past, our current identity as a community, and our access to resources in the future.

Figure 1. Will paleogenomics be used to further disenfranchise Indigenous peoples or empower them? According to the Hawaiian Homes Commission Act of 1920, the Office of Hawaiian Affairs (OHA) only allows access to Hawaiian Homestead land based on 50% Native Hawaiian blood quantum. Paleogenomics researchers studying Polynesia could extract DNA from hair follicles woven into lei niho palaoa, worn by Hawaiian chiefs as marks of their nobility. Yet if history is any guide, this action would likely be used by the government to establish a baseline for 100% Indigenous blood quantum. As a result, cultural artifacts such as the lei pictured above could be used to disenfranchise Kanaka ʻŌiwi and separate us from resources without our consent. We believe that DNA derived from our ancestors should be sequenced on our own accord, in an Indigenous ancient DNA laboratory within our own IndiGenomics Institute. DNA derived from this lei could be used to empower the Kanaka ʻŌiwi community in a way that could repatriate our history, and strengthen our Indigenous identity (Lei niho palaoa, Hawai‘i, Bishop Museum Ethnology Collection, Object 09267. Photograph by David Franzen, Bishop Museum Archives).

Blood quantum and the Hawaiian Homes Commission Act of 1920

These ancient locks of hair included in the lei niho palaoa contain DNA, and if that DNA is extracted and sequenced by genome scientists moving forward with industrial-scale paleogenomics sequencing projects (Fox and Hawks 2019), it could have profound effects on policy related to the determination of blood quantum in Hawai‘i, as well as Kānaka Maoli access to land and resources (Kauanui 2008; Lyte 2016; TallBear 2013). According to the Office of Hawaiian Affairs and the Hawaiian Homes Commission Act of 1920, lease successors on Hawaiian homestead land must be at least 1/4 Hawaiian in order to assume a lease (Kauanui 1999). Nearly 100 years later, a proposal at the state capitol is aiming to lower that requirement to 1/32 (McKeague 2019).

If 100 percent blood quantum is determined via ancient genome sequencing methods from artifacts housed in museums around the world (e.g., lei niho palaoa), this could potentially serve to disenfranchise the Kānaka Maoli community and dispossess our community from the fraction of land that has been allocated through the Hawaiian Homes Commission Act of 1920 (Kauanui 2008; Lyte 2016; TallBear 2013).

Making matters more complicated, human population geneticists have sequenced and analyzed the genomes of both ancient and contemporary Polynesian genomes, popularizing inaccurate interpretations of genome sequence data derived from Polynesian populations (Ioannidis *et al.* 2020). These inaccurate interpretations are often out of sync with archeological, linguistic, and local historical data, leading to an oversimplification of the voyaging achievements that took place during the Austronesian expansion (e.g. long-distance rafting). Slow boats, express trains, and metro networks aside (Bergström and Tyler-Smith 2018; Diamond 1988; Oppenheimer and Richards 2001), the real-life effects of moving forward with industrial-scale paleogenomics research projects in the name of establishing higher-resolution human migratory routes in the Pacific Ocean could have unforeseen consequences, including the continued oppression of Indigenous peoples in Polynesia and separation from our resources (Arvin 2019; Trask 1999).

Kānaka Maoli, Indigenous, and African American peoples are no strangers to the continued use of blood quantum as a method to “ethically” decide who deserves rights, privileges, protection, and access to land and resources (Hickman 1997; TallBear 2013). In the paleo-industrial genomic age, the Kānaka Maoli community should be involved as stakeholders in the debate over bidding on artifacts through Christie’s Auctions, including the lei niho palaoa (Christies 2018). What if angel investors were in direct dialog with the Kānaka Maoli community concerning strategies to prioritize financial support in auction houses like Christie’s to acquire important artifacts that would lead to repatriation? What if capital was aggregated via a collective (i.e., Kickstarter or GoFundMe) to mount successful bids for the lei niho palaoa that become available through Christie’s auctions in the future (Belleflamme *et al.* 2014)? What if resources were generated to develop automated digital auditing systems to safeguard against the illegal sale of human remains online (Swan 2015; Vigna and Casey 2019)?

Big data and safeguarding the exchange of human remains

The internet has made it easier than ever to communicate and exchange cash for human remains on a global scale (Seidemann *et al.* 2009). Additionally, the big data era of science has ushered in a suite of emerging technologies that simultaneously provide new challenges for the exchange of human remains as well as potential solutions to safeguard their access, exchange, and processing (Huffer *et al.* 2019). For example, Christie’s is not the only digital entity enabling the exchange of human remains to the highest bidder (Sotheby’s 2018). Look no further than e-commerce mainstays eBay (the online auction house) and Etsy (digital marketplace) for thriving digital ecosystems that are involved in cash exchanges for human remains including hair, skulls, and teeth (Seidemann *et al.* 2009). As of June 2018, Instagram has reached the one billion monthly active user mark, making buying and selling ancient remains online easier than ever (Huffer *et al.* 2019).

One recent study from Graham *et al.* (2020) showcased results from an experiment using computer vision and automated annotation of over 10,000 photographs from Instagram, and uncovered a massive network of buyers and sellers of human remains. Using Microsoft’s Azure cloud computing and machine learning services, Graham *et al.*

annotated and then visualized the co-occurrence of tags as a series of networks, uncovering an elaborate pattern of digital exchange of human remains including skulls, bones, hair and teeth, all of which contain DNA. This artificial intelligence (AI) driven digital surveillance approach may be useful for future large-scale investigations to uncover illegal networks of exchange, including the trade of human remains for cash beyond a single social media platform (Graham *et al.* 2020; Huffer and Graham 2017).

Another strategy that will utilize emerging big data technologies is the creation and utilization of digital human remains auditing lists, including ledger systems to create transparency and accountability around the processing of ancient remains in museum collections (Vigna and Casey 2019). Imagine a system where collections of ancient remains are weighed by the gram and accounted for in list formats through entire museum collections. These lists would be accompanied with time cross-section data, initial weight, weight after partial destruction and DNA extraction, and before and after CT scans, all of which would be publicly available via a ledger or auditing system (Kwan *et al.* 2000). The new system is important because it highlights an opportunity to create transparency around negative results (i.e. experiments that involve the partial destruction of human remains in an attempt to extract DNA when the experiment is not successful; Green *et al.* 2010).

Ledger or blockchain systems have already been used to create accountability as a mechanism for data protection in the field of medical record sharing (Azaria *et al.* 2016). Blockchain auditing systems have also been used to improve immigration reform, supply chain management, and in refugee camp settings to ensure equal access to provisions (De Filippi 2018; Kshetri and Voas 2018; Saberi *et al.* 2019). The paleogenomic accountability ledger or auditing system could have varying levels of access, transparency, and privacy all dependent on community consensus, involving a diverse board of stakeholders who represent the interests of investigating our deep past as a species. It is important to note that this ledger system could be applied to other collections of remains that are not of human origin, and it might even require proof-of-concept testing in a non-human collection before moving forward with human remains.

Conclusion

As wealthy collectors bid and win access to Kānaka Maoli remains online, our community is presented with a new set of problems. Given this new set of problems, the Kānaka Maoli community needs to prioritize strategies that utilize emerging technologies to safeguard against the trafficking of ancient Hawaiian remains. Native Hawaiian control of infrastructure (i.e. museum collections, biobanks, and digital sequencing information), emerging technologies such as artificial intelligence (e.g. machine learning and deep learning), auditing or ledger systems (e.g. blockchain), and genome technologies (e.g. sequencing and editing) represent an opportunity to take steps towards Native Hawaiian technological independence, Indigenous data sovereignty, and most importantly enable self-governance—directly impacting policy related to Native Hawaiian access to resources, including title to land and repatriation of our ancestors' remains.

In archaeology, "to dig is to destroy," and emerging technologies that bring new forms of destruction of human remains require updated ethical practices and the adoption of physical and digital tools to safeguard against the illicit exchange of human remains. These tools include detailed recordkeeping in destructive analysis and stronger enforcement of ethical policies. We must democratize emerging technologies that help us investigate our past, and engage Kānaka Maoli as equal stakeholders in decisions involving Hawaiian history, material culture, and modern or ancient DNA. Kānaka Maoli community members need to be included in the consensus-building and decision-making processes regarding ancient genomics projects that rely upon the extraction of ancient DNA from leis of human hair, fishhooks of human bone, or even soil that might contain our ancestors' DNA identified in museums and archaeological collections around the world (Slon *et al.* 2017; Stewart 2016).

Indigenous DNA should be used to empower the Kānaka Maoli community: repatriating our ancestors' remains and history, strengthening our identity today, and imagining a healthier future and relationship to the ʻĀina. The decisions that are made regarding our kupuna's DNA should prioritize the Kānaka Maoli community's potential to secure rights to not only colonially-obtained artifacts, but our ancestors that belong in our community, resting peacefully at home (Wright *et al.* 2018).

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